ADDENDUM

Public Building Commission of Chicago | Richard J. Daley Center | 50 West Washington Street, Room 200 | Chicago, Illinois 60602 | (312) 744-3090 | pbcchicago.com

ADDENDUM NO.: **01**

PROJECT NAME: **Kenwood Academy Link and Mechanical (Rebid)**

PROJECT NO.: **05326**

CONTRACT NO.: **C1602R**

DATE OF ISSUE: **February 23, 2024**

NOTICE OF CHANGES, MODIFICATIONS, OR CLARIFICATIONS TO CONTRACT DOCUMENTS

The following changes, modifications, or clarifications are hereby incorporated and made an integral part of the Contract Documents. Unless clearly expressed otherwise by this Addendum, all terms and conditions defined in the original Contract Documents shall continue in full force and effect and shall have the same meaning in this Addendum. Issued Addenda represent responses/clarifications to various inquiries. Contractors shall be responsible for including all associated labor/material costs in its bid. Drawings/specifications corresponding to inquiry responses will be issued with the Issue for Construction Documents, upon issuance of building permit.

ITEM NO. 1: **CHANGE TO KEY DATES**

None.

ITEM NO. 2: **REVISIONS TO BOOK 1 – PBC INSTRUCTIONS TO BIDDERS**

None.

ITEM NO. 3: **REVISIONS TO BOOK 2 – PBC STANDARD TERMS AND CONDITIONS**

None.

ITEM NO. 4: **REVISIONS TO BOOK 3 – TECHNICAL SPECIFICATIONS**

Change 1 **Book 3 – REVISED** – 00 01 02 Table of Contents, revised specification section numbering per revisions below

Change 2 **Book 3 – Volume 1 – REPLACED –** 22 07 19 (LNK) Plumbing Piping Insulation

Change 3 **Book 3 – Volume 1 – REPLACED –** 22 11 16 (LNK) Domestic Water Piping

Change 4 **Book 3 – Volume 1 – REPLACED –** 22 11 19 (LNK) Domestic Water Piping Specialties

Change 5 **Book 3 – Volume 1 – REPLACED –** 22 13 16 (LNK) Sanitary Waste & Vent and Storm Drainage Piping

Change 6 **Book 3 – Volume 1 – REPLACED –** 22 14 23 (LNK) Drainage Piping Specialties

Change 7 **Book 3 – Volume 1 – REPLACED –** 23 05 03 (LNK) General Provisions for HVAC Work

Change 8 **Book 3 – Volume 1 – REPLACED –** 23 05 05 (LNK) Basic HVAC Materials and Methods

Change 9 **Book 3 – Volume 1 – REPLACED –** 23 05 13 (LNK) Common Motor Requirements for HVAC Equipment

Change 10 **Book 3 – Volume 1 – REPLACED –** 23 05 19 (LNK) Meters and Gages for HVAC Piping

Change 11 **Book 3 – Volume 1 – REPLACED –** 23 05 23 (LNK) General-Duty Valves for HVAC Piping

Change 12 **Book 3 – Volume 1 – REPLACED –** 23 05 53 (LNK) Identification for HVAC Piping and Equipment

Change 13 **Book 3 – Volume 1 – REPLACED –** 23 05 93 (LNK) Testing, Adjusting, and Balancing for HVAC

Change 14 **Book 3 – Volume 1 – REPLACED –** 23 07 13 (LNK) Duct Insulation

Change 15 **Book 3 – Volume 1 – REPLACED –** 23 07 16 (LNK) HVAC Equipment Insulation

Change 16 **Book 3 – Volume 1 – REPLACED –** 23 07 19 (LNK) HVAC Piping Insulation

Change 17 **Book 3 – Volume 1 – REPLACED –** 23 09 21 (LNK) Building Automation System-Basic Materials, Interface Devices, And Sensors

Change 18 **Book 3 – Volume 1 – REPLACED –** 23 09 23 (LNK) Direct-Digital Control System for HVAC

Change 19 **Book 3 – Volume 1 – REPLACED –** 23 09 26 (LNK) Building Automation System-Sequence of Operation
Change 20 **Book 3 – Volume 1 – REPLACED –** 23 09 27 (LNK) Building Automation System-Commissioning
Change 21 **Book 3 – Volume 1 – REPLACED –** 23 21 13 (LNK) Hydronic Piping
Change 22 **Book 3 – Volume 1 – REPLACED –** 23 21 14 (LNK) Hydronic Specialties
Change 23 **Book 3 – Volume 1 – REPLACED –** 23 21 23 (LNK) Hydronic Pumps
Change 24 **Book 3 – Volume 1 – REPLACED –** 23 22 13 (LNK) Steam and Condensate Heating Piping
Change 25 **Book 3 – Volume 1 – REPLACED –** 23 22 14 (LNK) Steam and Condensate Heating Specialties
Change 26 **Book 3 – Volume 1 – REPLACED –** 23 25 00 (LNK) HVAC Water Treatment
Change 27 **Book 3 – Volume 1 – REPLACED –** 23 31 00 (LNK) HVAC Ducts and Casings
Change 28 **Book 3 – Volume 1 – REPLACED –** 23 33 00 (LNK) Air Duct Accessories
Change 29 **Book 3 – Volume 1 – REPLACED –** 23 34 23 (LNK) HVAC Power Ventilators
Change 30 **Book 3 – Volume 1 – REPLACED –** 23 36 00 (LNK) Air Terminal Units
Change 31 **Book 3 – Volume 1 – REPLACED –** 23 37 00 (LNK) Air Outlets and Inlets
Change 32 **Book 3 – Volume 1 – REPLACED –** 23 74 16.11 (LNK) Packaged Rooftop Unit (15 tons and less)
Change 33 **Book 3 – Volume 1 – REPLACED –** 23 82 00 (LNK) Convection Heating and Cooling Units
Change 34 **Book 3 – Volume 1 – REPLACED –** 26 05 05 (LNK) Selective Demolition for Electrical
Change 35 **Book 3 – Volume 1 – REPLACED –** 26 05 19 (LNK) Low-Voltage Electrical Power Conductors and Cables
Change 36 **Book 3 – Volume 1 – REPLACED –** 26 05 26 (LNK) Grounding and Bonding for Electrical Systems
Change 37 **Book 3 – Volume 1 – REPLACED –** 26 05 29 (LNK) Hangers and Supports for Electrical Systems
Change 38 **Book 3 – Volume 1 – REPLACED –** 26 05 33.13 (LNK) Conduit for Electrical Systems
Change 39 **Book 3 – Volume 1 – REPLACED –** 26 05 33.16 (LNK) Boxes for Electrical Systems
Change 40 **Book 3 – Volume 1 – REPLACED –** 26 05 33.23 (LNK) Surface Raceways for Electrical Systems
Change 41 **Book 3 – Volume 1 – REPLACED –** 26 05 53 (LNK) Identification for Electrical Systems
Change 42 **Book 3 – Volume 1 – REPLACED –** 26 05 73 (LNK) Power System Studies
Change 43 **Book 3 – Volume 1 – REPLACED –** 26 05 83 (LNK) Wiring Connections
Change 44 **Book 3 – Volume 1 – REPLACED –** 26 08 13 (LNK) Testing of Electrical Systems
Change 45 **Book 3 – Volume 1 – REPLACED –** 26 09 23 (LNK) Lighting Control Devices
Change 46 **Book 3 – Volume 1 – REPLACED –** 26 09 36 (LNK) Modular Dimming Controls
Change 47 **Book 3 – Volume 1 – REPLACED –** 26 09 43 (LNK) Lighting Controls
Change 48 **Book 3 – Volume 1 – REPLACED –** 26 21 00 (LNK) Low-Voltage Electrical Service Entrance
Change 49 **Book 3 – Volume 1 – REPLACED –** 26 22 00 (LNK) Low-Voltage Transformers
Change 50 **Book 3 – Volume 1 – REPLACED –** 26 24 13 (LNK) Switchboards
Change 51 **Book 3 – Volume 1 – REPLACED –** 26 24 16 (LNK) Panelboards
Change 52 **Book 3 – Volume 1 – REPLACED –** 26 27 26 (LNK) Wiring Devices
Change 53 **Book 3 – Volume 1 – REPLACED –** 26 28 13 (LNK) Fuses
Change 54 **Book 3 – Volume 1 – REPLACED –** 26 28 16.13 (LNK) Enclosed Circuit Breakers
Change 55 **Book 3 – Volume 1 – REPLACED –** 26 28 16.16 (LNK) Enclosed Switches
Change 56 **Book 3 – Volume 1 – REPLACED –** 26 29 13 (LNK) Enclosed Controllers
Change 57 **Book 3 – Volume 1 – REPLACED –** 26 29 23 (LNK) Variable-Frequency Motor Controllers
Change 58 **Book 3 – Volume 1 – REPLACED –** 26 43 00 (LNK) Surge Protective Devices
Change 59 **Book 3 – Volume 1 – REPLACED –** 26 51 00 (LNK) Interior Lighting
Change 60 **Book 3 – Volume 1 – REPLACED –** 26 56 00 (LNK) Exterior Lighting
Change 61 **Book 3 – Volume 2 – REPLACED –** 27 05 03 (LNK) Communications General Requirements
Change 62 **Book 3 – Volume 2 – REPLACED –** 27 05 53 (LNK) Identification for Communication Systems
Change 63 **Book 3 – Volume 2 – REPLACED –** 27 05 53.01 (LNK) Identification for Communication Systems Labeling Guidelines

Change 64 **Book 3 – Volume 2 – REPLACED –** 27 08 00 (LNK) Commissioning of Communications
Change 65 **Book 3 – Volume 2 – REPLACED –** 27 13 13 (LNK) Communications Copper Backbone Cabling
Change 66 **Book 3 – Volume 2 – REPLACED –** 27 13 23 (LNK) Communications Optical Fiber Backbone Cabling
Change 67 **Book 3 – Volume 2 – REPLACED –** 27 15 00 (LNK) Data Communications Horizontal Cabling
Change 68 **Book 3 – Volume 2 – REPLACED –** 27 53 15 (LNK) Intercom & Master Clock and Program Equipment Interface
Change 69 **Book 3 – Volume 2 – REPLACED –** 28 23 07 (LNK) DVS System - Existing School
Change 70 **Book 3 – Volume 2 – REPLACED –** 33 51 13 (LNK) Natural Gas Piping
Change 71 **Book 3 – Volume 1 – REPLACED –** 22 11 16 (MEP) Domestic Water Piping
Change 72 **Book 3 – Volume 1 – REPLACED –** 22 11 19 (MEP) Domestic Water Piping Specialties
Change 73 **Book 3 – Volume 1 – REPLACED –** 22 13 16 (MEP) Sanitary Waste & Vent and Storm Drainage Piping
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Change 87 **Book 3 – Volume 1 – REPLACED –** 23 22 13 (MEP) Steam and Condensate Heating Piping
Change 88 **Book 3 – Volume 1 – ADDED –** 23 23 00 (MEP) Refrigerant Piping
Change 89 **Book 3 – Volume 1 – REPLACED –** 23 31 00 (MEP) HVAC Ducts and Casings
Change 90 **Book 3 – Volume 1 – REPLACED –** 23 33 00 (MEP) Air Duct Accessories
Change 91 **Book 3 – Volume 1 – REPLACED –** 23 34 23 (MEP) HVAC Power Ventilators
Change 92 **Book 3 – Volume 1 – REPLACED –** 23 37 00 (MEP) Air Outlets and Inlets
Change 93 **Book 3 – Volume 1 – REPLACED –** 23 62 00 (MEP) Packaged Compressor Condenser Units
Change 94 **Book 3 – Volume 1 – REPLACED –** 23 82 00 (MEP) Convection Heating and Cooling Units
Change 95 **Book 3 – Volume 1 – REPLACED –** 23 84 17 (MEP) Natatorium Dehumidification Units
Change 96 **Book 3 – Volume 1 – REPLACED –** 26 05 05 (MEP) Selective Demolition for Electrical
Change 97 **Book 3 – Volume 1 – REPLACED –** 26 05 19 (MEP) Low-Voltage Electrical Power Conductors and Cables
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Change 99 **Book 3 – Volume 1 – REPLACED –** 26 05 29 (MEP) Hangers and Supports for Electrical Systems
Change 100 **Book 3 – Volume 1 – REPLACED –** 26 05 33.13 (MEP) Conduit for Electrical Systems
Change 101 **Book 3 – Volume 1 – REPLACED –** 26 05 33.16 (MEP) Boxes for Electrical Systems
Change 102 **Book 3 – Volume 1 – REPLACED –** 26 05 33.23 (MEP) Surface Raceways for Electrical Systems
Change 103 **Book 3 – Volume 1 – REPLACED –** 26 05 53 (MEP) Identification for Electrical Systems

Change 104 **Book 3 – Volume 1** – **REPLACED –** 26 05 83 (MEP) Wiring Connections
Change 105 **Book 3 – Volume 1** – **REPLACED –** 26 08 13 (MEP) Testing of Electrical Systems
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Change 107 **Book 3 – Volume 1** – **REPLACED –** 26 09 36 (MEP) Modular Dimming Controls
Change 108 **Book 3 – Volume 1** – **REPLACED –** 26 09 43 (MEP) Lighting Controls
Change 109 **Book 3 – Volume 1** – **REPLACED –** 26 24 16 (MEP) Panelboards
Change 110 **Book 3 – Volume 1** – **REPLACED –** 26 27 26 (MEP) Wiring Devices
Change 111 **Book 3 – Volume 1** – **REPLACED –** 26 28 13 (MEP) Fuses
Change 112 **Book 3 – Volume 1** – **REPLACED –** 26 28 16.13 (MEP) Enclosed Circuit Breakers
Change 113 **Book 3 – Volume 1** – **REPLACED –** 26 28 16.16 (MEP) Enclosed Switches
Change 114 **Book 3 – Volume 1** – **REPLACED –** 26 29 13 (MEP) Enclosed Controllers
Change 115 **Book 3 – Volume 1** – **REPLACED –** 26 29 23 (MEP) Variable-Frequency Motor Controllers
Change 116 **Book 3 – Volume 1** – **REPLACED –** 26 43 00 (MEP) Surge Protective Devices
Change 117 **Book 3 – Volume 1** – **REPLACED –** 26 51 00 (MEP) Interior Lighting
Change 118 **Book 3 – Volume 1** – **REPLACED –** 33 51 13 (MEP) Natural Gas Piping

ITEM NO. 5: REVISIONS TO DRAWINGS

Change 1 Drawing G000 - PBC COVER SHEET **REVISED**
Change 2 Drawing G002 – INDEX, GENERAL NOTES, ABBR. & LEGENDS **REVISED** with updated MEP sheet numbers and added sheets
Change 3 Drawing D201-DEMO ELEVATION CANTER SOUTH **REVISED** to add additional notations
Change 4 Drawing A011-SITE PLAN **REVISED** to add additional notations
Change 5 Drawing A107-EXISTING ROOF PLAN **REVISED** to add additional notations for the roof hatch
Change 6 Drawing A110-ENLARGED PARTIAL PLAN **REVISED** to revise size of the walk off mat
Change 7 Drawing A202-MEP FIRST FLOOR PLANS, ELEVATIONS, RCPs **REVISED** to add additional notations to Corridor C108
Change 8 **ADDED** Drawing E000-LNK ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS
Change 9 **ADDED** Drawing M300-MEP BAS GENERAL SYMBOLS
Change 10 **ADDED** Drawing P000-MEP PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS
Change 11 Drawing E000 **RENAMED** to E000-MEP ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS
Change 12 Drawing E001 **RENAMED** to E001-LNK ONE-LINE RISER DIAGRAM AND NOTES
Change 13 Drawing E002 **RENAMED** to E001-MEP ONE-LINE RISER DIAGRAM AND NOTES
Change 14 Drawing E003 **RENAMED** to E002-LNK ELECTRICAL DETAILS
Change 15 Drawing E004 **RENAMED** to E002-MEP ELECTRICAL DETAILS
Change 16 Drawing E010 **RENAMED** to E010-LNK DEMOLITION/REMOVAL SITE PLAN
Change 17 Drawing E011 **RENAMED** to E011-LNK ELECTRICAL SITE PLAN
Change 18 Drawing E012 **RENAMED** to E010-MEP ELECTRICAL SITE PLAN
Change 19 Drawing E100 **RENAMED** to E100-LNK FIRST FLOOR LINK DEMOLITION/REMOVAL PLAN – KENWOOD (BUILDING C) AND CANTER
Change 20 Drawing E101 **RENAMED** to E101-MEP ELECTRICAL FIRST FLOOR PLANS - KENWOOD (BUILDING C)
Change 21 Drawing E102 **RENAMED** to E102-LNK SECOND FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD Drawing (BUILDING C) AND CANTER
Change 22 Drawing E103 **RENAMED** to E103-MEP ELECTRICAL PENTHOUSE PLAN - KENWOOD (BUILDING C)
Change 23 Drawing E105 **RENAMED** to E105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER
Change 24 Drawing E106 **RENAMED** to E106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER
Change 25 Drawing E107 **RENAMED** to E107-LNK PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C)
Change 26 Drawing M000 **RENAMED** to M000-LNK MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS
Change 27 Drawing M001 **RENAMED** to M001-LNK MECHANICAL SCHEDULES

Change 28 Drawing M002 **RENAMED** to M000-MEP MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS

Change 29 Drawing M101 **RENAMED** to M101-MEP MECHANICAL FIRST FLOOR PLANS - KENWOOD (BUILDING C)

Change 30 Drawing M103 **RENAMED** to M103-MEP MECHANICAL PENTHOUSE PLANS - KENWOOD (BUILDING C)

Change 31 Drawing M104 **RENAMED** to M104-MEP MECHANICAL ROOF PLAN - KENWOOD (BUILDING C)

Change 32 Drawing M105 **RENAMED** to M105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Change 33 Drawing M106 **RENAMED** to M106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Change 34 Drawing M107 **RENAMED** to M107-LNK PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C)

Change 35 Drawing M200 **RENAMED** to M200-LNK MECHANICAL DETAILS

Change 36 Drawing M201 **RENAMED** to M200-MEP MECHANICAL SCHEDULES AND DETAILS

Change 37 Drawing M300 **RENAMED** to M300-LNK BAS GENERAL SYMBOLS

Change 38 Drawing M301 **RENAMED** to M301-LNK BAS CONTROL DIAGRAM

Change 39 Drawing M302 **RENAMED** to M302-LNK BAS CONTROL DIAGRAM

Change 40 Drawing M303 **RENAMED** to M301-MEP BAS CONTROL DIAGRAM

Change 41 Drawing M401 **RENAMED** to M401-MEP 1ST FLOOR LEGACY PLAN

Change 42 Drawing M402 **RENAMED** to M402-MEP 2ND FLOOR LEGACY PLAN

Change 43 Drawing M403 **RENAMED** to M403-MEP 3RD FLOOR LEGACY PLAN

Change 44 Drawing P000 **RENAMED** to P000-LNK PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS

Change 45 Drawing P101 **RENAMED** to P101-MEP PLUMBING FIRST FLOOR PLANS - KENWOOD (BUILDING C)

Change 46 Drawing P103 **RENAMED** to P103-MEP PLUMBING PENTHOUSE PLAN - KENWOOD (BUILDING C)

Change 47 Drawing P105 **RENAMED** to P105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Change 48 Drawing P105A **RENAMED** to P105A-LNK PLUMBING SITE PLAN

Change 49 Drawing P106 **RENAMED** to P106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, AND PENTHOUSE PLAN - (BUILDING C)

ITEM NO. 6: REQUESTS FOR INFORMATION

RFI-1. **Please provide a light fixture schedule for the Link project.**

Question: Please refer to Sheet E000-LNK included in this Addendum. Light Fixture Schedule has been added on Sheet E000- LNK.

RFI-2.

Question: **Are the surface mounted Flagpole and engraved stone "Kenwood Public School" sign on the southside of Canter building above Door 5 going to be salvaged? Please advise.**

Response: Existing surface mounted flagpole is to be salvaged and retained for future use. Please refer to Sheet D201 revised and included in this addendum. Existing stone "Kenwood Public School" signage is to be removed and retained for future use by owner as noted in the Contract Documents.

RFI-3.

Question: **Please advise if any trees in the Central Park Lot will be impacted from the construction link..**

Response: Please refer to Sheet C-102 for trees marked as to be removed.

RFI-4.

Question: **Please identify Roof Hatch on drawing M104 (at NE before the corner).**

Response: Please refer to Sheet M104 revised and included in this addendum.

This Addendum includes the following attached Specifications and/or Documents:

1. Specification Section 00 01 02 Table of Contents, date 02/23/2024
2. Specification Section 22 07 19 (LNK) Plumbing Piping Insulation, dated 02/23/2024.
3. Specification Section 22 11 16 (LNK) Domestic Water Piping, dated 02/23/2024.
4. Specification Section 22 11 19 (LNK) Domestic Water Piping Specialties, dated 02/23/2024.
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74. Specification Section 22 14 23 (MEP) Drainage Piping Specialties, dated 02/23/2024.
75. Specification Section 23 05 03 (MEP) General Provisions for HVAC Work, dated 02/23/2024.
76. Specification Section 23 05 05 (MEP) Basic HVAC Materials and Methods, dated 02/23/2024.
77. Specification Section 23 05 13 (MEP) Common Motor Requirements for HVAC Equipment, dated 02/23/2024.
78. Specification Section 23 05 53 (MEP) Identification for HVAC Piping and Equipment, dated 02/23/2024.
79. Specification Section 23 05 93 (MEP) Testing, Adjusting, and Balancing for HVAC, dated 02/23/2024.
80. Specification Section 23 07 13 (MEP) Duct Insulation, dated 02/23/2024.
81. Specification Section 23 07 19 (MEP) HVAC Piping Insulation, dated 02/23/2024.
82. Specification Section 23 09 21 (MEP) Building Automation System-Basic Materials, Interface Devices, And Sensors, dated 02/23/2024.
83. Specification Section 23 09 23 (MEP) Direct-Digital Control System for HVAC, dated 02/23/2024.
84. Specification Section 23 09 26 (MEP) Building Automation System-Sequence of Operation, dated 02/23/2024.
85. Specification Section 23 09 27 (MEP) Building Automation System-Commissioning, dated 02/23/2024.
86. Specification Section 23 21 13 (MEP) Hydronic Piping, dated 02/23/2024.
87. Specification Section 23 22 13 (MEP) Steam and Condensate Heating Piping, dated 02/23/2024.
88. Specification Section 23 23 00 (MEP) Refrigerant Piping, dated 02/23/2024.
89. Specification Section 23 31 00 (MEP) HVAC Ducts and Casings, dated 02/23/2024.
90. Specification Section 23 33 00 (MEP) Air Duct Accessories, dated 02/23/2024.
91. Specification Section 23 34 23 (MEP) HVAC Power Ventilators, dated 02/23/2024.
92. Specification Section 23 37 00 (MEP) Air Outlets and Inlets, dated 02/23/2024.
93. Specification Section 23 62 00 (MEP) Packaged Compressor Condenser Units, dated 02/23/2024.
94. Specification Section 23 82 00 (MEP) Convection Heating and Cooling Units, dated 02/23/2024.
95. Specification Section 23 84 17 (MEP) Natatorium Dehumidification Units, dated 02/23/2024.
96. Specification Section 26 05 05 (MEP) Selective Demolition for Electrical, dated 02/23/2024.
97. Specification Section 26 05 19 (MEP) Low-Voltage Electrical Power Conductors and Cables, dated 02/23/2024.
98. Specification Section 26 05 26 (MEP) Grounding and Bonding for Electrical Systems, dated 02/23/2024.
99. Specification Section 26 05 29 (MEP) Hangers and Supports for Electrical Systems, dated 02/23/2024.
100. Specification Section 26 05 33.13 (MEP) Conduit for Electrical Systems, dated 02/23/2024.
101. Specification Section 26 05 33.16 (MEP) Boxes for Electrical Systems, dated 02/23/2024.
102. Specification Section 26 05 33.23 (MEP) Surface Raceways for Electrical Systems, dated 02/23/2024.
103. Specification Section 26 05 53 (MEP) Identification for Electrical Systems, dated 02/23/2024.
104. Specification Section 26 05 83 (MEP) Wiring Connections, dated 02/23/2024.
105. Specification Section 26 08 13 (MEP) Testing of Electrical Systems, dated 02/23/2024.

106. Specification Section 26 09 23 (MEP) Lighting Control Devices, dated 02/23/2024.
107. Specification Section 26 09 36 (MEP) Modular Dimming Controls, dated 02/23/2024.
108. Specification Section 26 09 43 (MEP) Lighting Controls, dated 02/23/2024.
109. Specification Section 26 24 16 (MEP) Panelboards, dated 02/23/2024.
110. Specification Section 26 27 26 (MEP) Wiring Devices, dated 02/23/2024.
111. Specification Section 26 28 13 (MEP) Fuses, dated 02/23/2024.
112. Specification Section 26 28 16.13 (MEP) Enclosed Circuit Breakers, dated 02/23/2024.
113. Specification Section 26 28 16.16 (MEP) Enclosed Switches, dated 02/23/2024.
114. Specification Section 26 29 13 (MEP) Enclosed Controllers, dated 02/23/2024.
115. Specification Section 26 29 23 (MEP) Variable-Frequency Motor Controllers, dated 02/23/2024.
116. Specification Section 26 43 00 (MEP) Surge Protective Devices, dated 02/23/2024.
117. Specification Section 26 51 00 (MEP) Interior Lighting, dated 02/23/2024.
118. Specification Section 33 51 13 (MEP) Natural Gas Piping, dated 02/23/2024.

This Addendum includes the following attached Drawings:

1. G000 - PBC COVER SHEET, dated 02/23/2024
2. G002 – INDEX, GENERAL NOTES, ABBR. & LEGENDS, dated 02/23/2024
3. D201-DEMO ELEVATION CANTER SOUTH, dated 02/23/2024
4. A011-SITE PLAN, dated 02/23/2024
5. A107-EXISTING ROOF PLAN, dated 02/23/2024
6. A110-ENLARGED PARTIAL PLAN – FIRST FLOOR, dated 02/23/2024
7. A202-MEP FIRST FLOOR PLANS, ELEVATIONS, RCPs, dated 02/23/2024
8. M000-LNK MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
9. M000-MEP MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
10. M001-LNK MECHANICAL SCHEDULES, dated 02/23/2024.
11. M101-MEP MECHANICAL FIRST FLOOR PLANS - KENWOOD (BUILDING C), dated 02/23/2024.
12. M103-MEP MECHANICAL PENTHOUSE PLANS - KENWOOD (BUILDING C), dated 02/23/2024.
13. M104-MEP MECHANICAL ROOF PLAN - KENWOOD (BUILDING C), dated 02/23/2024.
14. M105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
15. M106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
16. M107-LNK PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C), dated 02/23/2024.
17. M200-LNK MECHANICAL DETAILS, dated 02/23/2024.
18. M200-MEP MECHANICAL SCHEDULES AND DETAILS, dated 02/23/2024.
19. M300-MEP BAS GENERAL SYMBOLS, dated 02/23/2024.
20. M300-LNK BAS GENERAL SYMBOLS, dated 02/23/2024.
21. M301-LNK BAS CONTROL DIAGRAM, dated 02/23/2024.
22. M301-MEP BAS CONTROL DIAGRAM, dated 02/23/2024.
23. M302-LNK BAS CONTROL DIAGRAM, dated 02/23/2024.
24. M401-MEP 1ST FLOOR LEGACY PLAN, dated 02/23/2024.
25. M402-MEP 2ND FLOOR LEGACY PLAN, dated 02/23/2024.
26. M403-MEP 3RD FLOOR LEGACY PLAN, dated 02/23/2024.
27. E000-LNK ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
28. E000-MEP ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
29. E001-LNK ONE-LINE RISER DIAGRAM AND NOTES, dated 02/23/2024.
30. E001-MEP ONE-LINE RISER DIAGRAM AND NOTES, dated 02/23/2024.
31. E002-LNK ELECTRICAL DETAILS, dated 02/23/2024.
32. E002-MEP ELECTRICAL DETAILS, dated 02/23/2024.
33. E010-LNK DEMOLITION/REMOVAL SITE PLAN, dated 02/23/2024.
34. E010-MEP ELECTRICAL SITE PLAN, dated 02/23/2024.
35. E011-LNK ELECTRICAL SITE PLAN, dated 02/23/2024.
36. E100-LNK FIRST FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
37. E101-MEP ELECTRICAL FIRST FLOOR PLANS - KENWOOD (BUILDING C), dated 02/23/2024.

38. E102-LNK SECOND FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
39. E103-MEP ELECTRICAL PENTHOUSE PLAN - KENWOOD (BUILDING C), dated 02/23/2024.
40. E105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
41. E106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
42. E107-LNK PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C), dated 02/23/2024.
43. P000-LNK PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
44. P000-MEP PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS, dated 02/23/2024.
45. P101-MEP PLUMBING FIRST FLOOR PLANS - KENWOOD (BUILDING C), dated 02/23/2024.
46. P103-MEP PLUMBING PENTHOUSE PLAN - KENWOOD (BUILDING C), dated 02/23/2024.
47. P105-LNK FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, dated 02/23/2024.
48. P105A-LNK PLUMBING SITE PLAN, dated 02/23/2024.
49. P106-LNK SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, AND PENTHOUSE PLAN - (BUILDING C), dated 02/23/2024.

END OF ADDENDUM NO. 01

SECTION 00 01 02

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END OF SECTION 00 01 02

SECTION 22 07 19 (LNK)

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping insulation materials (Including cements, adhesives, and mastics).

B. Jackets and accessories.

1.02 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2017.

E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in other sections.

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

1.08 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of preliminary acceptance, whichever is longer.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

A. Manufacturers:
1. CertainTeed Corporation

2. Johns Manville Corporation
3. Knauf Insulation
4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ

B. Preformed Pipe Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.
4. Provide with factory-applied ASJ-SSL jacket.

C. Insulating Cement: ASTM C195
1. Manufacturers:
a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

D. Hydraulic Setting Insulating and Finishing Cement
1. Insulco, Division of MFS, Inc.; SmoothKote.
2. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
3. Rock Wool Manufacturing Company; Delta One Shot.

E. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
1. Manufacturers:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. Marathon Industries, Inc.; 590.
d. Vimasco Corporation; 749.

F. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
1. Manufacturers:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. Marathon Industries, Inc.; 550.
d. Vimasco Corporation; WC-1/WC-5.

G. Insulating Cement: ASTM C449.
1. Manufacturers:
a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.

C. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

D. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

E. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

F. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

G. Exposed Piping: Locate insulation and cover seams in least visible locations. If exposed piping is installed in locations susceptible to washdown, such as: shower rooms, kitchens, etc., it shall be installed with PVC jacket to protect insulation from water damage.

H. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

I. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

J. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

K. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

L. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

M. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00 - Firestopping.

N. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

O. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 PIPING INSULATION SCHEDULES

A. General: Abbreviations used in the following schedules include:
1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

B. Interior Domestic Hot Water And Recirculated Hot Water:

PIPE SIZES (NPS)	MATERIALS	THERMAL CONDUCTIVITY, K	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD APPLIED JACKET
ALL SIZES	GLASS FIBER	0.28	1	NO	(P)

1. NOTE: Increase insulation thickness 1/2” for pipes > 1-1/2” in systems operating between 140 deg F and 169 deg F. Increase insulation thickness 1/2” for 1-1/2” and 2” pipes operating between 170 deg F and 180 deg F. Increase insulation thickness 1” for pipes > 2” operating between 170 deg F and 180 deg F.

C. Interior Domestic Cold Water And Storm Drainage:

PIPE SIZES (NPS)	MATERIALS	THERMAL CONDUCTIVITY, K	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD APPLIED JACKET
1/2 TO <1 1/2	GLASS FIBER	0.28	1/2	YES, FACTORY INSTALLED	(P)
1 1/2 TO <4	GLASS FIBER	0.28	1	YES, FACTORY INSTALLED	(P)

3.04 INDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. PVC, Color-Coded by System: 30 mils thick.

3.05 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
1. Aluminum, Stucco Embossed: 0.024 inch thick.

D. Piping, Exposed:
1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 22 07 19

SECTION 22 11 16 (LNK)

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Domestic water piping.
   2. Flanges, unions, and couplings.
   3. Pipe hangers and supports.
   4. Manufactured sleeve-seal systems.
   5. Valves.
      a. Flow controls.
      b. Check.
      c. Water pressure reducing valves.
      d. Relief valves.

1.02 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2015.

B. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500; 2016.

C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2016.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

F. ASME B31.9 - Building Services Piping; 2014.

G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2015.

I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

J. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples; 2016.

K. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

N. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

O. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

P. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; 2016.

Q. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.

R. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.

S. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017.

T. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2011.

U. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2017.

V. AWWA C651 - Disinfecting Water Mains; 2014.

W. AWWA C652 - Disinfection of Water-Storage Facilities; 2011.

X. MSS SP-67 - Butterfly Valves; 2017.

Y. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

Z. NSF 61 - Drinking Water System Components - Health Effects; 2017.

AA. ANSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. See Section 01 33 29 - LEED Sustainable Design Reporting, when required.

C. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

D. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.

E. Shop Drawings: Contractor shall submit complete shop drawings showing layout and sizing of all pipes, with all valves, specialties, and other relevant items shown.

F. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with Chicago Plumbing Code.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

F. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

G. Comply with NSF 61, for potable domestic water piping and components.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Board Authorized Representative except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.07 WARRANTY

A. Provide manufacturer’s standard 1-year warranty for materials and labor, commencing on date of substantial completion.

1.08 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig (860 kPa), unless otherwise indicated.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

2.02 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (Below Grade Applications), Type L (Indoor Above Grade Applications).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, alloy Sn95 solder.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
4. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.

2.03 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.04 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. The Metraflex Company; MetraSeal:

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

2.05 BALL VALVES

A. Manufacturers:
1. Nibco, Inc: www.nibco.com.
2. Conbraco Industries, Inc.; Apollo Div.
3. Crane Company: www.cranecpe.com.
4. Watts Industries, Inc.; Water Products Div.

B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PIPE AND FITTING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Under-Ground, Water-Service Piping on Service Side of Water Meter: Underground, Service Entrance Piping: Do not use flanges or valves underground. Use the following:
   1. NPS 2 and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints.
   2. 3- to 8-Inch NPS: Ductile-iron pipe and fittings, and mechanical joints.

D. Domestic Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
   1. NPS 4 and smaller: Hard copper tube, Type K; copper pressure fittings; and soldered joints.
   2. NPS 4 and larger: Steel pipe; galvanized, flanged or grooved fittings and joints.

E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
   1. NPS 3 and smaller: Hard copper tube, Type L, copper pressure fittings; and soldered joints.
   2. NPS 4 to NPS 6: Steel pipe; galvanized, flanged or grooved fittings and joints.
   3. NPS 8: Ductile iron pipe, mechanical joints.

F. Non-Potable-Water Piping: Use the following piping materials for each size range:
   1. NPS 3 and smaller: Steel pipe; galvanized, flanged or grooved fittings and joints.

3.03 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use bronze ball valves for piping NPS 2-1/2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 3 and larger.
   2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
   3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2-1/2 and smaller. Use butterfly or gate valves for piping NPS 3 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch, in the hot water return main where branches join together and on discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.04 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.05 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

F. Rough-in water piping for water meter installation according to City of Chicago Department of Water requirements. Water meters shall be purchased from Department of Water Management.

G. Install piping to maintain headroom, conserve space, and not interfere with use of space.

H. Group piping whenever practical at common elevations.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

J. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.

K. Install valves with stems upright or horizontal, not inverted.

L. Install water piping to ASME B31.9.

M. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

N. Sleeve pipes passing through partitions, walls and floors.

O. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.

2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Support cast iron drainage piping at every joint.

P. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

Q. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.06 CLEANING AND ADJUSTING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

D. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.08 STARTUP AND REPORTING

A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

B. Perform the following steps before putting into operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.

4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use

C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

D. Check plumbing specialties and verify proper settings, adjustments, and operation.

E. Energize pumps and verify proper operation.

3.09 HANGERS & SUPPORTS SCHEDULES

A. Pipe hangers and supports are specified in Division 23.

B. Domestic Water
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
5. Support vertical piping and tubing at base and at each floor.
6. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
7. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   b. NPS 1-1/2: 108 inches with 3/8-inch rod.
   c. NPS 2: 10 feet with 3/8-inch rod.
   d. NPS 2-1/2: 11 feet with 1/2-inch rod.
   e. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   f. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   g. NPS 6: 12 feet with 3/4-inch rod.
   h. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
8. Install supports for vertical steel piping every 15 feet.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   b. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   c. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   d. NPS 2-1/2: 108 inches with 1/2-inch rod.
   e. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   f. NPS 6: 10 feet with 5/8-inch rod.
   g. NPS 8: 10 feet with 3/4-inch rod.
10. Install supports for vertical copper tubing every 10 feet.

END OF SECTION 22 11 16

SECTION 22 11 16 (MEP)

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Domestic water piping.
   2. Flanges, unions, and couplings.
   3. Pipe hangers and supports.
   4. Manufactured sleeve-seal systems.
   5. Valves.
      a. Flow controls.
      b. Check.
      c. Water pressure reducing valves.
      d. Relief valves.

1.02 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2015.

B. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500; 2016.

C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2016.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

F. ASME B31.9 - Building Services Piping; 2014.

G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2015.

I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

J. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples; 2016.

K. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

N. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

O. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

P. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; 2016.

Q. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.

R. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.

S. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017.

T. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2011.

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Y. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

Z. NSF 61 - Drinking Water System Components - Health Effects; 2017.

AA. ANSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.

D. Shop Drawings: Contractor shall submit complete shop drawings showing layout and sizing of all pipes, with all valves, specialties, and other relevant items shown.

E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with Chicago Plumbing Code.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

F. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

G. Comply with NSF 61, for potable domestic water piping and components.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Board Authorized Representative except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.07 WARRANTY

A. Provide manufacturer’s standard 1-year warranty for materials and labor, commencing on date of substantial completion.

1.08 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig (860 kPa), unless otherwise indicated.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

2.02 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (Below Grade Applications), Type L (Indoor Above Grade Applications).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, alloy Sn95 solder.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
4. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.

B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, using one of the following joint types:
1. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
3. Cast-Iron Flanges: ASME B16.1, Class 125.
4. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
5. Steel-Piping, Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

C. Ductile-Iron Pipe: AWWA C151/A21.51, 250-psig minimum pressure rating with mechanical-joint bell, plain spigot end, and AWWA C104/A21.4 cement-mortar lining.
1. Include AWWA C111/A21.11 ductile-iron gland, rubber gasket, and steel bolts with mechanical-joint pipe.
2. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110/A21.10 orAWWA C153/A21.53. Include 2 gasketed ball-joint sections, 1 or more gasketed sleeve sections, 250-psig minimum working-pressure rating, and AWWA C550 epoxy interior coating. Assemble components for offset and expansion indicated. Include AWWA C111/A21.11 ductile-iron glands, rubber gaskets, and steel bolts.

2.03 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.04 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. The Metraflex Company; MetraSeal:

B. Modular/Mechanical Seal:

1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

2.05 BALL VALVES

A. Manufacturers:
1. Nibco, Inc: www.nibco.com.
2. Conbraco Industries, Inc.; Apollo Div.
3. Crane Company: www.cranecpe.com.
4. Watts Industries, Inc.; Water Products Div.

B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.06 BUTTERFLY VALVES

A. Manufacturers:
1. Crane Company: www.cranecpe.com.
2. Milwaukee Valve Company.
3. Nibco, Inc: www.nibco.com.
4. Watts Industries, Inc.; Water Products Div.

B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.07 RELIEF VALVES

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PIPE AND FITTING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Under-Ground, Water-Service Piping on Service Side of Water Meter: Underground, Service Entrance Piping: Do not use flanges or valves underground. Use the following:
1. NPS 2 and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints.
2. 3- to 8-Inch NPS: Ductile-iron pipe and fittings, and mechanical joints.

D. Domestic Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
   1. NPS 4 and smaller: Hard copper tube, Type K; copper pressure fittings; and soldered joints.
   2. NPS 4 and larger: Steel pipe; galvanized, flanged or grooved fittings and joints.

E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
   1. NPS 3 and smaller: Hard copper tube, Type L, copper pressure fittings; and soldered joints.
   2. NPS 4 to NPS 6: Steel pipe; galvanized, flanged or grooved fittings and joints.
   3. NPS 8: Ductile iron pipe, mechanical joints.

F. Non-Potable-Water Piping: Use the following piping materials for each size range:
   1. NPS 3 and smaller: Steel pipe; galvanized, flanged or grooved fittings and joints.

3.03 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use bronze ball valves for piping NPS 2-1/2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 3 and larger.
   2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
   3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2-1/2 and smaller. Use butterfly or gate valves for piping NPS 3 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch, in the hot water return main where branches join together and on discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.04 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.05 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

F. Rough-in water piping for water meter installation according to City of Chicago Department of Water requirements. Water meters shall be purchased from Department of Water Management.

G. Install piping to maintain headroom, conserve space, and not interfere with use of space.

H. Group piping whenever practical at common elevations.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.

L. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23 - General-Duty Valves for Plumbing Piping.

M. Install water piping to ASME B31.9.

N. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

O. Sleeve pipes passing through partitions, walls and floors.

P. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
   10. Support cast iron drainage piping at every joint.

Q. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

R. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.06 CLEANING AND ADJUSTING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

D. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.08 STARTUP AND REPORTING

A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

B. Perform the following steps before putting into operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
   5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use

C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

D. Check plumbing specialties and verify proper settings, adjustments, and operation.

E. Energize pumps and verify proper operation.

3.09 HANGERS & SUPPORTS SCHEDULES

A. Pipe hangers and supports are specified in Division 23.

B. Domestic Water
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
5. Support vertical piping and tubing at base and at each floor.
6. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
7. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   b. NPS 1-1/2: 108 inches with 3/8-inch rod.
   c. NPS 2: 10 feet with 3/8-inch rod.
   d. NPS 2-1/2: 11 feet with 1/2-inch rod.
   e. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   f. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   g. NPS 6: 12 feet with 3/4-inch rod.
   h. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
8. Install supports for vertical steel piping every 15 feet.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   b. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   c. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   d. NPS 2-1/2: 108 inches with 1/2-inch rod.
   e. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   f. NPS 6: 10 feet with 5/8-inch rod.
   g. NPS 8: 10 feet with 3/4-inch rod.
10. Install supports for vertical copper tubing every 10 feet.

END OF SECTION 22 11 16

SECTION 22 11 19 (LNK)
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backflow preventers.
B. Double check valve assemblies.
C. Water hammer arrestors.
D. Mixing valves.
E. Vacuum breakers.
F. Water pressure-reducing valves.
G. Balancing valves.
H. Strainers.
I. Air vents.
J. Flashing materials.

1.02 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
B. ASME B1.20.7 - Hose Coupling Screw Threads (Inch) 1991 (Reaffirmed 2018).
C. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers 2017.
D. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems 2020.
E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers 2017.
F. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2009.
G. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers 2021.
H. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations 2017 Edition, January 2017.
I. ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers 2016 Edition.
J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
K. ASTM B32 - Standard Specification for Solder Metal 2020.
L. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products 2020.
M. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane 2017.
N. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.
O. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
P. NSF 14 - Plastics Piping System Components and Related Materials 2017.
Q. NSF 61 - Drinking Water System Components - Health Effects 2020.
R. NSF 372 - Drinking Water System Components - Lead Content 2020.
S. PDI-WH 201 - Water Hammer Arresters 2017.
T. SSPC-Paint 12 - Cold-Applied Asphalt Mastic (Extra Thick Film) 1982.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
    1. Wiring Diagrams: Power, signal, and control wiring.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.
E. Operation Data: Indicate frequency of treatment required for interceptors.
F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
G. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Sediment Filters: Provide 1 new filter.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. NSF Compliance:
1. Comply with NSF 14 for plastic domestic water piping components.
2. Comply with NSF 61

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.
B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 WARRANTY

A. Provide manufacturer' s standard 1-year warranty for materials and labor, commencing on date of Preliminary Acceptance.

1.07 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.08 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 BACKFLOW PREVENTERS

A. Manufacturers:
1. Conbraco Industries, Inc: www.apollovalves.com.
2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
3. Zurn Industries, LLC: www.zurn.com.

B. Reduced Pressure Backflow Preventer Assembly:
1. ASSE 1013
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
4. Size: Same as pipe size.

5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through or vertical inlet, horizontal center section, and vertical outlet flow as applicable.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.03 DOUBLE CHECK-VALVE ASSEMBLIES

A. Manufacturers:
   1. Conbraco Industries, Inc: www.apollovalves.com.
   2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
   3. Zurn Industries, LLC: www.zurn.com.

B. Double Check Valve Assembly:
   1. ASSE 1012
   2. Operation: Continuous-pressure applications, unless otherwise indicated.
   3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   4. Size: Same as pipe size
   5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Configuration: Designed for horizontal, straight through or vertical flow as applicable
   8. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.04 WATER HAMMER ARRESTORS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
   2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
   3. Zurn Industries, LLC: www.zurn.com.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.05 MIXING VALVES

A. Primary Thermostatic Mixing Valves:
   1. Manufacturers:
      a. Leonard Valve Company: www.leonardvalve.com.
      b. Lawler Manufacturing Company, Inc.: www.temperedwater.com
      c. Powers, a Watts Industries Co.: www.watts.com

d. Symmons Industries, Inc.: www.symmons.com

2. Valve: Chrome-plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
3. Standard: ASSE 1017.
4. Valve Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
5. Accessories:
   a. Check valve on inlets.
   b. Volume control shut-off valve on outlet.
   c. Stem thermometer on outlet.
   d. Strainer stop checks on inlets.
6. Cabinet: 16 gauge, 0.0598 inch prime-coated steel, for recessed mounting with keyed lock.

B. Pressure Balanced Mixing Valves (Individual Fixtures):

1. Manufacturers:
   a. Apollo Valves: www.apollovalves.com
   b. Leonard Valve Company: www.leonardvalve.com.
   c. Symmons Industries, Inc.: www.symmons.com
   d. Watts Industries, Inc.: www.watts.com
   e. Zurn Industries, LLC: www.zurn.com
2. Valve: Chrome plated cast brass body, stainless steel cylinder, integral temperature adjustment.
3. Standard: ASSE 1016, thermostatically controlled water tempering valve.
4. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
5. Inlets and Outlet: Threaded.
6. Tempered-Water Setting: 105 deg F.

2.06 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze in unfinished back of house areas, chrome plated where exposed to public.

B. Spill-Resistant Vacuum Breakers :

1. Standard: ASSE 1056.
2. Operation: Continuous-pressure applications.
3. Size: Same as pipe size.
4. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.07 WATER PRESSURE REDUCING VALVES

A. Water Regulators (for piping 1-1/2 inch and smaller):

1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig.
3. Size: One size smaller than pipe size
4. Design Outlet Pressure Setting: As required by fixtures or equipment served, adjustable between 20 and 80 psi.
5. Body: Bronze in back of house areas, chrome-plated finish in public areas.
6. Valves for Booster Heater Water Supply: Include integral bypass.

7. End Connections: Threaded.

B. Water Control Valves (for piping 2 inch and larger)
1. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
2. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
3. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
   a. Size: One size smaller than pipe size.
   b. Pattern: Globe-valve design.
   c. Trim: Stainless steel.
4. Design Outlet Pressure Setting: Adjustable between 20 and 80 psi.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.08 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves (2 inch and smaller):
1. Type: Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.09 STRAINERS

A. Y-Pattern Strainers for domestic water applications :
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch .
   b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
   c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents :
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.11 FLASHING MATERIALS

A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.
4. Pipe relief from backflow preventer to nearest drain.

C. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks or washing machine outlets. Install water hammer arresters in water piping according to PDI-WH 201.

D. Install water filters with inlet/outlet unions and accessible valves.

E. Outlet boxes; Install boxes recessed in wall. Install fire-retardant-treated-wood or metal blocking, wall reinforcement between studs.

F. Install water regulators with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

G. Install water control valves with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

H. Install balancing valves in locations where they can easily be adjusted.

I. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

J. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

K. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 PROTECTION

A. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.03 CONTRACTOR STARTUP AND REPORTING

A. Perform the following final checks before startup:

1. Verify that specified tests of piping systems are complete.

END OF SECTION

SECTION 22 11 19 (MEP)
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydrants.
B. Backflow preventers.
C. Double check valve assemblies.
D. Water hammer arrestors.
E. Mixing valves.
F. Vacuum breakers.
G. Water pressure-reducing valves.
H. Balancing valves.
I. Strainers.
J. Air vents.
K. Flashing materials.

1.02 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
B. ASME B1.20.7 - Hose Coupling Screw Threads (Inch) 1991 (Reaffirmed 2018).
C. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers 2017.
D. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems 2020.
E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers 2017.
F. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2009.
G. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers 2021.
H. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations 2017 Edition, January 2017.
I. ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers 2016 Edition.
J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
K. ASTM B32 - Standard Specification for Solder Metal 2020.
L. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products 2020.
M. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane 2017.
N. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.
O. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
P. NSF 14 - Plastics Piping System Components and Related Materials 2017.
Q. NSF 61 - Drinking Water System Components - Health Effects 2020.
R. NSF 372 - Drinking Water System Components - Lead Content 2020.
S. PDI-WH 201 - Water Hammer Arresters 2017.
T. SSPC-Paint 12 - Cold-Applied Asphalt Mastic (Extra Thick Film) 1982.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation Data: Indicate frequency of treatment required for interceptors.

F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

G. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Sediment Filters: Provide 1 new filter.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
1. Comply with NSF 14 for plastic domestic water piping components.
2. Comply with NSF 61

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 WARRANTY

A. Provide manufacturer' s standard 1-year warranty for materials and labor, commencing on date of Preliminary Acceptance.

1.07 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.08 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 HYDRANTS (EXTERIOR)

A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Zurn Industries, LLC: www.zurn.com.
3. Watts Regulator Company: www.wattsregulator.com.
4. Woodford Manufacturing Company: www.woodfordmfg.com

2.03 BACKFLOW PREVENTERS

A. Manufacturers:
1. Conbraco Industries, Inc: www.apollovalves.com.
2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
3. Zurn Industries, LLC: www.zurn.com.

B. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013
   2. Operation: Continuous-pressure applications.
   3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   4. Size: Same as pipe size.
   5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Configuration: Designed for horizontal, straight through or vertical inlet, horizontal center section, and vertical outlet flow as applicable.
   8. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
      b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.04 DOUBLE CHECK-VALVE ASSEMBLIES

A. Manufacturers:
   1. Conbraco Industries, Inc: www.apollovalves.com.
   2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
   3. Zurn Industries, LLC: www.zurn.com.

B. Double Check Valve Assembly:
   1. ASSE 1012
   2. Operation: Continuous-pressure applications, unless otherwise indicated.
   3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   4. Size: Same as pipe size
   5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Configuration: Designed for horizontal, straight through or vertical flow as applicable
   8. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.05 WATER HAMMER ARRESTORS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
   2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com.
   3. Zurn Industries, LLC: www.zurn.com.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.06 MIXING VALVES

A. Primary Thermostatic Mixing Valves:
   1. Manufacturers:
      a. Leonard Valve Company: www.leonardvalve.com.
      b. Lawler Manufacturing Company, Inc.: www.temperedwater.com
      c. Powers, a Watts Industries Co.: www.watts.com
      d. Symmons Industries, Inc.: www.symmons.com
   2. Valve: Chrome-plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
   3. Standard: ASSE 1017.
   4. Valve Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
   5. Accessories:
      a. Check valve on inlets.
      b. Volume control shut-off valve on outlet.
      c. Stem thermometer on outlet.
      d. Strainer stop checks on inlets.
   6. Cabinet: 16 gauge, 0.0598 inch prime-coated steel, for recessed mounting with keyed lock.

B. Pressure Balanced Mixing Valves (Individual Fixtures):
   1. Manufacturers:
      a. Apollo Valves: www.apollovalves.com
      b. Leonard Valve Company: www.leonardvalve.com.
      c. Symmons Industries, Inc.: www.symmons.com
      d. Watts Industries, Inc.: www.watts.com
      e. Zurn Industries, LLC: www.zurn.com
   2. Valve: Chrome plated cast brass body, stainless steel cylinder, integral temperature adjustment.
   3. Standard: ASSE 1016, thermostatically controlled water tempering valve.
   4. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
   5. Inlets and Outlet: Threaded.
   6. Tempered-Water Setting: 105 deg F.

2.07 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :
   1. Standard: ASSE 1001.
   2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   3. Body: Bronze.
   4. Inlet and Outlet Connections: Threaded.
   5. Finish: Rough bronze in unfinished back of house areas, chrome plated where exposed to public.

B. Laboratory-Faucet Vacuum Breakers:
   1. Standard: ASSE 1035.
   2. Size: NPS 1/4 or NPS 3/8 matching faucet size.
   3. Body: Bronze.
   4. End Connections: Threaded.
   5. Finish: Chrome plated.

C. Spill-Resistant Vacuum Breakers :
   1. Standard: ASSE 1056.
   2. Operation: Continuous-pressure applications.
   3. Size: Same as pipe size.

4. Accessories:
    a. Valves: Ball type, on inlet and outlet.

2.08 WATER PRESSURE REDUCING VALVES

A. Water Regulators (for piping 1-1/2 inch and smaller):
1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig.
3. Size: One size smaller than pipe size
4. Design Outlet Pressure Setting: As required by fixtures or equipment served, adjustable between 20 and 80 psi.
5. Body: Bronze in back of house areas, chrome-plated finish in public areas.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded.

B. Water Control Valves (for piping 2 inch and larger)
1. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
2. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
3. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
    a. Size: One size smaller than pipe size.
    b. Pattern: Globe-valve design.
    c. Trim: Stainless steel.
4. Design Outlet Pressure Setting: Adjustable between 20 and 80 psi.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.09 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves (2 inch and smaller):
1. Type: Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.10 STRAINERS

A. Y-Pattern Strainers for domestic water applications :
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
    a. Strainers NPS 2 and Smaller: 0.033 inch .
    b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
    c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents :
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.12 FLASHING MATERIALS

A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
   3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft.
   2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.
   4. Pipe relief from backflow preventer to nearest drain.

C. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks or washing machine outlets. Install water hammer arresters in water piping according to PDI-WH 201.

D. Install water filters with inlet/outlet unions and accessible valves.

E. Outlet boxes; Install boxes recessed in wall. Install fire-retardant-treated-wood or metal blocking, wall reinforcement between studs.

F. Install water regulators with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

G. Install water control valves with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

H. Install balancing valves in locations where they can easily be adjusted.

I. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

J. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

K. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 PROTECTION

A. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.03 CONTRACTOR STARTUP AND REPORTING

A. Perform the following final checks before startup:
   1. Verify that specified tests of piping systems are complete.

END OF SECTION

SECTION 22 13 16 (LNK)

SANITARY WASTE & VENT AND STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary waste and vent piping.
   2. Storm water piping.
   3. Flanges, unions, and couplings.
   4. Pipe hangers and supports.
   5. Manufactured sleeve-seal systems.
   6. Valves and accessories.

1.02 REFERENCE STANDARDS

A. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.

B. ASME B31.9 - Building Services Piping; 2014.

C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2017.

E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

H. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

I. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

J. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2014.

K. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014.

L. NSF 61 - Drinking Water System Components - Health Effects; 2017.

M. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

B. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.

C. Shop Drawings: Contractor shall submit complete shop drawings showing layout and sizing of all pipes, with all valves, specialties, and other relevant items shown.

D. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with Chicago Plumbing Code.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

F. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Board Authorized Representative except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
   1. Notify Architect/Engineer of Record not less than 48 hours in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without receiving Architect/Engineer of Record's written permission.

1.07 WARRANTY

A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of substantial completion.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET FROM THE EXTERIOR FACE OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B29, pure lead and oakum.
3. Gaskets: ASTM C564, rubber.

2.02 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B 29, pure lead and oakum.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B).
1. Fittings: ASME B16.29, wrought copper, ASME B16.23 cast copper.
2. Joints: ASTM B32, alloy Sn50 solder. Use solder appropriate for the system pressures indicated on plans.
3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

2.03 STORM WATER PIPING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B29, pure lead and oakum.
3. Gaskets: ASTM C564, rubber.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

D. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Sleeve Materials:
a. For Cast-Iron Soil Pipes: ASTM C564, rubber.
b. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.

c. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

E. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

F. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Center-Sleeve Material: Stainless steel.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

2.05 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. The Metraflex Company; MetraSeal:

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger. 2 percent downward in direction of flow for piping within 40 ft. downstream of a low flow water closed of 1.28 gallon/flush or below.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

I. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Backwater valve are specified in Section 22 11 19 - Domestic Water Piping Specialties.

J. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

K. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

L. Install piping to maintain headroom, conserve space, and not interfere with use of space.

M. Group piping whenever practical at common elevations.

N. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

O. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

P. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.

Q. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23 - General-Duty Valves for Plumbing Piping.

R. Install water piping to ASME B31.9.

S. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

T. Sleeve pipes passing through partitions, walls and floors.

U. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Support cast iron drainage piping at every joint.

V. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

W. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.04 CLEANING AND ADJUSTING

A. Clean interior of sanitary piping. Remove dirt and debris as work progresses.

B. Protect sanitary drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted sanitary waste and vent piping at end of day and when work stops.

3.05 FIELD QUALITY CONTROL

A. During sanitary waste and vent system installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   4. Prepare reports for tests and required corrective action.

3.06 STARTUP AND REPORTING

A. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

B. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 HANGERS & SUPPORTS SCHEDULES

A. Pipe hangers and supports are specified in Division 23.

B. Sanitary Waste & Vent & Storm Sewer
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
5. Support vertical piping and tubing at base and at each floor.
6. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
7. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   b. NPS 3: 60 inches with 1/2-inch rod.
   c. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   d. NPS 6: 60 inches with 3/4-inch rod.
   e. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
8. Install supports for vertical cast-iron soil piping every 15 feet.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4: 72 inches with 3/8-inch rod.
   b. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   c. NPS 2-1/2: 108 inches with 1/2-inch rod.
   d. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   e. NPS 6: 10 feet with 5/8-inch rod.
   f. NPS 8: 10 feet with 3/4-inch rod.
10. Install supports for vertical copper tubing every 10 feet.

END OF SECTION 22 13 16

SECTION 22 13 16 (MEP)

SANITARY WASTE & VENT AND STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary waste and vent piping.
   2. Storm water piping.
   3. Flanges, unions, and couplings.
   4. Pipe hangers and supports.
   5. Manufactured sleeve-seal systems.
   6. Valves and accessories.

1.02 REFERENCE STANDARDS

A. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.

B. ASME B31.9 - Building Services Piping; 2014.

C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2017.

E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

H. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

I. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

J. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2014.

K. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014.

L. NSF 61 - Drinking Water System Components - Health Effects; 2017.

M. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

B. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.

C. Shop Drawings: Contractor shall submit complete shop drawings showing layout and sizing of all pipes, with all valves, specialties, and other relevant items shown.

D. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with Chicago Plumbing Code.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

F. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Board Authorized Representative except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
1. Notify Architect/Engineer of Record not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect/Engineer of Record's written permission.

1.07 WARRANTY

A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of substantial completion.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET FROM THE EXTERIOR FACE OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B29, pure lead and oakum.
3. Gaskets: ASTM C564, rubber.

2.02 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B 29, pure lead and oakum.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B).
1. Fittings: ASME B16.29, wrought copper, ASME B16.23 cast copper.
2. Joints: ASTM B32, alloy Sn50 solder. Use solder appropriate for the system pressures indicated on plans.
3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

2.03 STORM WATER PIPING

A. Cast Iron Pipe: ASTM A74 service weight.
1. Fittings: Cast iron.
2. Joints: ASTM B29, pure lead and oakum.
3. Gaskets: ASTM C564, rubber.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
2. Copper tube and pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

D. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Sleeve Materials:
a. For Cast-Iron Soil Pipes: ASTM C564, rubber.
b. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.

c. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

E. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

F. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Center-Sleeve Material: Stainless steel.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

2.05 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. The Metraflex Company; MetraSeal:

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger. 2 percent downward in direction of flow for piping within 40 ft. downstream of a low flow water closed of 1.28 gallon/flush or below.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

I. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Backwater valve are specified in Section 22 11 19 - Domestic Water Piping Specialties.

J. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

K. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

L. Install piping to maintain headroom, conserve space, and not interfere with use of space.

M. Group piping whenever practical at common elevations.

N. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

O. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

P. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.

Q. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23 - General-Duty Valves for Plumbing Piping.

R. Install water piping to ASME B31.9.

S. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

T. Sleeve pipes passing through partitions, walls and floors.

U. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Support cast iron drainage piping at every joint.

V. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

W. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.04 CLEANING AND ADJUSTING

A. Clean interior of sanitary piping. Remove dirt and debris as work progresses.

B. Protect sanitary drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted sanitary waste and vent piping at end of day and when work stops.

3.05 FIELD QUALITY CONTROL

A. During sanitary waste and vent system installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   4. Prepare reports for tests and required corrective action.

3.06 STARTUP AND REPORTING

A. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

B. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 HANGERS & SUPPORTS SCHEDULES

A. Pipe hangers and supports are specified in Division 23.

B. Sanitary Waste & Vent & Storm Sewer
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
5. Support vertical piping and tubing at base and at each floor.
6. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
7. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   b. NPS 3: 60 inches with 1/2-inch rod.
   c. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   d. NPS 6: 60 inches with 3/4-inch rod.
   e. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
8. Install supports for vertical cast-iron soil piping every 15 feet.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4: 72 inches with 3/8-inch rod.
   b. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   c. NPS 2-1/2: 108 inches with 1/2-inch rod.
   d. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   e. NPS 6: 10 feet with 5/8-inch rod.
   f. NPS 8: 10 feet with 3/4-inch rod.
10. Install supports for vertical copper tubing every 10 feet.

END OF SECTION 22 13 16

SECTION 22 14 23 (LNK)
DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Backwater valves.
D. Drain valves.
E. Flashing materials.
F. Miscellaneous drainage piping specialties.

1.02 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains 2019.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2003 (Reaffirmed 2012).
C. ASME B1.20.7 - Hose Coupling Screw Threads (Inch) 1991 (Reaffirmed 2018).
D. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2003 (Reapproved 2021).
E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
F. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
G. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2019)e1.
H. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
I. ASTM B32 - Standard Specification for Solder Metal 2020.
J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
K. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products 2020.
L. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures 2021 Edition.
M. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures 2021.
N. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane 2017.
O. ASTM D4101 - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials 2017, with Editorial Revision (2019).
P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010.
Q. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves 2013.
R. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
S. NSF 14 - Plastics Piping System Components and Related Materials 2017.
T. SSPC-Paint 12 - Cold-Applied Asphalt Mastic (Extra Thick Film) 1982.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
    1. Wiring Diagrams: Power, signal, and control wiring.
    2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.
E. Operation Data: Indicate frequency of treatment required for interceptors.
F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.
B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 WARRANTY

A. Provide manufacturer' s standard 1-year warranty for materials and labor, commencing on date of preliminary acceptance.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 DRAINS

A. Manufacturers
   1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
   2. Josam Company: www.josam.com.
   3. MIFAB, Inc.: www.mifab.com
   4. Zurn Industries, LLC: www.zurn.com.
B. Roof Drain (RD-1):
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. Strainer: Removable cast iron dome with vandal proof screws.
   4. Diameter of Body: 16 inch.
   5. Accessories: Coordinate with roofing type, refer to Division 07:
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable under deck clamp.
      c. Roof sump receiver.
      d. Waterproofing flange.
      e. Leveling frame.
      f. Adjustable extension sleeve for roof insulation.
C. Roof Overflow Drains:
   1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 4 inches above flood elevation.
D. Floor Drain (FD-1):
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and 6" round, adjustable polished nickel-bronze strainer.
E. Floor Drain (FD-2):

1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and 8" round, round rough brass strainer with removable perforated sediment bucket and deep seal p-trap.

F. Floor Drain (FD-3):
1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and 12" round, adjustable rough brass heavy duty strainer with hinged grate and sediment bucket.

G. Prefabricated Trench Drain (TD-1): Trench drain system assembled from factory fabricated, ductile or grey iron in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
1. Trench Width: 12 inches.
2. Trench Section Length: 39 inches and 19-1/2 inches.
3. Grating Support Rail: Stainless steel.

2.02 CLEANOUTS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Zurn Industries, LLC: www.zurn.com.
4. MIFAB, Inc: www.mifab.com
5. Watts Company: www.watts.com

B. Cleanouts at Interior Finished Floor Areas (FCO):
1. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
2. Size: Same as connected branch up to 4 inch diameter, 4 inch for larger piping.
3. Type: Threaded, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Extra Heavy Duty.
12. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cleanouts at Interior Finished Wall Areas (WCO):
1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: (frame and cover to be installed in drywall) Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
7. (stainless-steel wall-installation frame and cover to be used in other areas) Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Cleanouts at Interior Unfinished Accessible Areas (CO):
1. Standard: ASME A112.36.2M for cast iron cleanout test tee.
2. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.

3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.03 BACK WATER VALVES

A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com
2. MIFAB, Inc: www.mifab.com
3. Zurn Industries, LLC: www.zurn.com.
4. Watts Company: www.watts.com

B. Cast Iron Back Water Valves: ASME A112.6.4; lacquered cast iron body and cover, brass valve, extension sleeve, and access cover.

C. Cover: Cast iron with bolted access check valve.

D. End Connections: Hub and spigot.

E. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

F. Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.04 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves :
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.05 FLASHING MATERIALS

A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
E. Fasteners: Metal compatible with material and substrate being fastened.
F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
G. Solder: ASTM B32, lead-free alloy.
H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
C. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
D. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.
E. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.
F. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
G. Encase exterior cleanouts in concrete flush with grade.
H. Install floor cleanouts at elevation to accommodate finished floor.
I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.03 CONTRACTOR STARTUP AND REPORTING

A. Perform the following final checks before startup:
   1. Verify that specified tests of piping systems are complete.

END OF SECTION

SECTION 22 14 23 (MEP)

DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Drains.

B. Cleanouts.

C. Drain valves.

D. Flashing materials.

E. Miscellaneous drainage piping specialties.

1.02 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains; 2016.

B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2008 (Reaffirmed 2012).

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2017.

E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.

G. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products; 2014.

H. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane; 2015.

I. NFPA 70 - National Electrical Code; 2017.

J. NSF 14 - Plastics Piping System Components and Related Materials; 2017.

K. SSPC-Paint 12 - Cold-Applied Asphalt Mastic (Extra Thick Film); 1982.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
   1. Wiring Diagrams: Power, signal, and control wiring.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation Data: Indicate frequency of treatment required for interceptors.

F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.06 WARRANTY

A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of preliminary acceptance.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

2.02 DRAINS

A. Manufacturers

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Zurn Industries, LLC: www.zurn.com.
4. MIFAB, Inc.

B. Roof Drain (RD-1):
1. Assembly: ASME A112.6.4.
2. Body: Lacquered cast iron with sump.

3. Strainer: Removable cast iron dome with vandal proof screws.
4. Diameter of Body: 16 inch.
5. Accessories: Coordinate with roofing type, refer to Division 07:
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. Roof sump receiver.
   d. Waterproofing flange.
   e. Leveling frame.
   f. Adjustable extension sleeve for roof insulation.

C. Roof Dam Type Overflow Drains:
1. Lacquered cast iron body and clamp collar and bottom clamp ring; with 2" high cast iron water dam to prevent entrance of normal rainfall flow.

2.03 CLEANOUTS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Zurn Industries, LLC: www.zurn.com.
4. MIFAB, Inc.
5. Watts Drainage Products.

B. Cleanouts at Interior Finished Floor Areas (FCO):
1. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
2. Size: Same as connected branch up to 4 inch diameter, 4 inch for larger piping.
3. Type: Threaded, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Extra Heavy Duty.
12. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cleanouts at Interior Finished Wall Areas (WCO):
1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: (frame and cover to be installed in drywall) Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
7. (stainless-steel wall-installation frame and cover to be used in other areas) Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Cleanouts at Interior Unfinished Accessible Areas (CO):
1. Standard: ASME A112.36.2M for cast iron cleanout test tee.
2. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.

5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.04 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves :
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves :
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.05 FLASHING MATERIALS

A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

C. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

E. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

F. Encase exterior cleanouts in concrete flush with grade.

G. Install floor cleanouts at elevation to accommodate finished floor.

H. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
   1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
   2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
   3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
   4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

I. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain.

J. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.03 CONTRACTOR STARTUP AND REPORTING

A. Perform the following final checks before startup:
1. Verify that specified tests of piping systems are complete.

END OF SECTION 22 14 23

SECTION 23 05 03 (LNK)

GENERAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The work under Division 23 "Heating, Ventilating, and Air Conditioning (HVAC)" shall include all labor, services, materials and equipment and performance of all work required for the installation of all mechanical work as shown on the Drawings and herein specified in the following Sections.

B. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer for decision before ordering any equipment or materials or before starting any related work.

C. Where work connects to that of another trade, or to piping or equipment in place, take measurements in the field to make connecting work come true and line up with the item being connected.

D. Where work specified under other Divisions of the Specifications connects to equipment which is a part of Division 23, provide proper connection(s) to such equipment.

E. Minor items and accessories or devices reasonably inferable as necessary, to the complete and proper installation and operation of any system, shall be provided by the Trade Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

F. The Drawings and Specifications are to be taken together. Work specified and not shown or work shown and not specified shall be performed or furnished as though mentioned in both Specifications and Drawings. If there is a discrepancy between the Drawings and Specifications as to the quantity or quality to be provided, the greater quantity or the better quality shall be provided.

1.2 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, valves, hangers, and other supports and accessories related to such piping.

B. "Ductwork" includes, in addition to ducts, all fittings, transitions, dampers, hangers and other supports and accessories related to such ductwork.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Invert Elevations" means the elevation of the inside bottom of pipe or duct.

F. "HVAC Work" is all of the work in Division 23.

1.3 QUALITY ASSURANCE

A. Each major component of equipment to have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place.

B. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

C. All equipment provided under Division 23 to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment, as determined by the Owner's Representative, Architect/Engineer or School Principal to be producing objectionable noise or transmitting noise or vibration to the building to be repaired or removed and replaced.

D. All workmanship shall be first class in every respect and shall be performed only by skilled mechanics.

E. Shutdown and Notifications:

1. It is imperative that service interruptions on the various existing utilities be held to an absolute minimum. Wherever possible provide suitable temporary services or connections, where continuity of service for essential systems can be maintained by this means. It will be the Owner's final prerogative to decide which systems are to be considered as essential, and to establish the maximum allowable shutdown time, if any, for each system.
2. Owner will require not less than 72 hours advance notice, in writing, that an interruption of service in any system is desired. Such notice shall identify the system or systems involved, and shall be submitted in duplicate, one copy of which will be signed and returned by the Owner's authorized representative stating whether the requested shutdown will be permitted or not.

F. Existing Utilities:

1. Location of utilities as shown on the drawings has been determined from the best available information and is given for convenience; however, Owner does not assume responsibility in the event that during construction, utilities other than those shown may be encountered, and that the actual location of those which are shown may be different from the location as shown on the plans.
2. Assume responsibility for interference with or damage to any existing utilities, and repair or replace same with the least possible delay.

G. Notify Architect of broken or open pipes discovered during construction.

H. Layout and establish the lines and levels necessary for work.

I. The following Standards shall be used where referenced by the following abbreviations:

1. AABC: Associated Air Balance Council
2. ADC: Air Diffusion Council
3. AGA: American Gas Association
4. AIA: American Institute of Architects
5. AMCA: Air Moving and Conditioning Association
6. ANSI: American National Standards Institute
7. ARI: Air Conditioning and Refrigeration Institute
8. ASE: Association of Safety Engineers
9. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers

10. ASME: American Society of Mechanical Engineers
11. ASPE: American Society of Plumbing Engineers
12. ASTM: American Society of Testing and Materials
13. AWPB: American Wood Preserves Bureau
14. AWS: American Welding Society
15. AWWA: American Water Works Association
16. CSA: Canadian Standards Association
17. CISPI: Cast Iron Soil Pipe Institute
18. EIA: Electronic Industries Association
19. EPA: Environmental Protection Agency
20. FDA: Food and Drug Administration
21. FM: Factory Mutual Insurance Association
22. HIS: Hydraulic Institute Standards
23. IRI: Industrial Risk Insurers
24. IBR: Institute of Boiler and Radiator Manufacturers
25. IEEE: Institute of Electrical and Electronics Engineers
26. MCAA: Mechanical Contractors' Association of America
27. NIST: National Institute of Standards and Testing
28. NEBB: National Environmental Balancing Bureau
29. NEC: National Electric Code
30. NECA: National Electric Contractors Association
31. NEMA: National Electrical Manufacturers Association
32. NFPA: National Fire Protection Association
33. NSC: National Safety Council
34. NSF: National Sanitation Foundation
35. OSHA: Occupational Safety & Health Administration
36. SAE: Society of Automotive Engineers
37. SBI: Steel Boiler Institute Industry
38. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
39. TIMA: Thermal Insulation Manufacturers Association
40. UL: Underwriters' Laboratories
41. USDA: United States Department of Agriculture

J. Project Certification:

1. Each trade shall submit a project certification, guaranteeing that this project was constructed and will operate in accordance with the performance requirements of the Drawings and Specifications. This certification shall be signed by a principal of the firm and shall be delivered to the Architect/Engineer prior to final payment.

K. Drawings:

1. The Drawings are essentially diagrammatic in nature and show general arrangement of the equipment, piping, ductwork, accessories, etc. Because of the small scale of the Drawings, it is not possible to show each offsets, fittings, and accessories, which may be required. Carefully investigate the structural conditions, Architectural Drawings, Equipment Drawings, and the finished conditions of the work and arrange such work accordingly, furnish any fittings, pipe accessories that may be required to meet such conditions.
2. Any changes from the plans necessary to make the work conform to building as constructed and to fit work of other trades, or to conform to rules of the governing authorities and regulations, shall be met without extra cost to the Owner.
3. The layout of the piping, ductwork, equipment, etc., as shown on the Drawings shall be checked and exact locations shall be determined by the dimensions of equipment approved and Contractor shall obtain the Architect’s approval for revised layout before the apparatus is installed. Consult the Architectural, Structural, and Equipment Drawings

for the dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.

4. Refer to the Architectural Plans for details and large scale Drawings and to approved Shop Drawing of equipment furnished under other Contracts or Sections of the Specifications for exact location of service connections. The equipment Shop Drawings will be furnished to the Contractor before roughing in. Contractor shall not install any piping or ductwork for said equipment until they have received approved Coordination Drawings for same.

L. Minor Deviations:

1. The dimensions of equipment hereinafter specified or indicated on the Drawings are intended to establish the outlines and characteristics of such equipment in general. Minor deviations in dimensions will be permitted to allow the manufacturers specified to bid on their nearest stock equipment, provided the specified ratings are met or exceeded.
2. Where manufacturers' catalog numbers or types are mentioned in the Specifications or indicated on the Drawings, they are intended to be used as a guide only and shall not be interpreted as taking precedence over the basic rating and duty specified. In all cases, manufacturers shall verify the duty specified with particular characteristics of the equipment they intend to offer for approval and shall also pay the additional charges as may be required under other Divisions.

M. Interferences:

1. Before making any installation, the work of the trades must be coordinated and the necessary changes shall be made to avoid interferences or improper effect on work to be performed by any other Section. In the event that interferences develop, the Architect's decision will be final and no additional compensation will be allowed for moving of misplaced piping, ducts, conduit and/or equipment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Unless otherwise specified, all material and equipment incorporated in the work under the contract shall be new.

B. Material and equipment specified by one or more manufacturer's name, trade name and/or model number does not limit a bidder from bidding on other equipment providing the procedure set forth in the Conditions of the Contract and hereinafter specified is followed.

C. The various mechanical systems have been engineered and designed on equipment name and catalog numbers specified or designated on the Drawings.

D. A Contractor who intends to furnish equipment listed as approved equal shall proceed as follows:

1. Obtain Architect/Engineer's approval of said equipment.
2. Be fully responsible for said equipment.
3. Include in the Base Bid, all cost for any changes that may be required in his work and/or work of other trades for the proper installation and functioning of said equipment.

PART 3 - EXECUTION

3.1 ALTERATIONS IN PRESENT BUILDING AND SITE

A. Take particular note of the revisions and alterations of existing services, utilities, etc., due to the new construction as indicated on the Drawings and/or as required by alterations to the existing building.

1. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. The Trade Contractor involved with the interrupted service shall be responsible for accomplishing the required work whether shown on the Drawings or not.
2. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc. as required to be completely concealed after new work is complete.
3. In general, mechanical remodeling work is shown on the Mechanical Drawings but carefully study all Drawings for all contracts for "demolition" and "remodeling" work in the existing buildings and field check to verify locations where such work is being done to determine the exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on the Drawings.
4. Maintaining of Present Services: Maintain all services in the existing building. This shall include all temporary or permanent piping connections, etc., required to provide and maintain services to the present buildings and the equipment served. In the case of change over piping and ductwork or where new service connections are to be made to existing services and service interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the School. If the Owner's Representative directs that such work be performed during premium time hours then the Contractor shall be reimbursed for the premium time portion of the direct labor cost of the workmen actually performing the work. All costs (except for premium time portion of labor costs) incurred in order to comply with the foregoing shall be included in the Contractor's original bid for the work and without additional costs to the Board.
5. Remove or reroute, as required, all services at existing buildings to be demolished.

3.2 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, the Trade Contractor shall take possession of same and remove them from the site promptly, except as specified below or unless otherwise noted on Drawings.

B. All salvageable material and equipment, including but not necessarily limited to, electrical fixtures, conduit, wiring, plumbing fixtures, heating units, piping, valves, etc., shall be removed and maintained in as good condition as possible and turned over to the School. However, if the School decides any such materials are of no value, then they shall become the property of the Contractor who shall remove such discarded work from the premises and dispose of same.

C. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or systems, etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at the project site.

3.3 INSTALLATION

A. Each Trade Contractor shall be responsible for all of his work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Architect/Engineer.

B. Confer with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, etc., in order that there may be no interference between the installation of the progress of the work of any Trade Contractor on the

project. The Architectural Drawings shall take precedence over the Mechanical and Electrical Drawings.

C. The Mechanical Drawings are diagrammatic and shall be followed as closely as actual construction of the building and the work of other trade contractors will permit. All changes from Drawings necessary to make the work of each Contractor conform to the building construction and the work of other trade contractors shall be done at the appropriate Trade Contractor's expense.

D. Unless explicitly stated to the contrary, each Trade Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for a complete and operating installation.

E. All equipment and materials shall be installed according to the manufacturer's instructions unless otherwise specifically directed by the Trade Contract Documents. All piping, valves, connections, and other like items recommended by the manufacturer or required for proper operation shall be provided without additional cost to the Board.

F. All references to Contractors in Specifications and Drawings shall refer to the respective Trade Contractor performing that portion of the work.

G. In general, all piping, ductwork and similar items shall be installed concealed from view above the ceiling, in partitions, shafts, chases, unless otherwise indicated.

H. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site, subject to review.

I. Where pipes are in partitions, furred out spaces and chases, obtain information as to their exact location and size and install work so as to be entirely concealed in the allotted space. If conflicts arise making this impossible, obtain instructions from the Architect/Engineer before proceeding with the work.

J. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and servicing.

K. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

L. Where there is evidence that parts of the Mechanical Work will interfere with other work, assist in working out space conditions and/or the structure, make necessary adjustments to accommodate the work.

M. Mechanical Work installed before coordinating with other work so as to cause interference with other work shall be changed to correct such condition without additional cost to the Board.

N. In no case shall any pipe, conduit, duct, or item of equipment be installed where it is supported on or suspended from another pipe, conduit, duct or item of equipment.

O. Where an item or task is specified to be provided "under this Section," it shall be understood that, that item or task is the responsibility of the trade responsible for that Section, but the work must be performed by qualified workmen of the appropriate trade.

P. Accessibility:

1. Install Mechanical work to permit removal (without damage to other parts) of coils, heat exchangers, pumps, fan shafts and wheels, belt guards, sheaves and drives, and other parts requiring periodic replacement or maintenance.
2. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, starters, motors, dampers, control components, and to clear the openings of swinging and overhead doors and of access panels.
3. Change dimensions of ductwork when required to meet job conditions but maintain the same equivalent cross-sectional area.
4. Provide access panels in equipment, ducts, and like items for inspection of interiors and proper maintenance.

END OF SECTION

SECTION 23 05 03 (MEP)

GENERAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The work under Division 23 "Heating, Ventilating, and Air Conditioning (HVAC)" shall include all labor, services, materials and equipment and performance of all work required for the installation of all mechanical work as shown on the Drawings and herein specified in the following Sections.

B. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer for decision before ordering any equipment or materials or before starting any related work.

C. Where work connects to that of another trade, or to piping or equipment in place, take measurements in the field to make connecting work come true and line up with the item being connected.

D. Where work specified under other Divisions of the Specifications connects to equipment which is a part of Division 23, provide proper connection(s) to such equipment.

E. Minor items and accessories or devices reasonably inferable as necessary, to the complete and proper installation and operation of any system, shall be provided by the Trade Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

F. The Drawings and Specifications are to be taken together. Work specified and not shown or work shown and not specified shall be performed or furnished as though mentioned in both Specifications and Drawings. If there is a discrepancy between the Drawings and Specifications as to the quantity or quality to be provided, the greater quantity or the better quality shall be provided.

1.2 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, valves, hangers, and other supports and accessories related to such piping.

B. "Ductwork" includes, in addition to ducts, all fittings, transitions, dampers, hangers and other supports and accessories related to such ductwork.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Invert Elevations" means the elevation of the inside bottom of pipe or duct.

F. "HVAC Work" is all of the work in Division 23.

1.3 QUALITY ASSURANCE

A. Each major component of equipment to have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place.

B. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

C. All equipment provided under Division 23 to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment, as determined by the Owner's Representative, Architect/Engineer or School Principal to be producing objectionable noise or transmitting noise or vibration to the building to be repaired or removed and replaced.

D. All workmanship shall be first class in every respect and shall be performed only by skilled mechanics.

E. Shutdown and Notifications:

1. It is imperative that service interruptions on the various existing utilities be held to an absolute minimum. Wherever possible provide suitable temporary services or connections, where continuity of service for essential systems can be maintained by this means. It will be the Owner's final prerogative to decide which systems are to be considered as essential, and to establish the maximum allowable shutdown time, if any, for each system.
2. Owner will require not less than 72 hours advance notice, in writing, that an interruption of service in any system is desired. Such notice shall identify the system or systems involved, and shall be submitted in duplicate, one copy of which will be signed and returned by the Owner's authorized representative stating whether the requested shutdown will be permitted or not.

F. Existing Utilities:

1. Location of utilities as shown on the drawings has been determined from the best available information and is given for convenience; however, Owner does not assume responsibility in the event that during construction, utilities other than those shown may be encountered, and that the actual location of those which are shown may be different from the location as shown on the plans.
2. Assume responsibility for interference with or damage to any existing utilities, and repair or replace same with the least possible delay.

G. Notify Architect of broken or open pipes discovered during construction.

H. Layout and establish the lines and levels necessary for work.

I. The following Standards shall be used where referenced by the following abbreviations:

1. AABC: Associated Air Balance Council
2. ADC: Air Diffusion Council
3. AGA: American Gas Association
4. AIA: American Institute of Architects
5. AMCA: Air Moving and Conditioning Association
6. ANSI: American National Standards Institute
7. ARI: Air Conditioning and Refrigeration Institute
8. ASE: Association of Safety Engineers
9. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers

10. ASME: American Society of Mechanical Engineers
11. ASPE: American Society of Plumbing Engineers
12. ASTM: American Society of Testing and Materials
13. AWPB: American Wood Preserves Bureau
14. AWS: American Welding Society
15. AWWA: American Water Works Association
16. CSA: Canadian Standards Association
17. CISPI: Cast Iron Soil Pipe Institute
18. EIA: Electronic Industries Association
19. EPA: Environmental Protection Agency
20. FDA: Food and Drug Administration
21. FM: Factory Mutual Insurance Association
22. HIS: Hydraulic Institute Standards
23. IRI: Industrial Risk Insurers
24. IBR: Institute of Boiler and Radiator Manufacturers
25. IEEE: Institute of Electrical and Electronics Engineers
26. MCAA: Mechanical Contractors' Association of America
27. NIST: National Institute of Standards and Testing
28. NEBB: National Environmental Balancing Bureau
29. NEC: National Electric Code
30. NECA: National Electric Contractors Association
31. NEMA: National Electrical Manufacturers Association
32. NFPA: National Fire Protection Association
33. NSC: National Safety Council
34. NSF: National Sanitation Foundation
35. OSHA: Occupational Safety & Health Administration
36. SAE: Society of Automotive Engineers
37. SBI: Steel Boiler Institute Industry
38. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
39. TIMA: Thermal Insulation Manufacturers Association
40. UL: Underwriters' Laboratories
41. USDA: United States Department of Agriculture

J. Project Certification:

1. Each trade shall submit a project certification, guaranteeing that this project was constructed and will operate in accordance with the performance requirements of the Drawings and Specifications. This certification shall be signed by a principal of the firm and shall be delivered to the Architect/Engineer prior to final payment.

K. Drawings:

1. The Drawings are essentially diagrammatic in nature and show general arrangement of the equipment, piping, ductwork, accessories, etc. Because of the small scale of the Drawings, it is not possible to show each offsets, fittings, and accessories, which may be required. Carefully investigate the structural conditions, Architectural Drawings, Equipment Drawings, and the finished conditions of the work and arrange such work accordingly, furnish any fittings, pipe accessories that may be required to meet such conditions.
2. Any changes from the plans necessary to make the work conform to building as constructed and to fit work of other trades, or to conform to rules of the governing authorities and regulations, shall be met without extra cost to the Owner.
3. The layout of the piping, ductwork, equipment, etc., as shown on the Drawings shall be checked and exact locations shall be determined by the dimensions of equipment approved and Contractor shall obtain the Architect’s approval for revised layout before the apparatus is installed. Consult the Architectural, Structural, and Equipment Drawings

for the dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.

4. Refer to the Architectural Plans for details and large scale Drawings and to approved Shop Drawing of equipment furnished under other Contracts or Sections of the Specifications for exact location of service connections. The equipment Shop Drawings will be furnished to the Contractor before roughing in. Contractor shall not install any piping or ductwork for said equipment until they have received approved Coordination Drawings for same.

L. Minor Deviations:

1. The dimensions of equipment hereinafter specified or indicated on the Drawings are intended to establish the outlines and characteristics of such equipment in general. Minor deviations in dimensions will be permitted to allow the manufacturers specified to bid on their nearest stock equipment, provided the specified ratings are met or exceeded.
2. Where manufacturers' catalog numbers or types are mentioned in the Specifications or indicated on the Drawings, they are intended to be used as a guide only and shall not be interpreted as taking precedence over the basic rating and duty specified. In all cases, manufacturers shall verify the duty specified with particular characteristics of the equipment they intend to offer for approval and shall also pay the additional charges as may be required under other Divisions.

M. Interferences:

1. Before making any installation, the work of the trades must be coordinated and the necessary changes shall be made to avoid interferences or improper effect on work to be performed by any other Section. In the event that interferences develop, the Architect's decision will be final and no additional compensation will be allowed for moving of misplaced piping, ducts, conduit and/or equipment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Unless otherwise specified, all material and equipment incorporated in the work under the contract shall be new.

B. Material and equipment specified by one or more manufacturer's name, trade name and/or model number does not limit a bidder from bidding on other equipment providing the procedure set forth in the Conditions of the Contract and hereinafter specified is followed.

C. The various mechanical systems have been engineered and designed on equipment name and catalog numbers specified or designated on the Drawings.

D. A Contractor who intends to furnish equipment listed as approved equal shall proceed as follows:

1. Obtain Architect/Engineer's approval of said equipment.
2. Be fully responsible for said equipment.
3. Include in the Base Bid, all cost for any changes that may be required in his work and/or work of other trades for the proper installation and functioning of said equipment.

PART 3 - EXECUTION

3.1 ALTERATIONS IN PRESENT BUILDING AND SITE

A. Take particular note of the revisions and alterations of existing services, utilities, etc., due to the new construction as indicated on the Drawings and/or as required by alterations to the existing building.

1. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. The Trade Contractor involved with the interrupted service shall be responsible for accomplishing the required work whether shown on the Drawings or not.
2. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc. as required to be completely concealed after new work is complete.
3. In general, mechanical remodeling work is shown on the Mechanical Drawings but carefully study all Drawings for all contracts for "demolition" and "remodeling" work in the existing buildings and field check to verify locations where such work is being done to determine the exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on the Drawings.
4. Maintaining of Present Services: Maintain all services in the existing building. This shall include all temporary or permanent piping connections, etc., required to provide and maintain services to the present buildings and the equipment served. In the case of change over piping and ductwork or where new service connections are to be made to existing services and service interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the School. If the Owner's Representative directs that such work be performed during premium time hours then the Contractor shall be reimbursed for the premium time portion of the direct labor cost of the workmen actually performing the work. All costs (except for premium time portion of labor costs) incurred in order to comply with the foregoing shall be included in the Contractor's original bid for the work and without additional costs to the Board.
5. Remove or reroute, as required, all services at existing buildings to be demolished.

3.2 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, the Trade Contractor shall take possession of same and remove them from the site promptly, except as specified below or unless otherwise noted on Drawings.

B. All salvageable material and equipment, including but not necessarily limited to, electrical fixtures, conduit, wiring, plumbing fixtures, heating units, piping, valves, etc., shall be removed and maintained in as good condition as possible and turned over to the School. However, if the School decides any such materials are of no value, then they shall become the property of the Contractor who shall remove such discarded work from the premises and dispose of same.

C. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or systems, etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at the project site.

3.3 INSTALLATION

A. Each Trade Contractor shall be responsible for all of his work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Architect/Engineer.

B. Confer with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, etc., in order that there may be no interference between the installation of the progress of the work of any Trade Contractor on the

project. The Architectural Drawings shall take precedence over the Mechanical and Electrical Drawings.

C. The Mechanical Drawings are diagrammatic and shall be followed as closely as actual construction of the building and the work of other trade contractors will permit. All changes from Drawings necessary to make the work of each Contractor conform to the building construction and the work of other trade contractors shall be done at the appropriate Trade Contractor's expense.

D. Unless explicitly stated to the contrary, each Trade Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for a complete and operating installation.

E. All equipment and materials shall be installed according to the manufacturer's instructions unless otherwise specifically directed by the Trade Contract Documents. All piping, valves, connections, and other like items recommended by the manufacturer or required for proper operation shall be provided without additional cost to the Board.

F. All references to Contractors in Specifications and Drawings shall refer to the respective Trade Contractor performing that portion of the work.

G. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site, subject to review.

H. Where pipes are in partitions, furred out spaces and chases, obtain information as to their exact location and size and install work so as to be entirely concealed in the allotted space. If conflicts arise making this impossible, obtain instructions from the Architect/Engineer before proceeding with the work.

I. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and servicing.

J. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

K. Where there is evidence that parts of the Mechanical Work will interfere with other work, assist in working out space conditions and/or the structure, make necessary adjustments to accommodate the work.

L. Mechanical Work installed before coordinating with other work so as to cause interference with other work shall be changed to correct such condition without additional cost to the Board.

M. In no case shall any pipe, conduit, duct, or item of equipment be installed where it is supported on or suspended from another pipe, conduit, duct or item of equipment.

N. Where an item or task is specified to be provided "under this Section," it shall be understood that, that item or task is the responsibility of the trade responsible for that Section, but the work must be performed by qualified workmen of the appropriate trade.

O. Accessibility:

1. Install Mechanical work to permit removal (without damage to other parts) of coils, heat exchangers, pumps, fan shafts and wheels, belt guards, sheaves and drives, and other parts requiring periodic replacement or maintenance.
2. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, starters, motors, dampers, control components, and to clear the openings of swinging and overhead doors and of access panels.
3. Change dimensions of ductwork when required to meet job conditions but maintain the same equivalent cross-sectional area.
4. Provide access panels in equipment, ducts, and like items for inspection of interiors and proper maintenance.

END OF SECTION

SECTION 23 05 05 (LNK)

BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Concrete base construction requirements.
3. Dielectric fittings.
4. Equipment nameplate data requirements.
5. Nonshrink grout for equipment installations.
6. Field-fabricated metal and wood equipment supports.
7. Installation requirements common to equipment specification sections.
8. Mechanical demolition.
9. Cutting and patching.
10. Touchup painting and finishing.
11. Access panels.
12. Cleaning.

B. Pipe and pipe fitting materials are specified in Division 22 and Division 23.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. BS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. CR: Chlorosulfonated polyethylene synthetic rubber.
4. EPDM: Ethylene-propylene-diene terpolymer rubber.
5. NBR: Acrylonitrile-butadiene rubber.
6. PE: Polyethylene plastic.
7. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Refer to Division 01 Section "Product Requirements" for administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, access panels and identification materials and devices.

C. Coordination Drawings: For access panel and door locations.

D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Planned duct systems layout, including elbow radii and duct accessories.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
11. Access panel locations in ceilings/walls/floors.

1.4 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. American Society for Testing and Materials

a. ASTM A 53-98: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
b. ASTM B 32-96: Specification for Solder Metal
c. ASTM B 813-93: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
d. ASTM B 828-98: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
e. ASTM C 1107-97: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
f. ASTM C 1173-97: Specification for Flexible Transition Couplings for Underground Piping Systems
g. ASTM D 1785-96b: Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
h. ASTM D 2235-96a: Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

i. ASTM D 2564-96a: Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
j. ASTM D 2672-96a: Specification for Joints for IPS PVC Pipe Using Solvent Cement
k. ASTM D 2855-96: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
l. ASTM D 3139-98: Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
m. ASTM F 402-93: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermostatic Pipe and Fittings
n. ASTM F 493-97: Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
o. ASTM F 656-96a: Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

2. American Water Works Association

a. AWWA C110-98: Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In. (76 mm through 1219 mm), for Water and Other Liquids
b. AWWA C219-97: Bolted, Sleeve-Type Couplings for Plain-End Pipe

3. American Welding Society

a. AWS A5.8-92: Specification for Filler Metals for Brazing and Braze Welding
b. AWS D1.1-98: Structural Welding Code--Steel
c. AWS D10.12-89: Recommended Practices and Procedures for Welding Low Carbon Steel Pipe
d. Brazing Handbook. 1991.

4. ASME International

a. ASME B1.20.1-83 (Reaffirmed 1992): Pipe Threads, General Purpose (Inch)
b. ASME B16.21-92: Nonmetallic Flat Gaskets for Pipe Flanges
c. ASME B18.2.1-96: Square and Hex Bolts and Screws--Inch Series
d. ASME B31 Series: Code for Pressure Piping
e. 1998 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"

5. Copper Development Association Inc.

a. Copper Tube Handbook. 1995.

6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

a. MSS SP-107-91: Transition Union Fittings for Joining Metal and Plastic Products

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate phasing and sequencing of all work with the Owner and Building Engineer.

B. Coordinate mechanical equipment installation with other building components.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Coordinate installation of required supporting devices and sleeves in poured-in-place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

H. Coordinate connection of electrical services.

1.7 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Dielectric Unions: No preference.
2. Dielectric Flanges: No preference.
3. Dielectric-Flange Insulating Kits: No preference.
4. Dielectric Couplings: No preference.
5. Dielectric Nipples: No preference.
6. Metal, Flexible Connectors:

    a. Grinnell Corp.; Grinnell Supply Sales Co..
    b. Mercer Rubber Co.
    c. Metraflex Co.

7. Rubber, Flexible Connectors:

    a. General Rubber Corp.
    b. Metraflex Co.
    c. Red Valve Co., Inc.

8. Grooved Fittings:

    a. Grinnell Corp.; Grinnell Supply Sales Co.
    b. Victaulic Company of America.
    c. Central Sprinkler.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 and Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2-Inch NPS and Smaller: Threaded.
2. 2-1/2-Inch NPS and Larger: Flanged.
3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

B. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose. Do not use for potable water.

C. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose. Do not use for potable water.

D. Couplings may be used to provide allowance for controlled pipe movement, expansion, contraction, and or deflection to absorb movement for thermal changes, setting or seismic action and also vibration attenuation.

2.6 ACCESS PANELS

A. General: Refer to Division 08 Section, "Access Doors and Frames," for access panel manufacturers and other requirements.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Remove and cap all inactive or abandoned piping and ductwork in mechanical rooms. Larger duct and pipe located in accessible areas shall be removed and capped at the discretion of the contractor with concurrence of Owner and Building Engineer.

C. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated on the drawings to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

M. Verify final equipment locations for roughing-in.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
3. Align threads at point of assembly.
4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.6 PAINTING AND FINISHING

A. Refer to Division 09 Section "Painting" for paint materials, surface preparation, and application of paint.

B. Do not paint piping specialties with factory-applied finish.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.8 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's written instructions.

3.9 CLEANING

A. Coordinate general cleanup with the work as specified in Division 1.

3.10 ACCESS PANELS

A. Where control valves, shut-off valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, the Trade Contractor whose equipment is involved shall furnish and install access panels as required.

B. Each Trade shall confer with other trades with respect to access panel locations, and shall wherever practical group valves, traps, dampers, etc. in such a way as to be accessible from a single panel and eliminate as many access panels as possible.

3.11 ERECTION

A. Provide all necessary rigging, scaffolding, tools, tackle, labor and other like items necessary for the complete installation of the equipment.

B. Adapt his work to job conditions and install his work to clear beams, joists and light fixtures, adjusting risers, avoiding interferences with windows and openings, raising or lowering work to permit the passing of ductwork or the work of other trades, all as required or as job conditions dictate, without additional costs to the Owner.

C. Trade Contractor shall not rig, tie to, or rest weight upon any part of the building or make use of any stairway until specific permission is obtained.

1. Permission to rig to or make use of any part of the building premises shall not relieve the contractor of responsibility for any damage.

D. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

E. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.13 OPENINGS

A. Where temporary openings are necessary thru walls and partitions of the building for the entry or installation of tanks, fans, or other machinery or apparatus, or for driveways and other facilities, the permanent work of the mechanical trades at said openings shall be temporarily omitted and installed after equipment is brought into the building or after temporary facilities are removed.

B. Refer to other Sections of the Specifications for framing of openings for ducts, grilles, registers, etc., in walls, partitions, floors, roofs, etc. The trade for each service shall be responsible for locating and providing the proper dimensions for all required openings.

1. Space between ducts and wall or floor openings shall be sealed as specified in Division 07 Section "Penetration Firestopping."

C. No cutting or drilling of any building structural members will be permitted, unless the specific extent and limits are approved, in writing, by the Architect.

D. All openings in the existing structure shall be core drilled with a diamond drill. The use of jackhammers will not be permitted.

E. The Contractor shall notify the Architect if any existing openings are uncovered adjacent to location of a new opening. The new opening shall not be drilled if the existing can be used unless directed by the Architect.

END OF SECTION

SECTION 23 05 05 (MEP)

BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Equipment nameplate data requirements.
4. Field-fabricated metal and wood equipment supports.
5. Installation requirements common to equipment specification sections.
6. Mechanical demolition.
7. Cutting and patching.
8. Touchup painting and finishing.
9. Access panels.
10. Cleaning.

B. Pipe and pipe fitting materials are specified in Division 22 and Division 23.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. BS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. CR: Chlorosulfonated polyethylene synthetic rubber.
4. EPDM: Ethylene-propylene-diene terpolymer rubber.
5. NBR: Acrylonitrile-butadiene rubber.
6. PE: Polyethylene plastic.
7. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Refer to Division 01 Section “Submittal Procedures” for administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, access panels and identification materials and devices.

C. Coordination Drawings: For access panel and door locations.

D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Planned duct systems layout, including elbow radii and duct accessories.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
11. Access panel locations in ceilings/walls/floors.

1.4 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. American Society for Testing and Materials

a. ASTM A 53-98: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
b. ASTM B 32-96: Specification for Solder Metal
c. ASTM B 813-93: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
d. ASTM B 828-98: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
e. ASTM C 1107-97: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
f. ASTM C 1173-97: Specification for Flexible Transition Couplings for Underground Piping Systems
g. ASTM D 1785-96b: Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
h. ASTM D 2235-96a: Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

i. ASTM D 2564-96a: Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
j. ASTM D 2672-96a: Specification for Joints for IPS PVC Pipe Using Solvent Cement
k. ASTM D 2855-96: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
l. ASTM D 3139-98: Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
m. ASTM F 402-93: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermostatic Pipe and Fittings
n. ASTM F 493-97: Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
o. ASTM F 656-96a: Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

2. American Water Works Association

a. AWWA C110-98: Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In. (76 mm through 1219 mm), for Water and Other Liquids
b. AWWA C219-97: Bolted, Sleeve-Type Couplings for Plain-End Pipe

3. American Welding Society

a. AWS A5.8-92: Specification for Filler Metals for Brazing and Braze Welding
b. AWS D1.1-98: Structural Welding Code--Steel
c. AWS D10.12-89: Recommended Practices and Procedures for Welding Low Carbon Steel Pipe
d. Brazing Handbook. 1991.

4. ASME International

a. ASME B1.20.1-83 (Reaffirmed 1992): Pipe Threads, General Purpose (Inch)
b. ASME B16.21-92: Nonmetallic Flat Gaskets for Pipe Flanges
c. ASME B18.2.1-96: Square and Hex Bolts and Screws--Inch Series
d. ASME B31 Series: Code for Pressure Piping
e. 1998 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"

5. Copper Development Association Inc.

a. Copper Tube Handbook. 1995.

6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

a. MSS SP-107-91: Transition Union Fittings for Joining Metal and Plastic Products

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate phasing and sequencing of all work with the Owner and Building Engineer.

B. Coordinate mechanical equipment installation with other building components.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Coordinate installation of required supporting devices and sleeves in poured-in-place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

H. Coordinate connection of electrical services.

1.7 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 and Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 ACCESS PANELS

A. General: Refer to Division 08 Section, "Access Doors and Frames," for access panel manufacturers and other requirements.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Remove and cap all inactive or abandoned piping and ductwork in mechanical rooms. Larger duct and pipe located in accessible areas shall be removed and capped at the discretion of the contractor with concurrence of Owner and Building Engineer.

C. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated on the drawings to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

L. Verify final equipment locations for roughing-in.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
3. Align threads at point of assembly.
4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.6 PAINTING AND FINISHING

A. Refer to Division 09 Section "Painting" for paint materials, surface preparation, and application of paint.

B. Do not paint piping specialties with factory-applied finish.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.8 CLEANING

A. Coordinate general cleanup with the work as specified in Division 1.

3.9 ACCESS PANELS

A. Where control valves, shut-off valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, the Trade Contractor whose equipment is involved shall furnish and install access panels as required.

B. Each Trade shall confer with other trades with respect to access panel locations, and shall wherever practical group valves, traps, dampers, etc. in such a way as to be accessible from a single panel and eliminate as many access panels as possible.

3.10 ERECTION

A. Provide all necessary rigging, scaffolding, tools, tackle, labor and other like items necessary for the complete installation of the equipment.

B. Adapt his work to job conditions and install his work to clear beams, joists and light fixtures, adjusting risers, avoiding interferences with windows and openings, raising or lowering work to permit the passing of ductwork or the work of other trades, all as required or as job conditions dictate, without additional costs to the Owner.

C. Trade Contractor shall not rig, tie to, or rest weight upon any part of the building or make use of any stairway until specific permission is obtained.

1. Permission to rig to or make use of any part of the building premises shall not relieve the contractor of responsibility for any damage.

D. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

E. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 OPENINGS

A. Where temporary openings are necessary thru walls and partitions of the building for the entry or installation of tanks, fans, or other machinery or apparatus, or for driveways and other facilities, the permanent work of the mechanical trades at said openings shall be temporarily omitted and installed after equipment is brought into the building or after temporary facilities are removed.

B. Refer to other Sections of the Specifications for framing of openings for ducts, grilles, registers, etc., in walls, partitions, floors, roofs, etc. The trade for each service shall be responsible for locating and providing the proper dimensions for all required openings.

1. Space between ducts and wall or floor openings shall be sealed as specified in Division 07 Section "Penetration Firestopping."

C. No cutting or drilling of any building structural members will be permitted, unless the specific extent and limits are approved, in writing, by the Architect.

D. All openings in the existing structure shall be core drilled with a diamond drill. The use of jackhammers will not be permitted.

E. The Contractor shall notify the Architect if any existing openings are uncovered adjacent to location of a new opening. The new opening shall not be drilled if the existing can be used unless directed by the Architect.

END OF SECTION

SECTION 23 05 13 (LNK)

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.

C. NEMA MG 1 - Motors and Generators; 2017.

D. NFPA 70 - National Electrical Code; 2017.

1.03 QUALITY ASSURANCE

A. Conform to NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.05 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
   1. Compatible with the following:
      a. Magnetic controllers.
      b. Multispeed controllers.
      c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.06 WARRANTY

A. Written manufacturer's warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group

B. General Electric

C. Lincoln Motors

D. Marathon

E. Reliance

F. U.S. Motors

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors Larger than 1/2 Horsepower: 460 volts, three phase, 60 Hz.

B. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

B. Motors located outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. All three phase motors shall be rated for VFD applications.

G. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

L. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

M. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.08 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:
   1. Commercial:
      a. Through-the-Wall Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the through-the-wall unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) RPM: 300 through 1250.
      b. Hydronic Fan Coil Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the fan coil unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) Options: User-interface.

5) RPM: 300 through 1250.

c. Package Terminal Air Conditioner (PTAC):
   1) Operating Mode: Constant speed.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PTAC and/or specified sequence of operation.
   3) Shaft Extension: Single.
   4) Options: Resilient mounting.
   5) RPM: 600 through 1800.

d. Power Roof Ventilator and Inline Centrifugal Fans(PRV):
   1) Operating Mode: Constant cfm.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
   3) Shaft Extension: Single.
   4) Options: Remote mount control.

e. Fan Powered Boxes (FPB):
   1) Operating Mode: Constant cfm.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
   3) Shaft Extension: Single.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Check line voltage and phase and ensure agreement with nameplate.

3.02 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

A. Prepare for acceptance tests.
   1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
   2. Verify bearing lubrication.
   3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   4. Test interlocks and control and safety features for proper operation.
   5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

3.03 CLEANING

A. Comply with applicable requirements in Division 23 Section "HVAC Equipment Cleaning."

END OF SECTION 23 05 13

SECTION 23 05 13 (MEP)

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.

C. NEMA MG 1 - Motors and Generators; 2017.

D. NFPA 70 - National Electrical Code; 2017.

1.03 QUALITY ASSURANCE

A. Conform to NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.05 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
   1. Compatible with the following:
      a. Magnetic controllers.
      b. Multispeed controllers.
      c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.06 WARRANTY

A. Written manufacturer's warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group

B. General Electric

C. Lincoln Motors

D. Marathon

E. Reliance

F. U.S. Motors

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A. Electrical Service:
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2. Motors Larger than 1/2 Horsepower: 460 volts, three phase, 60 Hz.

B. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

B. Motors located outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. All three phase motors shall be rated for VFD applications.

G. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

L. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

M. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.08 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:
   1. Commercial:
      a. Through-the-Wall Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the through-the-wall unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) RPM: 300 through 1250.
      b. Hydronic Fan Coil Unit:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the fan coil unit and/or specified sequence of operation.
         3) Shaft Extension: Single.
         4) Options: User-interface.

5) RPM: 300 through 1250.

c. Package Terminal Air Conditioner (PTAC):
   1) Operating Mode: Constant speed.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PTAC and/or specified sequence of operation.
   3) Shaft Extension: Single.
   4) Options: Resilient mounting.
   5) RPM: 600 through 1800.

d. Power Roof Ventilator and Inline Centrifugal Fans(PRV):
   1) Operating Mode: Constant cfm.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
   3) Shaft Extension: Single.
   4) Options: Remote mount control.

e. Fan Powered Boxes (FPB):
   1) Operating Mode: Constant cfm.
   2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
   3) Shaft Extension: Single.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Check line voltage and phase and ensure agreement with nameplate.

3.02 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

A. Prepare for acceptance tests.
   1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
   2. Verify bearing lubrication.
   3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   4. Test interlocks and control and safety features for proper operation.
   5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

3.03 CLEANING

A. Comply with applicable requirements in Division 23 Section "HVAC Equipment Cleaning."

END OF SECTION 23 05 13

SECTION 23 05 19 (LNK)

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pressure gages and pressure gage taps.

B. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.

C. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

C. Project Record Documents: Record actual locations of components and instrumentation.

D. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer's instructions for job site storage and protection of materials during construction.

PART 2 - PRODUCTS

2.01 PRESSURE GAGES

A. Manufacturers:
1. Ashcroft
2. Trerice
3. Weiss Instruments

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, glass window, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi and KPa.
5. Range: 2 times operating pressure.

2.02 PRESSURE GAGE TAPPINGS

A. Needle Valve: Stainless Steel or 1/4 inch NPT for minimum 150 psi.

B. Pulsation Damper: ASME B40.5 Pressure snubber, brass with 1/4 inch connections.

C. Syphon: Brass, 1/4 inch angle or straight pattern, threaded ends.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
1. Weksler Glass Thermometer Corp
2. Palmer
3. Trerice
4. Weiss Instruments, Inc.
5. Miljoco

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
2. Window: Clear glass.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 1 percent.
5. Calibration: Degrees F.

2.04 THERMOWELLS

A. Socket: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.
1. Manufacturers:
   a. Ashcroft
   b. Trerice
   c. Weiss Instruments
2. Stem length: Extend 2 inches into the fluid or into the center of the pipe. Extension for insulated pipe shall be 2 inches nominal, but not less than the thickness of the insulation.
3. Provide threaded cap nut with chain permanently fastened to well and cap.

2.05 TEST PLUGS

A. Manufacturers:
1. MG Piping Products
2. Trerice
3. Watts Industries

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

D. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.

E. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.

F. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages (0-200 psi), one gage adapters with 1/8 inch probes, two 1 inch dial thermometers (one 25-125 deg. F and one 0-220 deg F).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gauge. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

C. Provide instruments with scale ranges selected according to service with largest appropriate scale.

D. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

E. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to manufacturers written instructions, after installation.

F. Locate test plugs adjacent thermometers and thermometer sockets.

G. Apply conductive paste to the thermometer or temperature sensor prior to installing it in the thermowell.

H. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

I. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

J. Install test plugs in tees in piping. Provide a test plug at every thermometer and pressure gage location, and where indicated on the Drawings.

3.02 SCHEDULE

A. THERMOMETER APPLICATIONS
1. Install liquid-in-glass thermometers in the following locations and elsewhere as noted:
   a. Inlet and outlet of each hydronic heat exchanger.
   b. As indicated on Drawings.
2. Provide the following temperature ranges for thermometers:
   a. Heating Hot Water (Non-condensing boiler applications): 30 to 300 deg F, with 2-degree scale divisions.

B. GAGE APPLICATIONS
1. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
2. Install dry-case-type pressure gages at suction and discharge of each pump.
3. Install gages as indicated on Drawings.

END OF SECTION 23 05 19

SECTION 23 05 23 (LNK)

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Applications.

B. General requirements.

C. Globe valves.

D. Ball valves.

E. Check valves.

F. Plug valves.

G. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Tetrafluoroethylene.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2015.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2017.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2017.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

F. ASME B16.34 - Valves - Flanged, Threaded and Welding End; 2017.

G. ASME B31.9 - Building Services Piping; 2014.

H. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

I. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2003 (Reapproved 2016).

J. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).

K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.

L. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.

M. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.

N. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.

O. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends; 2011.

P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

Q. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves; 2010.

1.04 SUBMITTALS

A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

B. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

C. Maintenance Materials: Furnish Board with one wrench for every five plug valves, in each size of square plug valve head.
1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

A. Manufacturer:
1. Obtain valves for each valve type from single manufacturer.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

C. ASME Compliance: ASME B31.9 for building services piping valves.

D. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
2. Protect valve parts exposed to piped medium against rust and corrosion.
3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
4. Adjust globe and angle valves to the closed position to avoid clattering.
5. Secure check valves in either the closed position or open position.
6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
a. Provide temporary inlet and outlet caps.
b. Maintain caps in place until installation.
2. Store valves in shipping containers and maintain in place until installation.
a. Store valves indoors in dry environment.
b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
1. Handle large valves with sling, modified to avoid damage to exposed parts.
2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Provide the following valves for the applications if not indicated on drawings:
1. Throttling (Hydronic): Ball, and Globe.
2. Isolation (Shutoff): Ball, and Plug.
3. Swing Check (Pump Outlet):
a. 2 NPS and Smaller: Bronze with bronze disc.
b. 2-1/2 NPS and Larger: Iron with lever and spring.

C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

D. Heating Hot Water Valves:
1. 2 NPS and Smaller, Bronze Valves:
a. Threaded ends.
b. Ball: Full port, two piece, bronze trim.
c. Swing Check: Bronze disc, Class 125.
d. Globe: Bronze disc, Class 125.

E. Low Pressure Steam Valves (15 PSIG or Less):
1. 2 NPS and Smaller, Bronze Valves:
a. Ball: Full port, twopiece, bronze trim.
b. Swing Check: Bronze disc, Class 125.
c. Globe: Bronze disc, Class 125.
2. 2-1/2 NPS and Larger, Iron Valves:
a. 2-1/2 NPS to 4 NPS: Flanged ends.
b. Ball: 2-1/2 NPS to 10 NPS, Class 150.
c. Swing Check: 2-1/2 NPS to 12 NPS, lever and spring closure. control, Class 125.
d. Globe: 2-1/2 NPS to 12 NPS: Class 125.

F. Steam-Condensate Valves:

1. 2 NPS and Smaller, Bronze Valves:
   a. Gate: NRS, Class 125.
   b. Ball: Full port, two piece, bronze trim.
   c. Globe: Bronze disc, Class 125.
2. 2-1/2 NPS and Larger, Iron Valves:
   a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
   b. Swing Check: Lever and spring closure control, Class 125.
   c. Gate: OSY, Class 125.
   d. Globe: 2-1/2 NPS to 12 NPS, Class 125.
   e. Lubricated Plug: Threaded, cylindrical, threaded, Class 125.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
2. Handwheel: Valves other than quarter-turn types.
3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
4. Wrench: Plug valves with square heads.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
1. Gate Valves: Rising stem.
2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 2 1/2 NPS through 24 NPS: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.

F. General ASME Compliance:
1. Building Services Piping Valves: ASME B31.9.

G. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE GLOBE VALVES

A. Class 125: CWP Rating: 200 psig:, and Class 150: CWP Rating: 300 psig:.
1. Comply with MSS SP-80, Type 1.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded or solder joint.
4. Stem: Silicon Bronze-alloy
5. Disc: Bronze or PTFE.
6. Packing: Asbestos free.
   a. Handwheel: Malleable iron.
   b. Manufacturers:

1) Crane Co.
2) Milwaukee Valve Company
3) NIBCO, Inc.
4) Apollo Valve

2.04 IRON GLOBE VALVES

A. Class 125: CWP Rating: 200 psig:.
1. Comply with MSS SP-85, Type I.
2. Body: Gray iron; ASTM A126, with bolted bonnet.
3. Ends: Flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free, teflon-impregnated packing with bronze nut.
6. Operator: Aluminum or malleable-iron handwheel or chainwheel.
7. Manufacturers:
a. Crane Co.
b. Milwaukee Valve Company
c. NIBCO, Inc.
d. Apollo Valve

2.05 BRONZE BALL VALVES

A. Two Piece, Full Port with Bronze or Brass Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Bronze.
5. Ends: Threaded or soldered.
6. Seats: PTFE .
7. Stem: Bronze or brass.
8. Ball: Chrome plated brass.
9. Manufacturers:
a. Conbraco Industries
b. Crane Co.
c. NIBCO, Inc.
d. Watts Industries
e. Apollo Valve

2.06 IRON BALL VALVES

A. Split Body, Full Port:
1. Comply with MSS SP-72.
2. CWP Rating: 200 psig.
3. Body: ASTM A126, gray iron.
4. Ends: Flanged.
5. Seats: PTFE.
6. Stem: Stainless steel.
7. Ball: Stainless steel.

2.07 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa) and Class 150: CWP Rating: 300 psig (2070 kPa).
1. Comply with MSS SP-80, Type 3.
2. Body Design: Horizontal flow.
3. Body Material: Bronze, ASTM B62.

4. Ends: Threaded.
5. Disc: Bronze.
6. Manufacturers:
   a. Crane Co.
   b. Milwaukee Valve Company
   c. NIBCO, Inc.
   d. Watts Industries
   e. Apollo Valve

2.08 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Compact-Wafer:
1. Comply with MSS SP-125.
2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. Body Material: ASTM A126, gray iron.
4. Metal Seat: Bronze.
5. Resilient Seat: Buna N.
6. Manufacturers:
   a. Crane Co.
   b. NIBCO, Inc.
   c. Watts Industries
   d. Apollo Valve

2.09 LUBRICATED PLUG VALVES

A. Regular Gland and Cylindrical with Threaded Ends:
1. Comply with MSS SP-78, Type II.
2. Class 125: 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. Body Material: Cast iron with lubrication sealing system.
4. Pattern: Regular or short.
5. Plug: Cast iron or bronze with sealant groove.
6. Operator:
   a. Lever for valves 5" and smaller
   b. Worm and gear with handwheel for valves 6" and larger
   c. Worm and gear with chain wheel, sizes 6 inches and larger, 96 inches or higher above floor.
7. Manufacturers:
   a. General Signal; DeZurik Unit.
   b. Grinnell Corporation.
   c. Tyco International, Ltd.; Tyco Valves & Controls.

2.10 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, and plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

B. Manufacturers:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Verify valve parts to be fully operational in all positions from closed to fully open.

E. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

F. Should valve is determined to be defective, replace with new valve.

G. Examine threads on valve and mating pipe for form and cleanliness.

H. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

I. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

J. Confirm valve component material is appropriate for hydronic systems using propylene or ethylene glycol.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

H. Provide chainwheels on operators for valves 4 NPS and larger where located 96 NPS or more above finished floor, terminating 60 NPS above finished floor.

END OF SECTION 23 05 23

SECTION 23 05 53 (LNK)
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.
B. Pipe markers.
C. Identification Signs
D. Warning Tags
E. Warning Signs and Labels

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Samples: For color, letter style, and graphic representation required for each identification material and device.
F. Project Record Documents: Record actual locations of tagged valves.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry and secure area on-site and protect against dirt and moisture damage
B. Do not apply or install damaged materials.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Letter Color: White.
B. Letter Height: 1/4 inch.
C. Label Content: Include Project number, equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data. See sample equipment schedule at the end of Part 3.

2.02 PIPE MARKERS

A. Color: Comply with ASME A13.1.
B. Plastic Coiled Pipe Markers
C. Pipe Marker Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
    1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe marker to indicate flow direction.
    2. Lettering Size: At least 1-1/2 inches high.

2.03 IDENTIFICATION SIGNS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative
J. Identification Signs are required for the following elements:
    1. “Gas Shut Off Valve” location at location of shut off button
    2. “Refrigerant Alarm” at alarm light outside of Chiller Room
    3. “Refrigerant Breathing Equipment” location near equipment locker or cabinet
    4. “Gas Usage Within Space” warning light adjacent to light outside of space
    5. “Emergency Boiler Shut Off” push button locations above buttons

2.04 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
    1. Size: Approximately 4 by 7 inches.
    2. Fasteners: Reinforced grommet and wire.
    3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
    4. Color: Safety yellow background with black lettering.

2.05 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: Yellow.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install plastic pipe markers in accordance with manufacturer's instructions.
C. Equipment Label Installation
    1. Install or permanently fasten labels on each major item of mechanical equipment.

2. Locate equipment labels where accessible and visible.

D. Pipe Label Installation
   1. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      a. Near each valve and control device.
      b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      d. At access doors, manholes, and similar access points that permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
      g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
   2. Pipe Label Color Schedule:
      a. Air-Conditioning Condensate Piping: Gray Background, White Lettering
      b. Heating Hot Water: Black Background, White Lettering
      c. Natural Gas Piping: Yellow Background, Black Lettering
      d. Refrigerant Piping: Orange Background, Black Lettering
      e. Steam Piping: Yellow Background, Black Lettering
      f. Steam Condensate Piping: Yellow Background, Black Lettering
      g. Makeup Water Piping: Green Background, White Lettering

E. Identification-Sign Installation
   1. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
      a. Identification Sign should be placed according to the equipment identified in paragraph 2.05-J above.

F. Warning-Tag Installation
   1. Write required message on, and attach warning tags to, equipment and other items where required.

G. Flow Diagrams
   1. Provide laminated system flow diagrams for each hydronic and air system and include with the tag schedules.

3.04 SAMPLE SCHEDULES

A. The following tables are examples of schedules required to be submitted by the Contractor. Example information has been included in the first row of the tables for reference only.

EQUIPMENT LABEL SCHEDULE				
EQUIPMENT IDENTIFICATION	**EQUIPMENT LOCATION**	**SPEC NUMBER**	**SPEC TITLE**	**REMARKS**
AHU-1	MECHANICAL ROOM M-215	23 XX XX	XX	MODULAR INDOOR AIR HANDLING UNITS

END OF SECTION

SECTION 23 05 53 (MEP)
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.
B. Pipe markers.
C. Identification Signs
D. Warning Tags
E. Warning Signs and Labels

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Samples: For color, letter style, and graphic representation required for each identification material and device.
F. Project Record Documents: Record actual locations of tagged valves.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry and secure area on-site and protect against dirt and moisture damage
B. Do not apply or install damaged materials.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Letter Color: White.
B. Letter Height: 1/4 inch.
C. Label Content: Include Project number, equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data. See sample equipment schedule at the end of Part 3.

2.02 PIPE MARKERS

A. Color: Comply with ASME A13.1.
B. Plastic Coiled Pipe Markers
C. Pipe Marker Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
    1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe marker to indicate flow direction.
    2. Lettering Size: At least 1-1/2 inches high.

2.03 IDENTIFICATION SIGNS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative
J. Identification Signs are required for the following elements:
   1. “Gas Shut Off Valve” location at location of shut off button
   2. “Refrigerant Alarm” at alarm light outside of Chiller Room
   3. “Refrigerant Breathing Equipment” location near equipment locker or cabinet
   4. “Gas Usage Within Space” warning light adjacent to light outside of space
   5. “Emergency Boiler Shut Off” push button locations above buttons

2.04 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Reinforced grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Safety yellow background with black lettering.

2.05 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: Yellow.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install plastic pipe markers in accordance with manufacturer's instructions.
C. Equipment Label Installation
   1. Install or permanently fasten labels on each major item of mechanical equipment.

2. Locate equipment labels where accessible and visible.

D. Pipe Label Installation
   1. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      a. Near each valve and control device.
      b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      d. At access doors, manholes, and similar access points that permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
      g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
   2. Pipe Label Color Schedule:
      a. Air-Conditioning Condensate Piping: Gray Background, White Lettering
      b. Natural Gas Piping: Yellow Background, Black Lettering
      c. Refrigerant Piping: Orange Background, Black Lettering

E. Identification-Sign Installation
   1. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
      a. Identification Sign should be placed according to the equipment identified in paragraph 2.05-J above.

F. Warning-Tag Installation
   1. Write required message on, and attach warning tags to, equipment and other items where required.

G. Flow Diagrams
   1. Provide laminated system flow diagrams for each hydronic and air system and include with the tag schedules.

3.04 SAMPLE SCHEDULES

A. The following tables are examples of schedules required to be submitted by the Contractor. Example information has been included in the first row of the tables for reference only.

EQUIPMENT LABEL SCHEDULE				
EQUIPMENT IDENTIFICATION	**EQUIPMENT LOCATION**	**SPEC NUMBER**	**SPEC TITLE**	**REMARKS**
AHU-1	MECHANICAL ROOM M-215	23 XX XX	XX	MODULAR INDOOR AIR HANDLING UNITS

END OF SECTION

SECTION 23 05 93 (LNK)
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic systems.
C. Measurement of final operating condition of HVAC systems.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, Adjusting, and Balancing.
D. TAB Firm: Entity responsible for performing and reporting TAB procedures.
E. TAB Specialist: Entity engaged by TAB Firm to perform TAB work.

1.03 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.
B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods 2016.
C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).
D. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems 2015, with Errata (2017).
E. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
    1. Submit to Architect/Engineer of Record.
    2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
    3. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect/Engineer of Record and other installers to sufficiently understand the design intent for each system.
    4. Include at least the following in the plan:
        a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
        b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
        c. Final test report forms to be used.
D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
    1. Revise TAB plan to reflect actual procedures and submit as part of final report.
    2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer of Record and for inclusion in operating and maintenance manuals.
    3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.

4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
5. Units of Measure: Report data in I-P (inch-pound) units only.

E. Sample report forms. Submit two copies of the sample TAB report forms

1.05 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. Certification of TAB Reports: Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB forms from NEBB or AABC as well as providing any additional information required by this specification.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE Std 111, Section 5, "Instrumentation."

E. Board reserves the right to select at random 10% of the TAB report data for field verification witnessed by the commission agent. The TAB contractor will be given sufficient notice of the date of field verification. The same instruments that were used when the original test was recorded shall be used. A failure of more than 10% of the selected field verification items shall result in a repeat of the testing of the entire system at the TAB contractor's expense. The repeated work is also subject to field verification.

1.06 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.07 WARRANTY

A. Provide warranty in accordance with AABC or NEBB standards:
1. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
2. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
3. Guarantee shall include the following provisions:
a. The certified TAB firm has tested and balanced systems according to the Contract Documents.
b. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
   4. SMACNA (TAB).

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

3.02 EXAMINATION

A. Examine the Contract Documents and field conditions to become familiar with Project requirements and to discover conditions that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
   7. Fans are rotating correctly.
   8. Fire and volume dampers are in place and open.
   9. Terminal units, such as variable-air-volume boxes, are accessible and their controls are connected and functioning.
   10. Air coil fins are cleaned and combed.
   11. Access doors are closed and duct end caps are in place.
   12. Air outlets are installed and connected.
   13. Duct system leakage is minimized.
   14. Hydronic systems are flushed, filled, and vented.
   15. Pumps are rotating correctly.
   16. Air has been eliminated from closed loop hydronic systems.
   17. Proper strainer baskets are clean and in place.
   18. Service and balance valves are open.
   19. Installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers- verify that locations of these balancing devices are accessible and all required devices have been installed for proper balancing of the systems.

D. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

E. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide a TAB Plan that includes strategies and step-by-step procedures.

C. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer of Record to facilitate spot checks during testing.

D. Provide additional balancing devices as required.

3.04 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust fans to deliver the design air flow capacity at the design static pressure. Fan sheaves shall be replaced as necessary to obtain desired results. Provide all labor and material.

E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

M. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
O. On fan powered VAV boxes, adjust air flow switches for proper operation.
P. Balance all individual air inlets and outlets.

3.06 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.
B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
D. Effect system balance with automatic control valves fully open to heat transfer elements.
E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
G. Report flow rates that are not within plus/minus 10 percent of design flow.

3.07 HEAT EXCHANGER PROCEDURE

A. Measure water flow through all circuits.
B. Adjust water flow to within specified tolerances.
C. Measure inlet and outlet water temperatures.
D. Measure inlet steam pressure.
E. Check settings and operation of safety and relief valves. Record settings.

3.08 MOTOR PROCEDURE

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
    1. Manufacturer's name, model number, and serial number.
    2. Motor horsepower rating.
    3. Motor rpm.
    4. Efficiency rating.
    5. Nameplate and measured voltage, each phase.
    6. Nameplate and measured amperage, each phase.
    7. Starter thermal-protection-element rating.
B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.09 HEAT TRANSFER COIL PROCEDURE

A. PROCEDURES FOR HEAT-TRANSFER COILS
    1. Measure, adjust, and record the following data for each water coil:
        a. Water flow rate.
        b. Water pressure drop.
        c. Airflow.
        d. Air pressure drop.
    2. Measure, adjust, and record the following data for each steam coil:
        a. Dry-bulb temperature of entering and leaving air.

b. Airflow.
c. Air pressure drop.
d. Inlet steam pressure.

3. Measure, adjust, and record the following data for each refrigerant coil:
   a. Dry-bulb temperature of entering and leaving air.
   b. Wet-bulb temperature of entering and leaving air.
   c. Airflow.
   d. Air pressure drop.
   e. Refrigerant suction pressure and temperature.

3.10 TEMPERATURE CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.
B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
C. Record controller settings and note variances between set points and actual measurements.
D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
G. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

A. Set HVAC system air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.

3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.

d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Number, type, and size of filters.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.

d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm
b. Air velocity in fpm
c. Preliminary air flow rate as needed in cfm
d. Preliminary velocity as needed in fpm
e. Final air flow rate in cfm
f. Final velocity in fpm
g. Space temperature in deg F

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm
b. Watrer flow rate in gpm.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Water pressure drop in feet of head or psig.
f. Entering-air temperature in deg F.
g. Leaving-air temperature in deg F.

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
a. Unit identification.
b. Location.

c. Service.
d. Make and size.
e. Model number and serial number.
f. Fluid flow rate in gpm
g. Fluid pressure differential in feet of head or psig
h. Required net positive suction head in feet of head or psig
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor horsepower and rpm.
l. Voltage at each connection.
m. Amperage for each phase.
n. Full-load amperage and service factor.

2. Test Data (Indicated and Actual Values): All values measured in a fluid other than water will include the measured value corrected to the equivalent in water.
   a. Static head in feet of head or psig,
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final fluid flow rate in gpm.
   j. Voltage, phase to phase.
   k. Amperage for each phase.

K. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Low ambient temperature cutoff in deg F.
2. Test Data (Indicated and Actual Values):
   a. Entering-air, dry-bulb temperature in deg F.
   b. Leaving-air, dry-bulb temperature in deg F.
   c. Control settings.
   d. Unloader set points.
   e. Low-pressure-cutout set point in psig.
   f. High-pressure-cutout set point in psig.
   g. Suction pressure in psig.
   h. Suction temperature in deg F.
   i. Condenser refrigerant pressure in psig.
   j. Condenser refrigerant temperature in deg F.
   k. Voltage at each connection.
   l. Amperage for each phase.
   m. Number of fans.
   n. Condenser fan motor voltage at each connection.

o. Condenser fan motor amperage for each phase.

L. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Ratings.
2. Steam Test Data (Indicated and Actual Values):
   a. Inlet pressure in psig.
   b. Condensate flow rate in lb/h.
3. Primary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Board’s Representative.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Board' Representative.
3. The Board's Representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Board may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 05 93 (MEP)
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of refrigerating systems.
C. Measurement of final operating condition of HVAC systems.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, Adjusting, and Balancing.
D. TAB Firm: Entity responsible for performing and reporting TAB procedures.
E. TAB Specialist: Entity engaged by TAB Firm to perform TAB work.

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A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
    1. Submit to Architect/Engineer of Record.
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    3. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect/Engineer of Record and other installers to sufficiently understand the design intent for each system.
    4. Include at least the following in the plan:
        a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
        b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
        c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
        d. Final test report forms to be used.
        e. Procedures for formal deficiency reports, including scope, frequency and distribution.
D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
    1. Revise TAB plan to reflect actual procedures and submit as part of final report.

2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer of Record and for inclusion in operating and maintenance manuals.
3. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
4. Units of Measure: Report data in I-P (inch-pound) units only.

E. Sample report forms. Submit two copies of the sample TAB report forms

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A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Prior to the start of the TAB work, and at Contractor's direction, coordinate a meeting at the Site to review the TAB strategies and procedures plan and to develop a mutual understanding of the details of the work involved. The meeting shall include the Commissioning Authority (CxA) (if applicable), the TAB field supervisor, and the TAB technicians. Provide at least seven days' advance notice of meeting date and time.
1. Agenda Items:
a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.
e. Submittal distribution requirements.
f. Work Schedule and Project-Site requirements.

C. Certification of TAB Reports: Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB forms from NEBB or AABC as well as providing any additional information required by this specification.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE Std 111, Section 5, "Instrumentation."

F. Board reserves the right to select at random 10% of the TAB report data for field verification witnessed by the commission agent. The TAB contractor will be given sufficient notice of the date of field verification. The same instruments that were used when the original test was recorded shall be used. A failure of more than 10% of the selected field verification items shall result in a repeat of the testing of the entire system at the TAB contractor's expense. The repeated work is also subject to field verification.

1.06 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.07 WARRANTY

A. Provide warranty in accordance with AABC or NEBB standards:

1. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
2. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
3. Guarantee shall include the following provisions:
   a. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   b. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
   4. SMACNA (TAB).

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

3.02 EXAMINATION

A. Examine the Contract Documents and field conditions to become familiar with Project requirements and to discover conditions that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
   7. Fans are rotating correctly.
   8. Fire and volume dampers are in place and open.
   9. Terminal units, such as variable-air-volume boxes, are accessible and their controls are connected and functioning.
   10. Air coil fins are cleaned and combed.
   11. Access doors are closed and duct end caps are in place.
   12. Air outlets are installed and connected.

13. Duct system leakage is minimized.

D. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

E. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide a TAB Plan that includes strategies and step-by-step procedures.

C. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer of Record to facilitate spot checks during testing.

D. Provide additional balancing devices as required.

3.04 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust fans to deliver the design air flow capacity at the design static pressure. Fan sheaves shall be replaced as necessary to obtain desired results. Provide all labor and material.

E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
M. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
N. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
O. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
P. Balance all individual air inlets and outlets.

3.06 STEAM SYSTEM PROCEDURE

A. Measure and record supply pressure at each piece of equipment.
B. Measure and record upstream and downstream steam pressure at pressure-reducing valves.
C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
D. Verify the operation of each steam trap.
E. Check settings and operation of each safety valve. Record settings.

3.07 MOTOR PROCEDURE

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
    1. Manufacturer's name, model number, and serial number.
    2. Motor horsepower rating.
    3. Motor rpm.
    4. Efficiency rating.
    5. Nameplate and measured voltage, each phase.
    6. Nameplate and measured amperage, each phase.
    7. Starter thermal-protection-element rating.
B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.08 HEAT TRANSFER COIL PROCEDURE

A. PROCEDURES FOR HEAT-TRANSFER COILS
    1. Measure, adjust, and record the following data for each water coil:
        a. Entering- and leaving-water temperature.
        b. Dry-bulb temperature of entering and leaving air.
        c. Wet-bulb temperature of entering and leaving air for cooling coils.
        d. Airflow.
        e. Air pressure drop.
    2. Measure, adjust, and record the following data for each electric heating coil:
        a. Nameplate data.
        b. Airflow.
        c. Entering- and leaving-air temperature at full load.
        d. Voltage and amperage input of each phase at full load and at each incremental stage.
        e. Calculated kilowatt at full load.
        f. Fuse or circuit-breaker rating for overload protection.

3. Measure, adjust, and record the following data for each steam coil:
    a. Dry-bulb temperature of entering and leaving air.
    b. Airflow.
    c. Air pressure drop.
    d. Inlet steam pressure.
4. Measure, adjust, and record the following data for each refrigerant coil:
    a. Dry-bulb temperature of entering and leaving air.
    b. Wet-bulb temperature of entering and leaving air.
    c. Airflow.
    d. Air pressure drop.
    e. Refrigerant suction pressure and temperature.

3.09 EXISTING SYSTEMS PROCEDURE

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
    1. Measure and record the operating speed, airflow, and static pressure of each fan.
    2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
    3. Check the refrigerant charge.
    4. Check the condition of filters.
    5. Check the condition of coils.
    6. Check the operation of the drain pan and condensate-drain trap.
    7. Check bearings and other lubricated parts for proper lubrication.
    8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
    1. New filters are installed.
    2. Coils are clean and fins combed.
    3. Drain pans are clean.
    4. Fans are clean.
    5. Bearings and other parts are properly lubricated.
    6. Deficiencies noted in the preconstruction report are corrected.
C. Perform testing and balancing of existing systems. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer and within the limits of the motor HP. All fans shall deliver the design air flow capacity at actual static pressure up to design static. Fan sheaves shall be replaced as necessary to obtain desire results.
    1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
    2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
    3. Balance each air outlet.

3.10 TEMPERATURE CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.
B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
G. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

A. Set HVAC system air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and product data.
C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for fan performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
3. Test Data (Indicated and Actual Values):
    a. Total air flow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat coil static-pressure differential in inches wg.
    g. Cooling coil static-pressure differential in inches wg.
    h. Heating coil static-pressure differential in inches wg.
    i. Outdoor airflow in cfm.

j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.
k. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in kW
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
a. Heat output in kW
b. Air flow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.

f. Arrangement and class.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated air flow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual air flow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

J. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Low ambient temperature cutoff in deg F.
2. Test Data (Indicated and Actual Values):
   a. Entering-air, dry-bulb temperature in deg F.
   b. Leaving-air, dry-bulb temperature in deg F.
   c. Control settings.
   d. Unloader set points.
   e. Low-pressure-cutout set point in psig.
   f. High-pressure-cutout set point in psig.
   g. Suction pressure in psig.
   h. Suction temperature in deg F.
   i. Condenser refrigerant pressure in psig.
   j. Condenser refrigerant temperature in deg F.
   k. Voltage at each connection.

l. Amperage for each phase.
m. Kilowatt input.
n. Number of fans.

3.14 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
c. Verify that balancing devices are marked with final balance position.
d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Board's Representative.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Board' Representative.
3. The Board's Representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Board may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 07 13 (LNK)

DUCT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Insulation jackets.

1.02 REFERENCE STANDARDS

A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2016.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

D. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2007 (Reapproved 2012).

E. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation; 2013.

F. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2008 (Reapproved 2014).

G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.

H. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

I. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

J. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

K. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

N. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Shop Drawings:
1. Detail insulation application at elbows, fittings, flanges, and specialties for each type of insulation.
2. Detail removable insulation at equipment connections, and access panels.
3. Detail application of field-applied jackets.

C. Samples: For each type of insulation jacket, and identification indicated. Identify each Sample, describing product and intended use.
1. Sample Sizes:
a. Sheet Form Insulation Materials: 12 inches square.
b. Sheet Jacket Materials: 12 inches square.
c. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 SCHEDULING

A. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.07 WARRANTY

A. Special Warranty: Submit a written warranty, signed by the manufacturer and Installer, agreeing to replace components that fail in material or workmanship within 18 months from date of delivery, or one year from date of Preliminary Acceptance / Substantial Completion, whichever is longer.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

B. Regulatory Requirements: Insulation installations shall comply with the City of Chicago Building Code, Chapter 18-13, "Energy Conservation," and the Illinois Energy Conservation Code. Where conflicts exist between the codes identified above and this section, the more stringent requirement shall apply.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
1. Johns Manville: www.jm.com/#sle.
2. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
3. CertainTeed Corporation: www.certainteed.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 1200 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
1. Johns Manville
2. Owens Corning Corporation; 700 Series FIBERGLAS Insulation
3. CertainTeed Corporation

B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corporation; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
1. Aeroflex USA, Inc
2. Armacell LLC; AP Armaflex FS
3. K-Flex USA LLC; Insul-Sheet

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
1. Manufacturers:
a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2.05 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A240/A240M, Type 304; 0.020-inch thick, 3/4 inch wide with wing seal or closed seal.
a. Type 304 for interior installations.
b. Type 316 for exterior installations, and interior installations subject to high humidity.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; CHP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.

4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.06 JACKETS

A. Aluminum Jacket: ASTM B209 (ASTM B209M).
   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   3. Joining: Longitudinal slip joints and 2 inch laps.

4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

B. Stainless Steel Jacket: ASTM A240/A240M
1. Sheet and roll stock ready for shop or field sizing.
2. Material, finish, and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
5. Factory-Fabricated Fitting Covers: Fabricated from the same material, finish, and thickness as jacket. Provide factory-fabricated covers for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows; tee covers; flange and union covers; end caps; beveled collars; and valve covers. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Keep insulation materials dry during application and finishing.

C. Install insulation with least number of joints practical.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Insulated ducts conveying air below ambient temperature:
1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

H. Insulated ducts conveying air above ambient temperature:
1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

I. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

J. Weatherproof Rectangular Duct Insulation
1. Provide flexible elastomeric insulation as required to provide the required R-values indicated in the schedule at the end of Part 3. Provide on the exterior of all supply and return ducts exposed to the weather. Cover insulation with a field-applied jacket.
2. Install duct insulation in shingled fashion to shed water, beginning at the bottom and working to the top of the duct. Top of duct insulation shall overlap the side of duct insulation. Side of duct insulation shall overlap the bottom of duct insulation. Provide corner angles at each corner.
3. The ductwork shall be sloped to prevent water from accumulating. Ducts shall be sloped not less than 1/4-inch per foot (2 percent) from the high point to the low points at the outside edges. Insulation thickness shall be the minimum required to provide the R-values indicated in the schedule at the end of Part 3. Duct pitch shall be provided by the duct supports
4. Flexible elastomeric insulation shall be completely adhered directly to clean, oil-free surfaces with a full coverage of waterproof adhesive recommended by the insulation manufacturer.
5. Butt-edge seams shall be adhered using adhesives recommended by the insulation manufacturer. Provisions for expansion and contraction shall be made. Overlap the insulation 1/4-inch at the butt-edge seams and compress the edges into place.
6. Standing metal duct seams shall be insulated as required to provide the R-values indicated in the schedule at the end of Part 3.
7. Insulation seams shall be staggered when applying multiple layers of insulation. Secure each layer of insulation to duct with manufacturer's recommended adhesive.
8. Longitudinal seams and end joints shall be sealed with adhesive recommended by insulation manufacturer, as required to eliminate openings in insulation and prevent passage of outside air to surface of duct being insulated.
9. Vapor retarder type mastic, or joint sealer, shall be applied on longitudinal and butt joints to prevent moisture and moisture vapor infiltration. Vapor retarder butt joints shall be sealed with 3-inch wide vapor retarder tape.
10. Tightly wrap the insulation circumferentially with saran film. Overlap the seams by a minimum of 2 inches. Seal the overlapped seams with vapor retarder tape.
11. Jacketing shall be secured with 1/2-inch wide stainless steel bands on 12-inch centers. Rivets, screws, staples, or any other fastener capable of penetrating the underlying vapor retarder shall not be used.

K. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the Article "Duct Insulation Schedule, General".
2. Inspect field-insulated equipment, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment requiring insulation for this project. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the Article "Piping Insulation Schedule, General".

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Architect/Engineer of Record may reject all work if sample work is found to be defective.

3.04 SCHEDULES

A. Duct Insulation Application
1. Plenums and Ducts Requiring Insulation:
a. Indoor, supply and outdoor air.
b. Indoor, concealed return located in non-conditioned space.
c. Indoor, return located in non-conditioned space.
d. Indoor, kitchen hood exhaust.
e. Indoor, exhaust between isolation damper and penetration of building exterior.
f. Outdoor, supply and return air.
2. Items Not Insulated:
a. Factory-insulated flexible ducts.
b. Factory-insulated plenums and casings.
c. Flexible connectors.
d. Vibration-control devices.
e. Factory-insulated access panels and doors.

B. Duct Systems Insulation Schedule

Duct Location	Outdoor Air, Supply Air, Exhaust Air (Downstream of Damper) Insulation-Installed R-Value	Return Air Insulation-Installed R-Value
Exterior of Building (Notes 5,6,8)	12.0	12.0
Ventilated Attic (Notes 5,7)	12.0	12.0
Unvented Attic Above Insulated Ceiling (Notes 5,7)	12.0	12.0
Unvented Attic with Roof Insulation (Notes 1,5,7)	6.0	N/A
Unconditioned Space (Notes 2,5,6,7)	12.0	12.0
Indirectly Conditioned Space (Notes 7)	6.0	N/A
Ceiling Cavity/ Shafts/ Soffits/ Mechanical Spaces and Rooms (Notes 1,4,6)	6.0	N/A
Exposed Locations within Conditioned Space	6.0	N/A
Buried	6.0	N/A

1. INSULATION R-VALUES, MEASURED IN (H X FT^2 X F)/BTU, ARE FOR THE INSULATION AS INSTALLED AND DO NOT INCLUDE FILM RESISTANCE. WHERE EXTERIOR WALLS ARE USED AS PLENUM WALLS, WALL INSULATION SHALL BE AS REQUIRED BY APPLICABLE CODES AND AUTHORITIES HAVING JURISDICTION. INSULATION RESISTANCE MEASURED ON A HORIZONTAL PLANE IN ACCORDANCE WITH ASTM C518 AT A MEAN TEMPERATURE OF 75 DEG F AT THE INSTALLED THICKNESS.
2. INCLUDING CRAWL SPACES (BOTH VENTILATED/NON-VENTILATED), FRAMED CAVITIES IN WALLS, FLOOR AND CEILING ASSEMBLIES WHICH (A) SEPARATE CONDITIONED SPACE FROM UNCONDITIONED SPACE OR OUTSIDE AIR, AND (B) ARE UNINSULATED ON THE SIDE FACING AWAY FROM CONDITIONED SPACE.
3. CAVITY CONTAINED WITHIN THE INSULATED BUILDING ENVELOPE.
4. VAPOR BARRIER REQUIRED.
5. FIELD APPLIED JACKET (STAINLESS STEEL, OR ALUMINUM, FOR EXTERIOR APPLICATIONS, PVC FOR INTERIOR EXPOSED LOCATIONS).
6. PROVIDE MINERAL FIBER BOARD IN EXPOSED LOCATIONS IN LIEU OF MINERAL FIBER BLANKET. PROVIDE WITH FIELD APPLIED JACKET (SS, OR AL) FOR EXTERIOR LOCATIONS.
7. PROVIDE FLEXIBLE ELASTOMERIC INSULATION FOR OUTDOOR DUCTWORK

END OF SECTION 23 07 13

SECTION 23 07 13 (MEP)

DUCT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Insulation jackets.

1.02 REFERENCE STANDARDS

A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2016.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

D. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2007 (Reapproved 2012).

E. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation; 2013.

F. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2008 (Reapproved 2014).

G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.

H. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

I. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

J. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

K. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

N. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Shop Drawings:
1. Detail insulation application at elbows, fittings, flanges, and specialties for each type of insulation.
2. Detail removable insulation at equipment connections, and access panels.
3. Detail application of field-applied jackets.

C. Samples: For each type of insulation jacket, and identification indicated. Identify each Sample, describing product and intended use.
1. Sample Sizes:
a. Sheet Form Insulation Materials: 12 inches square.
b. Sheet Jacket Materials: 12 inches square.
c. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 SCHEDULING

A. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.07 WARRANTY

A. Special Warranty: Submit a written warranty, signed by the manufacturer and Installer, agreeing to replace components that fail in material or workmanship within 18 months from date of delivery, or one year from date of Preliminary Acceptance / Substantial Completion, whichever is longer.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

B. Regulatory Requirements: Insulation installations shall comply with the City of Chicago Building Code, Chapter 18-13, "Energy Conservation," and the Illinois Energy Conservation Code. Where conflicts exist between the codes identified above and this section, the more stringent requirement shall apply.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
1. Johns Manville; _____: www.jm.com/#sle.
2. Owens Corning Corporation; _____: www.ocbuildingspec.com/#sle.
3. CertainTeed Corporation; _____: www.certainteed.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 1200 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
1. Johns Manville
2. Owens Corning Corporation; 700 Series FIBERGLAS Insulation
3. CertainTeed Corporation

B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Manufacturers:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corporation; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.04 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A240/A240M, Type 304; 0.020-inch thick, 3/4 inch wide with wing seal or closed seal.
a. Type 304 for interior installations.
b. Type 316 for exterior installations, and interior installations subject to high humidity.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; CHP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following:
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.
b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following:
a. Products: Subject to compliance with requirements, provide one of the following:
1) GEMCO; Nylon Hangers.

2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.

2) GEMCO; Peel & Press.

3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Keep insulation materials dry during application and finishing.

C. Install insulation with least number of joints practical.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Insulated ducts conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

H. Insulated ducts conveying air above ambient temperature:
1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

I. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the Article "Duct Insulation Schedule, General".
2. Inspect field-insulated equipment, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment requiring insulation for this project. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect/Engineer of Record, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the Article "Piping Insulation Schedule, General".

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Architect/Engineer of Record may reject all work if sample work is found to be defective.

3.04 SCHEDULES

A. Duct Insulation Application
1. Plenums and Ducts Requiring Insulation:
   a. Indoor, supply and outdoor air.
   b. Indoor, concealed return located in non-conditioned space.
   c. Indoor, return located in non-conditioned space.
   d. Indoor, kitchen hood exhaust.
   e. Indoor, exhaust between isolation damper and penetration of building exterior.
   f. Outdoor, supply and return air.
2. Items Not Insulated:
   a. Factory-insulated flexible ducts.
   b. Factory-insulated plenums and casings.
   c. Flexible connectors.
   d. Vibration-control devices.
   e. Factory-insulated access panels and doors.

B. Duct Systems Insulation Schedule

Duct Location	Outdoor Air, Supply Air, Exhaust Air (Downstream of Damper) Insulation-Installed R-Value	Return Air Insulation-Installed R-Value
Exterior of Building (Notes 5,6,8)	**12.0**	**12.0**
Ventilated Attic (Notes 5,7)	**12.0**	**12.0**
Unvented Attic Above Insulated Ceiling (Notes 5,7)	**12.0**	**12.0**
Unvented Attic with Roof Insulation (Notes 1,5,7)	**6.0**	**N/A**
Unconditioned Space (Notes 2,5,6,7)	**12.0**	**12.0**
Indirectly Conditioned Space (Notes 7)	**6.0**	**N/A**
Ceiling Cavity/ Shafts/ Soffits/ Mechanical Spaces and Rooms (Notes 1,4,6)	**6.0**	**N/A**
Exposed Locations within Conditioned Space	**6.0**	**N/A**
Buried	**6.0**	**N/A**

1. INSULATION R-VALUES, MEASURED IN (H X FT^2 X F)/BTU, ARE FOR THE INSULATION AS INSTALLED AND DO NOT INCLUDE FILM RESISTANCE. WHERE EXTERIOR WALLS ARE USED AS PLENUM WALLS, WALL INSULATION SHALL BE AS REQUIRED BY APPLICABLE CODES AND AUTHORITIES HAVING JURISDICTION. INSULATION RESISTANCE MEASURED ON A HORIZONTAL PLANE IN ACCORDANCE WITH ASTM C518 AT A MEAN TEMPERATURE OF 75 DEG F AT THE INSTALLED THICKNESS.
2. INCLUDING CRAWL SPACES (BOTH VENTILATED/NON-VENTILATED), FRAMED CAVITIES IN WALLS, FLOOR AND CEILING ASSEMBLIES WHICH (A) SEPARATE CONDITIONED SPACE FROM UNCONDITIONED SPACE OR OUTSIDE AIR, AND (B) ARE UNINSULATED ON THE SIDE FACING AWAY FROM CONDITIONED SPACE.

3. CAVITY CONTAINED WITHIN THE INSULATED BUILDING ENVELOPE.
4. VAPOR BARRIER REQUIRED.
5. FIELD APPLIED JACKET (STAINLESS STEEL, OR ALUMINUM, FOR EXTERIOR APPLICATIONS, PVC FOR INTERIOR EXPOSED LOCATIONS).
6. PROVIDE MINERAL FIBER BOARD IN EXPOSED LOCATIONS IN LIEU OF MINERAL FIBER BLANKET. PROVIDE WITH FIELD APPLIED JACKET (SS, OR AL) FOR EXTERIOR LOCATIONS.
7. PROVIDE FLEXIBLE ELASTOMERIC INSULATION FOR OUTDOOR DUCTWORK

END OF SECTION 23 07 13

SECTION 23 07 16 (LNK)

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

1.02 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

D. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016.

E. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2007 (Reapproved 2012).

F. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

G. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).

H. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation; 2013.

I. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2008 (Reapproved 2014).

J. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.

K. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

L. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2016.

M. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

N. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

O. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2016.

P. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

R. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

S. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

T. MIL-A-3316 - Adhesives, Fire-Resistant, Thermal Insulation; 1987 (with 1998 & 1990 Amendments).

U. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in other Division 23 Sections.

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 WARRANTY

A. Special Warranty: Submit a written warranty, signed by the manufacturer and Installer, agreeing to replace components that fail in material or workmanship within 18 months from date of delivery, or one year from date of Preliminary Acceptance, whichever is longer.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

B. Regulatory Requirements: Insulation installations shall comply with the City of Chicago Building Code, Chapter 18-13, "Energy Conservation," and the Illinois Energy Conservation Code. Where conflicts exist between the codes identified above and this section, the more stringent requirement shall apply.

2.02 MINERAL-FIBER BOARD INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Article "Jackets", Paragraph "Factory-Applied Jackets."

B. Products: Subject to compliance with requirements, provide one of the following:
1. CertainTeed Corp.; Commercial Board.
2. Johns Manville; 800 Series Spin-Glas.
3. Knauf Insulation; Insulation Board.
4. Manson Insulation Inc.; AK Board.
5. Owens Corning; Fiberglas 700 Series.

2.03 CALCIUM SILICATE INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Industrial Insulation Group, LLC (IIG).

B. Properties:
1. Compressive Strength: ASTM C165; 100 psi, minimum, at 5 percent deformation.
2. Dry Density, Average: ASTM C302; 14.0 pcf, minimum.
3. Fire-Test-Response Characteristics: ASTM E84; flame spread index of 0 and smoke developed index of 0, as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to the authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

C. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

2.04 JACKETS

A. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
1. Manufacturers
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.
2. Thickness: 0.010 inch.
3. Finish: Smooth.
4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Exposed Equipment: Locate insulation and cover seams in least visible locations.

D. Equipment, Tank, and Vessel Insulation Installation
1. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
c. Protect exposed corners with secured corner angles.
d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
1) Do not weld anchor pins to ASME-labeled pressure vessels.
2) Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
3) On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
4) Do not over-compress insulation during installation.
5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
6) Impale insulation over anchor pins and attach speed washers.
7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

f. Where insulation hangers on equipment and vessels are not permitted or practical, where insulation support rings are not provided, or where insulation is to be secured with tie wire or bands, install a girdle network for securing insulation.
   1) Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs.
   2) Place one circumferential girdle around equipment approximately 6 inches from each end.
   3) Install wire or cable between two circumferential girdles 12 inches o.c.
   4) Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle.
   5) Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c.

g. Stagger joints between insulation layers at least 3 inches.

h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

E. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

F. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

G. Inserts and Shields:
   1. Application: Equipment 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between hangers and inserts.
   3. Insert Location: Between support shield and equipment and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

H. Finish insulation at supports, protrusions, and interruptions.

3.03 SCHEDULE

A. General: Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that are not factory insulated.

C. Steam-to-hot-water converter insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches thick and 3 pcf nominal density. Stainless steel jacket.
   2. Mineral-Fiber Pipe and Tank: 2 inches thick. Stainless steel jacket.

END OF SECTION 23 07 16

SECTION 23 07 19 (LNK)

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jackets and accessories.

1.02 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

D. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2007 (Reapproved 2012).

E. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

F. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).

G. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation; 2013.

H. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).

I. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2008 (Reapproved 2014).

J. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

K. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2016.

L. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2017.

M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

N. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

P. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

Q. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets. Include outdoor piping insulation installation.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in other Division 23 Sections.

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

B. Regulatory Requirements: Insulation installations shall comply with the City of Chicago Building Code, Chapter 18-13, "Energy Conservation," and the Illinois Energy Conservation Code. Where conflicts exist between the codes identified above and this section, the more stringent requirement shall apply.

2.02 GLASS FIBER

A. Manufacturers:
1. Johns Manville Corporation; Micro-Lok
2. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation
3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ

B. Insulation(Hot Pipes): ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation(Cold Pipes): ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
1. 'K' Value: ASTM C177, 0.23 at 75 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.
1. Manufacturers:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449.

2.03 CALCIUM SILICATE INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of theASTM C533 following:
1. Industrial Insulation Group, LLC (IIG).

B. Properties:
1. Compressive Strength: ASTM C165; 100 psi, minimum, at 5 percent deformation.
2. Dry Density, Average: ASTM C302; 14.0 pcf, minimum.
3. Fire-Test-Response Characteristics: ASTM E84; flame spread index of 0 and smoke developed index of 0, as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to the authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

C. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

D. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.04 JACKETS

A. PVC Plastic.
1. Manufacturers:
   a. Johns Manville Corporation
   b. IC Plastics, Inc.
   c. Proto Corp.
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
   a. Minimum Service Temperature: 0 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
   d. Thickness: 10 mil.
   e. Connections: Brush on welding adhesive.
3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Coordinate insulation installation with the trade installing heat tracing, if any.

D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature.
1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, strainers, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation continuously through walls and partitions, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Install removable insulation covers at locations where access is required (e.g. - unions, flanges, strainers, and valves)

3.03 SCHEDULE

Pipe System	Operating Temp (F)	Insulation Type (Note 1,4,5,6)		Thickness (In.)				
		Glass Fiber	Flexible Elastomeric	<1	1 to 1 1/4	1 1/2 to 3 1/2	4 to 6	8 and larger
Steam - Low Pressure	201-250	X		2.5	2.5	3.0	3.0	3.0
Steam Condensate	Any	X		1.0	1.5	2.0	2.0	2.0
Hot Water	60-140	X		1.0	1.0	2.0	2.0	2.0

1. GLASS-FIBER INSULATION ONLY FOR HYDRONIC PIPING.
2. PVC, ALUMINUM, OR STAINLESS STEEL FIELD-APPLIED JACKET ON OUTDOOR INSTALLATIONS, EXPOSED AND CONCEALED.
3. FOR OUTDOOR USE ONLY.
4. PIPING INSULATION IS NOT REQUIRED BETWEEN THE CONTROL VALVE AND COIL ON RUNOUTS, WHEN THE CONTROL VALVE IS WITHIN 4-FEET OF THE COIL AND THE PIPE SIZE IS 1-INCH OR LESS.
5. FOR PIPING EXPOSED TO OUTDOOR AIR, INCREASE INSULATION THICKNESS BY 1-INCH.
6. INSULATION THICKNESS IS BASED ON INSULATION HAVING A THERMAL CONDUCTIVITY OF 0.27 BTU·INCH/(H·FT2·deg F).
7. VAPOR BARRIER REQUIRED. INSULATION NOT REQUIRED FOR AC CONDENSATE WHEN LOCATED AT FLOOR OF MECHANICAL ROOM.

END OF SECTION 23 07 19

SECTION 23 07 19 (MEP)

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jackets and accessories.

1.02 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

D. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2007 (Reapproved 2012).

E. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

F. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).

G. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation; 2013.

H. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).

I. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2008 (Reapproved 2014).

J. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

K. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2016.

L. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2017.

M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

N. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

P. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

Q. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets. Include outdoor piping insulation installation.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in other Division 23 Sections.

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

B. Regulatory Requirements: Insulation installations shall comply with the City of Chicago Building Code, Chapter 18-13, "Energy Conservation," and the Illinois Energy Conservation Code. Where conflicts exist between the codes identified above and this section, the more stringent requirement shall apply.

2.02 GLASS FIBER

A. Manufacturers:
1. Johns Manville Corporation; Micro-Lok
2. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation
3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ

B. Insulation(Hot Pipes): ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation(Cold Pipes): ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
1. 'K' Value: ASTM C177, 0.23 at 75 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.
1. Manufacturers:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449.

2.03 CALCIUM SILICATE INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of theASTM C533 following:
1. Industrial Insulation Group, LLC (IIG).

B. Properties:
1. Compressive Strength: ASTM C165; 100 psi, minimum, at 5 percent deformation.
2. Dry Density, Average: ASTM C302; 14.0 pcf, minimum.
3. Fire-Test-Response Characteristics: ASTM E84; flame spread index of 0 and smoke developed index of 0, as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to the authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

C. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

D. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
1. Aeroflex USA, Inc
2. Armacell LLC; AP Armaflex
3. K-Flex USA LLC; K-Flex Titan

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
1. Manufacturers:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.

2.05 JACKETS

A. PVC Plastic.

1. Manufacturers:
   a. Johns Manville Corporation
   b. IC Plastics, Inc.
   c. Proto Corp.
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
   a. Minimum Service Temperature: 0 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
   d. Thickness: 10 mil.
   e. Connections: Brush on welding adhesive.
3. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
1. Manufacturers
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
2. Thickness: 0.016 inch sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

C. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
1. Manufacturers
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
2. Thickness: 0.010 inch.
3. Finish: Smooth.
4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
5. Provide moisture barrier for outdoor installation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Coordinate insulation installation with the trade installing heat tracing, if any.

D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature.
1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, strainers, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation continuously through walls and partitions, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Install removable insulation covers at locations where access is required (e.g. - unions, flanges, strainers, and valves)

L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

Pipe System	**Operating Temp (F)**	**Insulation Type (Note 1,4,5,6)**				**Thickness (In.)**		
		Glass Fiber	**Flexible Elastomeric**	**<1**	**1 to 1 1/4**	**1 1/2 to 3 1/2**	**4 to 6**	**8 and larger**
Steam - Low Pressure	**201-250**	**X**		**2.5**	**2.5**	**3.0**	**3.0**	**3.0**

Steam Condensate	**Any**	**X**		**1.0**	**1.5**	**2.0**	**2.0**	**2.0**
Hot Water	**60-140**	**X**		**1.0**	**1.0**	**2.0**	**2.0**	**2.0**
DX	**Below 40**	**X (Note 2,7)**	**X**	**0.5**	**1.0**	**1.0**	**1.0**	**1.5**
AC Condensate Drain	**40-60**	**X (Note 7)**	**X**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**

1. GLASS-FIBER INSULATION ONLY FOR HYDRONIC PIPING.
2. PVC, ALUMINUM, OR STAINLESS STEEL FIELD-APPLIED JACKET ON OUTDOOR INSTALLATIONS, EXPOSED AND CONCEALED.
3. FOR OUTDOOR USE ONLY.
4. PIPING INSULATION IS NOT REQUIRED BETWEEN THE CONTROL VALVE AND COIL ON RUNOUTS, WHEN THE CONTROL VALVE IS WITHIN 4-FEET OF THE COIL AND THE PIPE SIZE IS 1-INCH OR LESS.
5. FOR PIPING EXPOSED TO OUTDOOR AIR, INCREASE INSULATION THICKNESS BY 1-INCH.
6. INSULATION THICKNESS IS BASED ON INSULATION HAVING A THERMAL CONDUCTIVITY OF 0.27 BTU·INCH/(H·FT2·deg F).
7. VAPOR BARRIER REQUIRED. INSULATION NOT REQUIRED FOR AC CONDENSATE WHEN LOCATED AT FLOOR OF MECHANICAL ROOM.

END OF SECTION 23 07 19

SECTION 23 09 21 (LNK)
BUILDING AUTOMATION SYSTEM (BAS) - BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
1. Wiring.
2. Control Valves and Actuators.
3. Control Dampers and Actuators.
4. Field Panels.
5. Sensors / Thermostats.
6. Transmitters.
7. Switches.
8. Transformers.
9. Electric Control Components (Switches, Thermostats, Relays, Smoke Detectors, etc.).
10. Transducers.
11. Current Switches.
12. Nameplates.
13. Testing Equipment.

1.02 DESCRIPTION OF WORK

A. Refer to Division 23 Sections 230923 Direct-Digital Control System for HVAC, 230926 Building Automation System-Sequence of Operation and 230927 Building Automation System-Commissioning and Division 26 for additional requirements.

B. Refer to other Division 23 Sections for installation of instrument wells, valve bodies, flow meters, and dampers in mechanical systems; not work of this Section.

C. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:
1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
4. All other necessary wiring for fully complete and functional control system as specified.
5. Power wiring from spare circuits in electrical panels to Digital Control System Field Panels.

1.03 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper operation of the damper

C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper installation and application.

D. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120V control devices controlling 120V equipment, Division 26 Contractor shall

extend power wiring to the equipment. Digital Control System Contractor shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Instrument Pipe and Tube
   1. Hydronic and Instruments
      a. Connection to Main Piping: Provide ½ inch minimum size threadolet, ½" x 2-inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
      b. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
      c. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90-degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
      d. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead-free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
      e. Rigid Piping For Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.
   2. Low Pressure Air Instrument Sensing Lines
      a. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
      b. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

C. Communication Wiring: All wiring shall be in accordance with National Electrical Codes, CPS Infrastructure Standards and Division 26 of this specification.
   1. Contractor shall supply all communication wiring between all Controllers, Routers, Gateways, and local and remote peripherals (e.g., operator workstations, printers, and modems).
   2. Local Supervisory LAN: For any portions of this network required under this Section of the specification, contractor shall use Fiber or Category 6E of standard TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
   3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over

thirty (30) volts. Shield shall be terminated, and wiring shall be grounded as recommended by controller manufacturer.

D. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes, CPS Infrastructure Standards and Division 26 of this Specification.
   1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
   2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes, CPS Infrastructure Standards and Division 26 of this Specification.
   1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

F. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
   1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
   2. Provide UL-listed cabinets for use with line voltage devices.
   3. All gauges and control components shall be identified by means of nameplates.
   4. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
   5. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

2.02 CONTROL VALVES

A. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application and shall generally be considered at dead head rating of the pump. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly. Size all valves and actuators for the appropriate application and submit this information on a valve schedule.

B. Plug-Type Globe Pattern for Water Service (2 Position, 3-way modulating and 2 position dual temperature changeover control valve applications only):
   1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
   2. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on ‘top-and-bottom’ guided plugs.

3. Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
4. Temperature Rating: 25°F minimum, 250°F maximum
5. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
6. Valve Trim: Bronze; Stem: Polished stainless steel.
7. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. Plug: Brass, bronze or stainless steel, Seat: Brass
9. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
10. Ambient Operating Temperature Limits: -10 to 150°F
11. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Invensys
    c. Warren
    d. Bray
    e. Belimo

C. Plug-Type Globe Pattern for Steam Service:
1. Valve Sizing: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
    a. Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
3. Body: Bronze, screwed, 250 psig steam working pressure for 1/2" to 2"; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2" and larger for applications of 50 psig or less.
4. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
5. Packing: Spring Loaded Teflon.
6. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
7. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Invensys
    c. Warren
    d. Bray
    e. Belimo

D. Pressure Independent Control Valves and Actuators - (all 2-way valve hydronic modulating applications)
1. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly.
2. Size all valves and actuators for the appropriate application and submit this information on a valve schedule.

3. For valves 3/4” and less, use Belimo Zone Tight Pressure Independent Zone Valves (PIQCV) or approved equal by Flow Control Industries. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature.
    a. A flow-characterizing disc incorporated within the ball shall be installed in the stainless-steel ball The valve trim shall utilize a stainless-steel ball with an internal characterizing disc and stem for all water or glycol solutions up to 60% incorporating a dual EPDM O-ring packing design with fiberglass reinforced Teflon® seats and seals. Bodies rated at 360 psi with a maximum media temperature limit of 250 deg F.
    b. The valve shall incorporate an internal pressure regulator located upstream of the ball to regulate pressure and maintain a constant pressure differential. Replaceable cartridges are not permitted. The valve shall operate within a pressure differential range of 5 to 50 psi with a flow control tolerance of +/- 5%. Two internal P/T ports shall be incorporated for differential pressure verification.
    c. The flow characteristic shall be equal percentage.
    d. The actuator shall attach directly to the valve requiring no tools.
4. For valves 1” to 6” valves use Belimo Electronic Pressure Independent Control Valves (ePIV)or approved equal by Flow Control Industries. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature
    a. A characterized control valve shall be integrated with an ultrasonic flow meter (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential of 1 to 50 psi. The ultrasonic flow meter shall incorporate an algorithm to automatically compensate for the glycol concentration.
    b. A Teflon® PTFE flow-characterizing disc shall be installed in the inlet of the characterized control valve. The valve trim shall utilize a stainless-steel ball and stem for all water or glycol solutions up to 60%. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼” shall be rated at 600 psi and sizes 1 ½ to 2” at ANSI 125, Class B with a temperature range of 14 to 250 deg F. The maximum allowable pressure differential shall be 50 psi.
    c. The flow characteristic shall be equal percentage.
5. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating-point control is not allowed (the exception to this is VAV reheat applications). Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator and shall not require opening the housing.
6. Actuators shall fail open on loss of power for all hot water applications. Closing time shall be less than 30 seconds.
    a. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.
7. Provide for manual positioning of the valve actuator without power and without disconnection the actuator from the valve.

2.03 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. Provide parallel blade dampers for dampers providing two-position control (for multi zone dampers a parallel blade application with lower torque requirements should be submitted as an alternate). For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service.

B. For zone dampers and other applications with duct or opening areas less than 5 square feet that do not provide isolation to outdoors and function in a general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm, differential pressure not greater than 2.5" w.c.:
   1. Performance: Test in accordance with AMCA 500.
   2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
   3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts with set screws, 16-gauge minimum thickness.
   4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
   5. Jamb Seals: None.
   6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
   7. Linkage: Concealed in frame if parallel.
   8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
   9. Leakage: Less than one percent based on approach velocity of 1500 ft./min. and 1-inch wg.
   10. Maximum Pressure Differential: 2.5 inches wg.
   11. Temperature Limits: -40 to 200 °F.
   12. Where two dampers are to be mechanically interlocked such as a face and bypass arrangement, the manufacturer will provide required torque values for the combined damper assembly.
   13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
      a. Johnson Controls D-1100
      b. Ruskin CD36
      c. Vent Products 5800

C. For applications with duct or opening areas greater than 5 square feet that do not provide isolation to outdoors and function in a general isolation and modulating control service in rectangular ducts at velocities exceeding 1500 fpm, differential pressure greater than 2.5" w.c.:
   1. Performance: Test in accordance with AMCA 500.
   2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
   3. Blades: Galvanized steel or extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts, 14-gauge minimum extrusion thickness.
   4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
   5. Jamb Seals: Stainless steel.
   6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless-steel sleeve, with thrust washers at bearings.
   7. Linkage: Concealed in frame if parallel.
   8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
   9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1-inch wg..
   10. Maximum Pressure Differential: 6 inches wg.
   11. Temperature Limits: -40 to 200 °F.
   12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple

dampers driven by a jackshaft the shaft will be rigid in torsion and driven by at least two actuators located at either end of the shaft.

13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. TAMCO 1000
    b. Ruskin CD60
    c. CESCO Products AGA or AGB

D. For all outside air intake or exhaust control dampers that provide isolation to outdoors or otherwise need to provide thermal isolation:
1. Performance: Test in accordance with AMCA 500.
2. Frames: Aluminum, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum thermally broken insulated, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts, 14-gauge minimum extrusion thickness.
4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
5. Jamb Seals: Non-metallic seal.
6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless-steel sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame if parallel.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1-inch wg..
10. Maximum Pressure Differential: 6 inches wg.
11. Temperature Limits: -40 to 200 °F.
12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple dampers driven by a jackshaft the shaft will be rigid in torsion and driven by at least two actuators located at either end of the shaft.
13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. TAMCO 9000
    b. Ruskin TED50XT

2.04 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Damper Actuators
1. Ambient Operating Temperature Limits: -10 to 122°F
2. Two Position Electric Actuators: Line voltage with spring return
3. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds, unless prior approval is obtained. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor

protection. Actuators shall have manual override. Modulating actuators for valves shall have minimum rangeability of 40 to 1.

a. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent. When shutoff does not apply the actuator will be sized based on the manufactures required torque plus 30%.

b. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
   1) Belimo
   2) Delta
   3) Invensys

C. Quarter-Turn Actuators (for ball and butterfly valves):

1. Electric

a. Motor: Suitable for 120- or 240-Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.

b. Gear Train. Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.

c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure

d. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning. Actuators shall fail open on loss of power for all hot water applications. Closing time shall be less than 30 seconds. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.

e. Enclosure: Actuator enclosure shall be NEMA-4 rated and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.

f. Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.

g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless-steel construction to limit actuator to specific degrees of rotation.

h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.

i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position. Provide for manual positioning of the valve actuator without power and without disconnection the actuator from the valve.

j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.

k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.

l. Ambient Conditions: Actuator shall be designed for operation from –10 to 150 °F ambient temperature with 0 to 100 percent relative humidity.

m. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating-point control is not allowed (the exception to this is VAV reheat applications). Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator and shall not require opening the housing.

2.05 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into all controllers . Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non repeatability and hysteresis.

2.06 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of controller, or Smart Sensor (SS), sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. Matched Sensors: The following applications shall require matched sensors:

1. Building Loop Connections: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential), monitoring temperature across energy wheels / plates / run around coils (both air stream) and supply/return sensors adjacent to flow meters / btu meters.
2. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations, energy calculations or sequencing such as across chillers, boilers, plants and pumping systems.
3. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

C. Room Temperature Sensor: Shall be a stainless-steel wall plate sensor. An electronic thermostat with manual override will be provided in the principal, main office areas, select administrative areas, where required by the project energy code and as approved by CPS. Provide ¼” medical grade closed cell foam insulating material. The following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point.

D. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point

E. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three-square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
   1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3°F accuracy at calibration point.

F. Liquid immersion temperature sensor shall include thermowell, sensor and connection head for wiring connections. Provide thermally conductive paste in well to ensure good contact with the well. Temperature range shall be as required for resolution of 0.15°F.
   1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
   2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.

G. Pipe Surface-Mount Temperature Sensor: Sensor are only for use in applications specifically identified on the drawings. Normally only used on condensate return piping for steam systems. Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as required for resolution indicated in paragraph A.
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

H. Outside air sensors shall consist of a sensor, an aspirated enclosure, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as required for resolution indicated in Paragraph A
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
   2. Acceptable Manufacturers: Kele A21 or equal

2.07 TEMPERATURE TRANSMITTERS

A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

2.08 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor and CO2 may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
   1. Input Range: 0 to 100% RH.
   2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
   3. Sensor Operating Range: As required by application
   4. Long Term Stability: Less than 1% drift per year.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series, Kele H_20K.

2.09 PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. General Purpose - Water: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.
   1. Acceptable units shall be Kele & Associates Model 360 C

B. Liquid, Steam and Gas:
   1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
   2. Environmental limits: –40 to 250 °F, 0 to 100% RH.
   3. Accuracy: less than 0.1 percent of span.
   4. Output Damping: Time constant user selectable from 0 to 36 seconds.
   5. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
   6. Electrical Enclosure: NEMA-4, -4X, -7, -9.
   7. Approvals: FM, CSA.
   8. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac.

C. General-Purpose Low-Pressure Air: Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered two-wire differential capacitance cell-type transmitter.
   2. Output: two wire 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1% of reading.
   4. Minimum Range: 0.1 in. w.c.
   5. Maximum Range: 10 inches w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Modus T30.
   8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
   9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

D. General Purpose Low Pressure/Low Differential Air: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered, two-wire differential capacitance cell type transmitter.
   2. Output: Two-wire 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1% of reading.
   4. Minimum Range: 0 in. w.c.
   5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Modus T30 or Setra.
   8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
   9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

E. Velocity Pressure: Generally for use in air velocity pressure measurement where the range is applicable.
   1. General: Loop powered two-wire differential capacitance cell type transmitter.
   2. Output: Two-wire, 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 0.25%
   4. Minimum Range: 0 in. w.c.

5. Maximum Range: 1-inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Setra 264 with optional FS accuracy above or equal..
8. Range: Select for minimum range that will accept the maximum velocity pressure expected.

2.10 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing

B. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

2.11 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.12 TRANSDUCERS

A. Binary to Analog Transducers or Tri-State-to-Voltage or -Current:
   1. Adjustable zero and span.
   2. Failure Mode on Power Loss: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
   3. Accuracy: ± 1% of span
   4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
   5. Input: 4-20 mA, pulse width modulated or tri-state input.
   6. Tri-state Input Time Base: Dip switch selectable.
   7. Enclosure: Polymer designed for surface or panel mount.
   8. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
   9. Acceptable Manufacturers: RE Technologies Model PWA Series.

B. Electronic-to Electronic (Voltage or Current to Current or Voltage):
   1. Adjustable zero and span.
   2. Failure Mode on Power Loss: Memory feature to allow the transducer to return to last value on power failure.
   3. Accuracy: ± 1% of span.
   4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
   5. Input: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
   6. Enclosure: Polymer enclosure designed for surface or panel mount.
   7. Acceptable Manufacturers: RE Technologies Model PWA Series.

2.13 CURRENT SWITCHES (CS)

A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
   1. Range: 1.5 to 150 amps.
   2. Trip Point: Adjustable.
   3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
   4. Lower Frequency Limit: 6 Hz.
   5. Trip Indication: LED

6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED.

B. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150.
   1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor / Electronically Commutated Motor Status Indication
   1. Range: 1.5 to 135 Amps.
   2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
   3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
   4. Frequency Range: 5-75 Hz
   5. Trip Indication: LED
   6. Approvals: UL, CSA
   7. Max. Cable Size: 350 MCM
   8. Acceptable Manufacturers: Veris Industries, Inc. H-904.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors / Electronically Commutated Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.14 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)
   1. Range: 1-10 amps minimum, 20-200 amps maximum
   2. Trip Point: Adjustable
   3. Output: 0-5 VDC.
   4. Accuracy: ±0.2% from 20 to 100 Hz.
   5. Acceptable Manufacturers: KELE SA100, Veris Hawkeye 720.

2.15 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

A. Single or Multi-Point Averaging (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

2.16 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire

element, minimum bulb size of 1/8" x 20', junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F, factory set at 38°F.

C. High Temperature Detectors ('Firestat') (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F.

D. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150°F, and a minimum 10°F fixed setpoint differential.

E. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F, switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

F. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
   1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
      a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
      b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
      c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
      d. Pilot light indication of power-to-coil and coil retainer clips.
      e. Coil rated for 50 and 60 Hz service.
      f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA.
   2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC.
   3. Relays used for stop/start control shall have low voltage coils (30 VAC or less) and shall be provided with transient and surge suppression devices at the controller interface.

G. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.

H. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application and mounted in minimum NEMA-1 enclosure.
   1. Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson.

I. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
   1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
   2. TDRs shall be UL and CSA listed, Crouzet type.

J. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley.

K. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley.

L. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory.

M. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley.

2.17 DUCT SMOKE DETECTOR

A. Photoelectric detector with sampling tube that spans the entire width of duct. Detector shall be compatible with the building/project fire alarm system. Coordinate with fire alarm / electrical contractor.

B. Velocity Rating: 100 to 4000 fpm or 500 to 4000fpm depending on the minimum velocity in the duct. Provide the 100 to 4000 fpm detector if the min duct velocity is below 550 fpm.

C. Output Contact: Alarm, two sets form “C” rated at 10amps 115V resistive. One set of alarm contacts for BAS monitoring and fan shutdown. Second set for the fire alarm system trouble alarm.

D. Temperature & RH limits: 32 to 120°F and 10 to 85% relative humidity.

E. Acceptable Manufacturer:

1. Invensys FIREX model 2650
2. Sensor Systems D4120
3. Air Products and Controls SL-2000

2.18 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.19 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Install all control wiring external to panels in electric metallic tubing or raceway. On Renovation projects, wiring in finished areas shall be routed in wire mold. The routing of wiring in finished areas must be specifically approved by the AOR/EOR. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code CPS

Infrastructure Standards and Division 26 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 of this Specification.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals. All WAN and LAN cabling shall comply with applicable Division 26 requirements.
5. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

C. Control Valves: Provide pressure independent control valves for all modulating 2-way valve hydronic applications. Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

D. Freezestats: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. The length of element not just downstream of the coil will not be included in the coverage calculation. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips such that sensor is not in direct contact with equipment. Coordinate the location of the switch such that it is normally accessible.

E. Install sensors and meters in accordance with manufacturer's recommendations / requirements and as indicated in paragraphs below and on drawings.

F. Room Temperature Sensors: Install sensors as shown on the drawings. Provide approved security screws for mounting, matching those installed in other areas of the project. Provide 3 tools to the Owner for installation and removal of the security screws. Seal conduit penetrations at the wall box airtight. Install batt insulation in the wall box to completely fill the box. Electrical connections shall be made using a twist-on sealant filled connectors suitable for the installation. Locate sensor such that computers, water coolers, and other heat generating equipment are not operating near the sensor.

G. Averaging Temperature Sensors: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally the sensor will be located where flow is sufficiently homogeneous/adequately mixed, consult AE for requirements. Averaging sensors shall be used in airstreams at the inlet / outlet of energy recovery devices (wheels, plates, run around coils, etc.), mixed air streams, coil leaving air, etc.).

H. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

I. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

J. Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

K. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.
L. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
M. Supply Duct Pressure Transmitters:
    1. General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration and maintenance.
    2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.
N. Hydronic Pressure Transmitters:
    1. General: Install per manufacturers recommendations. Locate the transmitter at an accessible location to facilitate calibration and maintenance.
    2. Locate on the most hydraulic demanding branch approximately 2/3 of the way in the system. Where a system serves multiple buildings / wings on a school / school campus, provide one transmitter in each building / wing. Transmitter shall not be located near the pumps being controlled.
O. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.
P. Mount sensors rigidly and adequately for the environment within which the sensor operates.
Q. Provide 7-day programmable wall mount stand-alone control thermostats to control all unit heaters and cabinet heaters. Heating shall be reset down at night/unoccupied periods. On hydronic units, stat shall control the unit hydronic valve / aquastat / fan.
R. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
S. Averaging sensors and low-limit switches
    1. Sensors used in mixing plenums, hot and cold decks, energy recovery applications or ducts over 48" any direction shall be of the averaging type.
    2. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
    3. Low limit sensors shall be mounted in a serpentine manner, horizontally across duct in accordance with manufacturers recommended installation procedures.
    4. Provide 1 ft of sensing element for each 1 ft2 of coil area.
    5. For large duct areas where the sensing element does not provide full coverage of the air stream, additional sensors or switches shall be provided as required to provide full protection of the air stream.
    6. Wire one pole of the low-limit switch to the supply and return fan starters, one pole to a BAS input, and one pole to interrupt power to the associated unit heating valves and economizer dampers.
T. All pipe-mounted temperature sensors shall be installed in wells. Use conductive compound in all wells to provide good heat transfer.
U. Install aspirated enclosure containing outdoor air temperature, carbon dioxide sensor and humidity sensors on north wall at designated locations. They shall be located so as to avoid effects of sun, reflected sun, exhaust air, radiant heat from building materials, etc. Location to be approved by Engineer.
V. Pressure sensors and switches.

1. Provide accessories as required to dampen input signal to transducers and reduce fluctuations in the signal.
2. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
3. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
4. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

W. Low-limit sensors and other safeties shall have at least two poles; one hard wired to fan starter, and one wired to BAS. Low limit sensors will have an additional pole to interrupt power to the associated unit heating valves and economizer dampers.

X. Smoke detectors are to be installed with sampling tube, and in a section of ductwork as noted by the manufacturer. One N.C. contact will be wired to shut down the supply and return/relief fans and alarm at the BAS; the second shall be N.O. and provide an input to the fire alarm system. Wiring to the fire alarm system by fire alarm provider. Coordinate with fire alarm.

Y. Coordinate location/orientation of all meters and associated sensors / displays in the field with meter manufacturer's factory representative for compliance with installation requirements, accessibility and maintenance.

Z. Provide dry contacts and monitor on the BAS the school / campus fire alarm (trouble, status, alarm).

END OF SECTION

SECTION 23 09 21 (MEP)
BUILDING AUTOMATION SYSTEM (BAS) - BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
1. Wiring.
2. Control Valves and Actuators.
3. Control Dampers and Actuators.
4. Field Panels.
5. Sensors / Thermostats.
6. Transmitters.
7. Switches.
8. Transformers.
9. Electric Control Components (Switches, Thermostats, Relays, Smoke Detectors, etc.).
10. Transducers.
11. Air Flow Measuring Stations.
12. Current Switches.
13. Nameplates.
14. Testing Equipment.

1.02 DESCRIPTION OF WORK

A. Refer to Division 23 Sections 230923 Direct-Digital Control System for HVAC, 230926 Building Automation System-Sequence of Operation and 230927 Building Automation System-Commissioning and Division 26 for additional requirements.

B. Refer to other Division 23 Sections for installation of instrument wells, valve bodies, flow meters, and dampers in mechanical systems; not work of this Section.

C. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:
1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
4. All other necessary wiring for fully complete and functional control system as specified.
5. Power wiring from spare circuits in electrical panels to Digital Control System Field Panels.

1.03 WORK BY OTHERS

A. Control Valves furnished under this Section shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper operation of the valve.

B. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper operation of the damper

C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who will be fully responsible for the proper installation and application.

D. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120V control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. Digital Control System Contractor shall extend it from the equipment to the control device.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Instrument Pipe and Tube
   1. Hydronic and Instruments
      a. Connection to Main Piping: Provide ½ inch minimum size threadolet, ½" x 2-inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
      b. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
      c. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90-degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
      d. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead-free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
      e. Rigid Piping For Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.
   2. Low Pressure Air Instrument Sensing Lines
      a. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
      b. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

C. Communication Wiring: All wiring shall be in accordance with National Electrical Codes, CPS Infrastructure Standards and Division 26 of this specification.
   1. Contractor shall supply all communication wiring between all Controllers, Routers, Gateways, and local and remote peripherals (e.g., operator workstations, printers, and modems).
   2. Local Supervisory LAN: For any portions of this network required under this Section of the specification, contractor shall use Fiber or Category 6E of standard TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
   3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall

PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated, and wiring shall be grounded as recommended by controller manufacturer.

D. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes, CPS Infrastructure Standards and Division 26 of this Specification.
   1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
   2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes, CPS Infrastructure Standards and Division 26 of this Specification.
   1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

F. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
   1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
   2. Provide UL-listed cabinets for use with line voltage devices.
   3. All gauges and control components shall be identified by means of nameplates.
   4. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
   5. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

2.02 CONTROL VALVES

A. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application and shall generally be considered at dead head rating of the pump. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly. Size all valves and actuators for the appropriate application and submit this information on a valve schedule.

B. Plug-Type Globe Pattern for Water Service (2 Position, 3-way modulating and 2 position dual temperature changeover control valve applications only):
   1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
   2. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on ‘top-and-bottom’ guided plugs.

3. Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
4. Temperature Rating: 25°F minimum, 250°F maximum
5. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
6. Valve Trim: Bronze; Stem: Polished stainless steel.
7. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. Plug: Brass, bronze or stainless steel, Seat: Brass
9. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
10. Ambient Operating Temperature Limits: -10 to 150°F
11. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Invensys
    c. Warren
    d. Bray
    e. Belimo

C. Plug-Type Globe Pattern for Steam Service:
1. Valve Sizing: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
    a. Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
3. Body: Bronze, screwed, 250 psig steam working pressure for 1/2" to 2"; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2" and larger for applications of 50 psig or less.
4. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
5. Packing: Spring Loaded Teflon.
6. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
7. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Invensys
    c. Warren
    d. Bray
    e. Belimo

D. Pressure Independent Control Valves and Actuators - (all 2-way valve hydronic modulating applications)
1. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly.
2. Size all valves and actuators for the appropriate application and submit this information on a valve schedule.

3. For valves 3/4” and less, use Belimo Zone Tight Pressure Independent Zone Valves (PIQCV) or approved equal by Flow Control Industries. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature.
   a. A flow-characterizing disc incorporated within the ball shall be installed in the stainless-steel ball The valve trim shall utilize a stainless-steel ball with an internal characterizing disc and stem for all water or glycol solutions up to 60% incorporating a dual EPDM O-ring packing design with fiberglass reinforced Teflon® seats and seals. Bodies rated at 360 psi with a maximum media temperature limit of 250 deg F.
   b. The valve shall incorporate an internal pressure regulator located upstream of the ball to regulate pressure and maintain a constant pressure differential. Replaceable cartridges are not permitted. The valve shall operate within a pressure differential range of 5 to 50 psi with a flow control tolerance of +/- 5%. Two internal P/T ports shall be incorporated for differential pressure verification.
   c. The flow characteristic shall be equal percentage.
   d. The actuator shall attach directly to the valve requiring no tools.
4. For valves 1” to 6” valves use Belimo Electronic Pressure Independent Control Valves (ePIV)or approved equal by Flow Control Industries. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature
   a. A characterized control valve shall be integrated with an ultrasonic flow meter (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential of 1 to 50 psi. The ultrasonic flow meter shall incorporate an algorithm to automatically compensate for the glycol concentration.
   b. A Teflon® PTFE flow-characterizing disc shall be installed in the inlet of the characterized control valve. The valve trim shall utilize a stainless-steel ball and stem for all water or glycol solutions up to 60%. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼” shall be rated at 600 psi and sizes 1 ½ to 2” at ANSI 125, Class B with a temperature range of 14 to 250 deg F. The maximum allowable pressure differential shall be 50 psi.
   c. The flow characteristic shall be equal percentage.
5. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating-point control is not allowed (the exception to this is VAV reheat applications). Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator and shall not require opening the housing.
6. Actuators shall fail open on loss of power for all hot water applications. Closing time shall be less than 30 seconds.
   a. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.
7. Provide for manual positioning of the valve actuator without power and without disconnection the actuator from the valve.

2.03 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. Provide parallel blade dampers for dampers providing two-position control (for multi zone dampers a parallel blade application with lower torque requirements should be submitted as an alternate). For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service.

B. For zone dampers and other applications with duct or opening areas less than 5 square feet that do not provide isolation to outdoors and function in a general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm, differential pressure not greater than 2.5" w.c.:
   1. Performance: Test in accordance with AMCA 500.
   2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
   3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts with set screws, 16-gauge minimum thickness.
   4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
   5. Jamb Seals: None.
   6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
   7. Linkage: Concealed in frame if parallel.
   8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
   9. Leakage: Less than one percent based on approach velocity of 1500 ft./min. and 1-inch wg.
   10. Maximum Pressure Differential: 2.5 inches wg.
   11. Temperature Limits: -40 to 200 °F.
   12. Where two dampers are to be mechanically interlocked such as a face and bypass arrangement, the manufacturer will provide required torque values for the combined damper assembly.
   13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
      a. Johnson Controls D-1100
      b. Ruskin CD36
      c. Vent Products 5800

C. For applications with duct or opening areas greater than 5 square feet that do not provide isolation to outdoors and function in a general isolation and modulating control service in rectangular ducts at velocities exceeding 1500 fpm, differential pressure greater than 2.5" w.c.:
   1. Performance: Test in accordance with AMCA 500.
   2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
   3. Blades: Galvanized steel or extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts, 14-gauge minimum extrusion thickness.
   4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
   5. Jamb Seals: Stainless steel.
   6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless-steel sleeve, with thrust washers at bearings.
   7. Linkage: Concealed in frame if parallel.
   8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
   9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1-inch wg..
   10. Maximum Pressure Differential: 6 inches wg.
   11. Temperature Limits: -40 to 200 °F.
   12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple

dampers driven by a jackshaft the shaft will be rigid in torsion and driven by at least two actuators located at either end of the shaft.

13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. TAMCO 1000
    b. Ruskin CD60
    c. CESCO Products AGA or AGB

D. For all outside air intake or exhaust control dampers that provide isolation to outdoors or otherwise need to provide thermal isolation:
1. Performance: Test in accordance with AMCA 500.
2. Frames: Aluminum, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum thermally broken insulated, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2-inch shafts, 14-gauge minimum extrusion thickness.
4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
5. Jamb Seals: Non-metallic seal.
6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless-steel sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame if parallel.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1-inch wg..
10. Maximum Pressure Differential: 6 inches wg.
11. Temperature Limits: -40 to 200 °F.
12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts. For multiple dampers driven by a jackshaft the shaft will be rigid in torsion and driven by at least two actuators located at either end of the shaft.
13. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. TAMCO 9000
    b. Ruskin TED50XT

2.04 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Damper Actuators
1. Ambient Operating Temperature Limits: -10 to 122°F
2. Two Position Electric Actuators: Line voltage with spring return
3. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds, unless prior approval is obtained. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor

protection. Actuators shall have manual override. Modulating actuators for valves shall have minimum rangeability of 40 to 1.

a. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent. When shutoff does not apply the actuator will be sized based on the manufactures required torque plus 30%.

b. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
   1) Belimo
   2) Delta
   3) Invensys

C. Quarter-Turn Actuators (for ball and butterfly valves):

1. Electric

a. Motor: Suitable for 120- or 240-Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.

b. Gear Train. Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.

c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure

d. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning. Actuators shall fail open on loss of power for all hot water applications. Closing time shall be less than 30 seconds. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.

e. Enclosure: Actuator enclosure shall be NEMA-4 rated and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.

f. Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.

g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless-steel construction to limit actuator to specific degrees of rotation.

h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.

i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position. Provide for manual positioning of the valve actuator without power and without disconnection the actuator from the valve.

j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.

k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.

l. Ambient Conditions: Actuator shall be designed for operation from –10 to 150 °F ambient temperature with 0 to 100 percent relative humidity.

m. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating-point control is not allowed (the exception to this is VAV reheat applications). Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator and shall not require opening the housing.

2.05 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into all controllers . Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non repeatability and hysteresis.

2.06 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of controller, or Smart Sensor (SS), sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. Matched Sensors: The following applications shall require matched sensors:

1. Building Loop Connections: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential), monitoring temperature across energy wheels / plates / run around coils (both air stream) and supply/return sensors adjacent to flow meters / btu meters.
2. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations, energy calculations or sequencing such as across chillers, boilers, plants and pumping systems.
3. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

C. Room Temperature Sensor: Shall be a stainless-steel wall plate sensor. An electronic thermostat with manual override will be provided in the principal, main office areas, select administrative areas, where required by the project energy code and as approved by CPS. Provide ¼" medical grade closed cell foam insulating material. The following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point.
2. Manual-reset button to permit return to occupied mode during unoccupied cycles for a preset time period, with automatic reset to normal during next cycle of operation.
3. See Humidity Transmitters for combination temperature and humidity sensor and CO2 used for zone level monitoring.

D. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point

E. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three-square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
   1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3°F accuracy at calibration point.

F. Liquid immersion temperature sensor shall include thermowell, sensor and connection head for wiring connections. Provide thermally conductive paste in well to ensure good contact with the well. Temperature range shall be as required for resolution of 0.15°F.
   1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
   2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.

G. Pipe Surface-Mount Temperature Sensor: Sensor are only for use in applications specifically identified on the drawings. Normally only used on condensate return piping for steam systems. Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as required for resolution indicated in paragraph A.
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

H. Outside air sensors shall consist of a sensor, an aspirated enclosure, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as required for resolution indicated in Paragraph A
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
   2. Acceptable Manufacturers: Kele A21 or equal

2.07 TEMPERATURE TRANSMITTERS

A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

2.08 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor and CO2 may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
   1. Input Range: 0 to 100% RH.
   2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
   3. Sensor Operating Range: As required by application

4. Long Term Stability: Less than 1% drift per year.
5. Comply with requirements of CO2 Sensors/Transmitters sections for combination sensors.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series, Kele H_20K.

2.09 PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. General Purpose - Water: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.
   1. Acceptable units shall be Kele & Associates Model 360 C

B. Liquid, Steam and Gas:
   1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
   2. Environmental limits: –40 to 250 °F, 0 to 100% RH.
   3. Accuracy: less than 0.1 percent of span.
   4. Output Damping: Time constant user selectable from 0 to 36 seconds.
   5. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
   6. Electrical Enclosure: NEMA-4, -4X, -7, -9.
   7. Approvals: FM, CSA.
   8. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac.

C. General-Purpose Low-Pressure Air: Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered two-wire differential capacitance cell-type transmitter.
   2. Output: two wire 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1% of reading.
   4. Minimum Range: 0.1 in. w.c.
   5. Maximum Range: 10 inches w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Modus T30.
   8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
   9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

D. General Purpose Low Pressure/Low Differential Air: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered, two-wire differential capacitance cell type transmitter.
   2. Output: Two-wire 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1% of reading.
   4. Minimum Range: 0 in. w.c.
   5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Modus T30 or Setra.
   8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
   9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

E. Velocity Pressure: Generally for use in air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell type transmitter.
2. Output: Two-wire, 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 0.25%
4. Minimum Range: 0 in. w.c.
5. Maximum Range: 1-inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Setra 264 with optional FS accuracy above or equal..
8. Range: Select for minimum range that will accept the maximum velocity pressure expected.

2.10 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing

B. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

2.11 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.12 TRANSDUCERS

A. Binary to Analog Transducers or Tri-State-to-Voltage or -Current:
   1. Adjustable zero and span.
   2. Failure Mode on Power Loss: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
   3. Accuracy: ± 1% of span
   4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
   5. Input: 4-20 mA, pulse width modulated or tri-state input.
   6. Tri-state Input Time Base: Dip switch selectable.
   7. Enclosure: Polymer designed for surface or panel mount.
   8. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
   9. Acceptable Manufacturers: RE Technologies Model PWA Series.

B. Electronic-to Electronic (Voltage or Current to Current or Voltage):
   1. Adjustable zero and span.
   2. Failure Mode on Power Loss: Memory feature to allow the transducer to return to last value on power failure.
   3. Accuracy: ± 1% of span.
   4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
   5. Input: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
   6. Enclosure: Polymer enclosure designed for surface or panel mount.
   7. Acceptable Manufacturers: RE Technologies Model PWA Series.

2.13 CURRENT SWITCHES (CS)

A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
   1. Range: 1.5 to 150 amps.
   2. Trip Point: Adjustable.

3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Lower Frequency Limit: 6 Hz.
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED.

B. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150.
1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor / Electronically Commutated Motor Status Indication
1. Range: 1.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Frequency Range: 5-75 Hz
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: Veris Industries, Inc. H-904.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors / Electronically Commutated Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.14 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)
1. Range: 1-10 amps minimum, 20-200 amps maximum
2. Trip Point: Adjustable
3. Output: 0-5 VDC.
4. Accuracy: ±0.2% from 20 to 100 Hz.
5. Acceptable Manufacturers: KELE SA100, Veris Hawkeye 720.

2.15 AIRFLOW MEASURING STATIONS (AFMS)

A. Air Flow Measuring Stations – General
1. Air Measuring Stations to be furnished under this section of the specification and installed under Division 23 Section 233300, Duct Accessories.

B. Outside Air Measuring Stations:
   1. General:
      a. Airflow measuring station (AFMS) shall use the principle of thermal dispersion.
      b. Each AFMS shall consist of multiple sensing nodes each with one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor, hermetically sealed and potted in a marine grade waterproof epoxy.
      c. Each AFMS shall be provided with a remotely located microprocessor-based transmitter and one or more sensor probes, with each probe contain one or more independently wired sensing nodes. Provide one (1) sensor node for each square foot of area, up to a maximum of 16 nodes.
      d. Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.
   2. Performance:
      a. Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 5,000 FPM. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
      b. Each sensing node shall have a temperature accuracy of ±0.15° F over an operating range of -20° F to 160° F.
      c. Airflow measurement shall be field configurable to determine the average actual or standard mass airflow rate.
      d. The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.
   3. Interface:
      a. The transmitter shall be provided with a 16-character, alpha-numeric, remote mounted LCD display (Coordinate Display location in field with project design engineer / owners rep / commissioning agent.). The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display
      b. Analog output signals shall provide the total airflow rate and average temperature.
      c. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and one isolated RS-485 (field selectable BACnet MS/TP or Modbus AHU) network connection.
   4. The manufacturer's authorized representative shall review in the field, approve placement and the operating airflow rates for each measurement location indicated on the plans / diagrams.
   5. Acceptable Manufacturers:
      a. Ebtron – GTx116
      b. Air Monitor – Electra-Flo

2.16 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

A. Single or Multi-Point Averaging (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

2.17 CO2 SENSORS/TRANSMITTERS (CARBON DIOXIDE)

A. CO2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.
B. Range: 0-2000 ppm
C. Accuracy: ±36ppm at 800 ppm and 68°F.
D. Stability: 5% over 5 years.
E. Output: 4-20 mA, 0-10 Vdc or relay, or BACnet interface.
F. Mounting: Ducted as indicated. Wall mounted as indicated.

G. Wall mount units: Include LED lights (normal 500 PPM, elevated 1000 PPM, high 1200 or higher. All values adjustable) or LCD display with PPM readout. Units shall include feature to allow owner to lock out local display when LCD display provided. Unit LED lights or LCD Display shall include feature such that PPM actual values are monitored by the BAS. Unit shall include feature to allow owner to lock out audible alarm both locally and remotely through BAS.
H. Provide BACnet interface.
I. Acceptable Manufacturer: Vaisala, MSA, Kele 8000 series, Vulcain, Belimo, Honeywell, CRC.
J. See Humidity Transmitters for combination temperature and humidity sensor and CO2 used for zone level monitoring.

2.18 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.
B. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20', junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F, factory set at 38°F.
C. High Temperature Detectors (‘Firestat’) (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F.
D. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150°F, and a minimum 10°F fixed setpoint differential.
E. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F, switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.
F. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
    1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
        a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
        b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
        c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
        d. Pilot light indication of power-to-coil and coil retainer clips.
        e. Coil rated for 50 and 60 Hz service.
        f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA.
    2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC.
    3. Relays used for stop/start control shall have low voltage coils (30 VAC or less) and shall be provided with transient and surge suppression devices at the controller interface.
G. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.
H. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application and mounted in minimum NEMA-1 enclosure.
    1. Transformers shall be manufactured by Westinghouse, Square ‘D’, or Jefferson.

I. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
   1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
   2. TDRs shall be UL and CSA listed, Crouzet type.

J. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley.

K. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley.

L. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory.

M. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley.

2.19 DUCT SMOKE DETECTOR

A. Photoelectric detector with sampling tube that spans the entire width of duct. Detector shall be compatible with the building/project fire alarm system. Coordinate with fire alarm / electrical contractor.

B. Velocity Rating: 100 to 4000 fpm or 500 to 4000fpm depending on the minimum velocity in the duct. Provide the 100 to 4000 fpm detector if the min duct velocity is below 550 fpm.

C. Output Contact: Alarm, two sets form “C” rated at 10amps 115V resistive. One set of alarm contacts for BAS monitoring and fan shutdown. Second set for the fire alarm system trouble alarm.

D. Temperature & RH limits: 32 to 120°F and 10 to 85% relative humidity.

E. Acceptable Manufacturer:
   1. Invensys FIREX model 2650
   2. Sensor Systems D4120
   3. Air Products and Controls SL-2000

2.20 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.21 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Install all control wiring external to panels in electric metallic tubing or raceway. On Renovation projects, wiring in finished areas shall be routed in wire mold. The routing of wiring in finished areas must be specifically approved by the AOR/EOR. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code CPS Infrastructure Standards and Division 26 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 of this Specification.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals. All WAN and LAN cabling shall comply with applicable Division 26 requirements.
5. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

C. Control Valves: Provide pressure independent control valves for all modulating 2-way valve hydronic applications. Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

D. Freezestats: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. The length of element not just downstream of the coil will not be included in the coverage calculation. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips such that sensor is not in direct contact with equipment. Coordinate the location of the switch such that it is normally accessible.

E. Install sensors and meters in accordance with manufacturer’s recommendations / requirements and as indicated in paragraphs below and on drawings.

F. Room Temperature Sensors: Install sensors as shown on the drawings. Provide approved security screws for mounting, matching those installed in other areas of the project. Provide 3 tools to the Owner for installation and removal of the security screws. Seal conduit penetrations at the wall box airtight. Install batt insulation in the wall box to completely fill the box. Electrical connections shall be made using a twist-on sealant filled connectors suitable for

the installation. Locate sensor such that computers, water coolers, and other heat generating equipment are not operating near the sensor.

G. Averaging Temperature Sensors: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally the sensor will be located where flow is sufficiently homogeneous/adequately mixed, consult AE for requirements. Averaging sensors shall be used in airstreams at the inlet / outlet of energy recovery devices (wheels, plates, run around coils, etc.), mixed air streams, coil leaving air, etc.).

H. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans, provide at each individual fan in all fan array applications and provide inlet cone adapter as recommended by AFMS station manufacturer. Manufacturer / manufacturer's representative shall visit the site and finalize / approve all sizes and locations.

I. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

J. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

K. Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

L. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

M. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

N. Supply Duct Pressure Transmitters:
   1. General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration and maintenance.
   2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

O. Hydronic Pressure Transmitters:
   1. General: Install per manufacturers recommendations. Locate the transmitter at an accessible location to facilitate calibration and maintenance.
   2. Locate on the most hydraulic demanding branch approximately 2/3 of the way in the system. Where a system serves multiple buildings / wings on a school / school campus, provide one transmitter in each building / wing. Transmitter shall not be located near the pumps being controlled.

P. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

Q. Mount sensors rigidly and adequately for the environment within which the sensor operates.

R. Provide 7-day programmable wall mount stand-alone control thermostats to control all unit heaters and cabinet heaters. Heating shall be reset down at night/unoccupied periods. On hydronic units, stat shall control the unit hydronic valve / aquastat / fan.

S. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

T. Averaging sensors and low-limit switches

1. Sensors used in mixing plenums, hot and cold decks, energy recovery applications or ducts over 48” any direction shall be of the averaging type.
2. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
3. Low limit sensors shall be mounted in a serpentine manner, horizontally across duct in accordance with manufacturers recommended installation procedures.
4. Provide 1 ft of sensing element for each 1 ft2 of coil area.
5. For large duct areas where the sensing element does not provide full coverage of the air stream, additional sensors or switches shall be provided as required to provide full protection of the air stream.
6. Wire one pole of the low-limit switch to the supply and return fan starters, one pole to a BAS input, and one pole to interrupt power to the associated unit heating valves and economizer dampers.

U. All pipe-mounted temperature sensors shall be installed in wells. Use conductive compound in all wells to provide good heat transfer.

V. Install aspirated enclosure containing outdoor air temperature, carbon dioxide sensor and humidity sensors on north wall at designated locations. They shall be located so as to avoid effects of sun, reflected sun, exhaust air, radiant heat from building materials, etc. Location to be approved by Engineer.

W. Pressure sensors and switches.
1. Provide accessories as required to dampen input signal to transducers and reduce fluctuations in the signal.
2. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
3. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
4. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

X. Low-limit sensors and other safeties shall have at least two poles; one hard wired to fan starter, and one wired to BAS. Low limit sensors will have an additional pole to interrupt power to the associated unit heating valves and economizer dampers.

Y. Smoke detectors are to be installed with sampling tube, and in a section of ductwork as noted by the manufacturer. One N.C. contact will be wired to shut down the supply and return/relief fans and alarm at the BAS; the second shall be N.O. and provide an input to the fire alarm system. Wiring to the fire alarm system by fire alarm provider. Coordinate with fire alarm.

Z. Coordinate location/orientation of all meters and associated sensors / displays in the field with meter manufacturer’s factory representative for compliance with installation requirements, accessibility and maintenance.

AA. Provide dry contacts and monitor on the BAS the school / campus fire alarm (trouble, status, alarm).

END OF SECTION

SECTION 23 09 23 (LNK)
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System description.
B. Controllers.
C. Power supplies and line filtering.
D. System software.
E. Controller software.
F. HVAC control programs.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2021).
B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems 2019, with Addendum (2020).
C. Bluetooth CS - Bluetooth Core Specification 2016, Addendum 2017.
D. CTA-709.1 - Control Network Protocol Specification Revision D, 2014.
E. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications 2020, with 2021 Amendments.
F. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests 2019h.
G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL (DIR) - Online Certifications Directory Current Edition.

1.03 DESCRIPTION OF WORK

A. Coordinate with existing control system that was provided by Automatic Building Controls, LLC in 2020. Provide new controls and reconfigure existing controls as required to accommodate the new mechanical equipment included within the scope of this project. Fully integrate all controls associated with the work of this project into the existing control systems. Provide graphics displays at the existing BAS for all new equipment and existing equipment where control modifications are being made. New graphics displays shall be similar in appearance and fully integrated into the existing BAS programming.
B. Contractor shall provide all interface devices and software to provide an integrated system connecting Advanced Application Controllers, Application Specific Controllers, Building Controllers, and Gateways. The Control System Server provided by CPS will also be connected to the CPS's WAN. Install all the cabling per CPS Spec.

1.04 APPLICATION OF OPEN PROTOCOLS

A. Subject to the detailed requirements provided throughout the specification, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing one of the following standards:
   1. BACnet: System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all BACnet building controllers (B-BC), advanced application controllers (B-AAC) and all application specific controllers (B-ASC). Gateways to other communication protocols are not acceptable. All controllers must be BACnet Testing Labs listed for their required profile (B-BC, B-AAC or B-ASC).
   2. Each component of the system, including the LANs and software, shall be in full compliance with ASHRAE Standard 135, commonly referred to as BACnet. The BAS shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless

Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks). All physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

3. The contractor will provide all software licenses, software products, hardware connectors, hardware products to become self-maintainer if they choose to. CPS shall be free to direct the modification of any software license, regardless of supplier. In addition, CPS shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project. Any and all required Ids and passwords for access to any component or software program shall be provided to CPS.
4. CPS shall provide license naming detail to the contractor.

1.05 DEFINITIONS

A. Acknowledged: Data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.
B. Adjustable (ADJ): A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program.
C. Analog Calibration Offsets: For all analog input measured variables, with the exception of velocity pressure, the value measured by the hardware based analog input point shall be adjusted to match the value reported by a certified test instrument. An analog calibration offset is a parameter that can be added or subtracted from the raw value measured by the sensor to produce a calibrated value used by the control logic and reported to the operator workstations. The initial value of this parameter is set at zero and it is adjusted when the calibration process is executed. This adjustment is referred to as a single point calibration. These parameters are mandatory for all analog inputs except velocity pressure sensors. These offset values are configuration parameters and shall be written to EEPROM. It shall be possible to change the value of these parameters from a graphic page.
D. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications. A fully programmable control module. This control module shall be capable of certain advanced features found in Building Controllers (e.g. storing trends, and initiating read and write requests) but it shall not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet. A BACnet device to be used as an AAC will meet the requirements of ASHRAE 135, Annex L and will be listed as an AAC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.
E. AHU: A factory-made encased assembly consisting of a fan or fans and other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying and mixing of air
F. Application Programming Tool: A vendor unique software tool used to create applications for programmable controllers.
G. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and application user data (ISO 9545).
H. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). A pre-programmed control module, intended for

use in a specific application. ASCs shall have limited configurability, allowing the user to select various pre-programmed options, but it shall not be fully customizable. A BACnet device used as an ASC will meet the requirements of ASHRAE 135, Annex L and will be listed as an ASC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.

I. BACnet/BACnet Standard: BACnet communication requirements, as defined by ASHRAE/ANSI 135, current version including all annexes and addenda.

J. Bandwidth Utilization: The average utilization of the network capacity. Network loading is controlled by the use of event driven broadcast based data propagation and the use of appropriate binding services.

K. Binding Services: When the network management tool within Niagara or Plexus is used to establish a binding, one of the following three types of binding services shall be selected:
   1. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. Used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.
   2. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. Used for most process control related data requiring timely receipt of the data.
   3. Acknowledged: The data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.

L. Binding: The concept of associating an output network variable from one device to the input network variable of a second device. There are three types of bindings:
   1. One to One: A single output network variable is bound to a single input network variable
   2. One to Many: A single output network variable is bound to input network variables on multiple devices.
   3. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

M. Broadcasting: The propagation of data from a device to the control network. Software objects that broadcast data to the network shall include the following parameters:

N. Building Automation System (BAS): The entire integrated energy management and control system.

O. Building Controller (BC): The BC is a Server that is either a physical server provided by CPS or a virtual machine provided by CPS to run the BAS software from connected to the CPS Enterprise WAN that can communicate with the vendor provided hardware / software.

P. Typically this controller is located on the Ethernet/IP backbone of the BAS. A BACnet device to be used as a BC shall meet the requirements of ASHRAE 135, Annex L and will be listed as a BC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.

Q. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-current version)

R. Client: A device that is the requester of services from a server. A client device makes requests of, and receives responses from, a server device.

S. Configuration Parameter: An input network variable to a controller that is written to the EEPROM.

T. Continuous Monitoring: Sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

U. Control System Server (CSS), Web Server (WS): Provides access to the control system. This device will allow access to the control system with a web browser over the CPS WAN. As the BAS network devices are on the CPS Enterprise Network, the CSS is not required

for communications to occur. The webserver will be provided by Owner and connected to the CPS Enterprise Network on the same VLAN as the BAS network devices.

V. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and is a PCU.

W. CPS WAN: Reference to Chicago Public Schools Information Technology network, used for normal business-related e-mail and Internet communication.

X. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic

Y. Error Rate: A measurement of communication quality that assesses the number of defective data packets as a percentage of the total number of data packets. Defective data packets are generally the result of poor installation practices or improper cable selection.

Z. Event Driven Communication: A term used to describe the propagation of data from a device to the network based on broadcasting rather than polling. The send on delta parameter is used to define the event and the data propagation is further controlled by the minimum and maximum send time parameters.

AA. Fully Open BAS: Building Automation System that all materials, hardware, firmware, and software can be procured through open market non-proprietary vendor warehouse distribution channels, in addition to being installed and maintained by any Tridium Niagara Framework factory authorized/qualified Building Automation and Controls Company.

BB. Free Topology: A data wiring topology that allows for loops, tees, y-connections etc. When this topology is used only one terminator of a specific design is required and allowable cable lengths are significantly reduced.

CC. Functional Profile: A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.

DD. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-1995).

EE. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.

FF. Host-Based Controller: Applicable only to Lon-based controllers where the on-board Neuron chip is used solely as the Communications Interface and a processor independent from the Neuron chip to is used to execute Application control and I/O processes.

GG. JACE: Java Application Control Engine. Term used within the Niagara Framework to describe a component that serves several key functions:

HH. Serve as the LANID.

II. Transmission of data to operator workstations on the TCP/IP network.

JJ. Location for time schedules to support all of the devices.

KK. Location for trend logs for all data to be trended from the devices.

LL. Location for alarm handling software. The JACE shall process event broadcasted data from the devices (alarm indication) and enter the appropriate alarm information in the alarm reporting system at the TCP/IP level.

MM. Local Supervisory LAN Interface Device (LANID): Device used to facilitate communication and sharing of data throughout the BAS and CPS WAN

NN. Media Access Control address (MAC): Hardware address that uniquely identifies each node of a network. Each different type of network medium requires a different MAC layer.

OO. Managed Communication: Transmission of data from a controller to a data manager, which in turn re-broadcasts the data to a second controller.

PP. Manual Control: Where the operator takes control of an end device and forces a specific position or state. The manual mode and the desired manual position or states are parameters that are set by the operator.

QQ. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

RR. Maximum Send Time Parameter: Parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of the variable, a re-broadcast of the current value shall be executed. See also "Send on Delta" and "Maximum Send Time."

SS. Maximum Send Time: Adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.

TT. Minimum Send Time Parameter: Parameter used to control unnecessary broadcasting of data onto the network. Broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also "Send on Delta" and "Maximum Send Time" definitions.

UU. Minimum Send Time: Adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.

VV. Multiple Controller Integrated Control (MCIC): Where multiple controllers with I/O are used to control a single mechanical system, which is sub-divided into a collection of processes to be controlled. All primary measured variables and the end device associated with a single process along with the primary control logic for the process shall be contained within a single controller. Secondary data from one process that affects the control of another process may be sent from one controller to the primary controller controlling the process. When data is sent from one controller to another controller, broadcasting concepts as defined above must be used. If the data being received over the network only affects the general thermodynamic or psychometric performance of the process but does not have a significant affect on safety or equipment protection then unacknowledged repeated binding services shall be used. If the data being received over the network has a safety or equipment protection impact, then acknowledged repeated binding services shall be used. In both cases peer-to-peer communication is mandatory. All controllers must be on the same channel. Managed communication shall not be used to move data between the multiple controllers.

WW. One to Many: A single output network variable is bound to input network variables on multiple devices.

XX. One to One: A single output network variable is bound to a single input network variable.

YY. Open Database Connectivity (ODBC): Open standard application-programming interface (API) for accessing a database, making access to any data, regardless of which database management system (DBMS) is handling the data, possible.

ZZ. Operator Interface (OI): A device used by the operator to manage the BAS.

AAA. Operator Workstation (OWS): Used to interface with the BAS system.

BBB. Peer-to-Peer Communication: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.

CCC. Polling Communication: The concept of a control device requesting a network variable from a second control device at a specified interval. Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.

DDD. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller.

EEE. Primary Control Unit (PCU): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems.

FFF. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, identifying the particular options specified by BACnet that are implemented in the device.

GGG. Router: A device that connects two or more networks at the network layer.

HHH. Send on Delta Parameter: A parameter used to control unnecessary broadcasting of data onto the network. For binary data the send on delta parameter is assumed to be a change of state.

III. Send on Delta: Adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data this parameter defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met.

JJJ. Smart Device: A control I/O device such as a smart sensor (SS) or smart actuator (SA) that can directly communicate with the controller network to which it is connected rather than through a binary or analog signal.

KKK. Standardized Query Language (SQL): Standardized means for requesting information from a database.

LLL. Stand-Alone Controller: A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.

MMM. Supervisory Logic: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices.

NNN. Terminator: An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment. On a bus topology, a terminator is connected to each end of a segment. For a channel consisting of two bus topology segments, a total of 4 terminators are required, one at each end of each segment.

OOO. Test Mode: A concept where the operator from the operator workstation can interrupt the flow of data from a sensor to the control logic and insert a mandatory test value or test state to be used by the control logic. The test mode and the desired test value or states are parameters that are set by the operator.

PPP. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. This type of service shall be used for most process control related data requiring timely receipt of the data.

QQQ. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. This type of service shall be used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.

RRR. Web Server: Refer to "Control System Server."

SSS. WiFi: The facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.

TTT. Wireless: Refers to WiFi application to CPS WiFi Enterprise Network.

UUU. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium.

1.06 FUNCTIONAL INTENT

A. Where detailed functional or performance requirements are specified, products intended for the Project, conforming to the specified requirements, must be submitted to, and approved by, CPS prior to shipment to the Project site.

1.07 SUBMITTALS / DELIVERABLES

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.

1. Drawings and Diagrams: Shop drawings shall be provided on electronic media as an AutoCAD 2014 or later version drawing file and/or Adobe Portable Document Format file. All 'x reference' and font files must be provided with AutoCAD files.
2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format (PDF). Provide documents, such as Cheat Sheets and TroubleShooting Guide, in rich text format (rtf) or Microsoft Word format as required.

C. Product Data: For each control device, panel, and accessory indicated or furnished. Include dimensions, capacities, performance and electrical characteristics, and material finishes. Include installation and start-up instructions. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

D. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:

1. System Architecture and System Layout:
   a. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, thermostats/sensors, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, terminators, ground locations etc. shall be located on the diagram.
   b. Provide floor plans locating all control units, thermostats/sensors, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include contractor written description of sequence of operation.
3. All physical and virtual points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type,

instance number). See Division 23 Section “Building Automation System (BAS) - Software and Programming," PART 3 for additional requirements.

5. Label each control device with setting.
6. Label each input and output with the appropriate range.
7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable. Also identify the specification section and specification reference.
8. Provide a valve or damper and the associated actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal (fail) positions of spring return valves and dampers. This is the valve or damper position with no power to the actuator.
9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, boiler burner, chiller, RTU, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed. For all devices with safety circuits, including burners and chillers, field wiring will be labeled and all added devices will be properly mounted. Any internal wiring changes shall be approved by the manufacturer in writing. If for example a gas booster needs to be tied into the burner circuit the manufacturer shall identify the terminal points and provide an updated control diagram.
10. Sample Operator Interface Graphic Screens for each unique type of system, with final screens to be received 60 days prior to system startup.
11. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
12. Sheets shall be consecutively numbered.
13. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
14. Table of Contents listing sheet titles and sheet numbers.
15. Legend and list of abbreviations.
16. Provide an operating schedule for review. The schedule will have a schedule for each AHU/RTU and the associated equipment. Terminal units serving the principal’s office and associated administrative areas will have a separate schedule from the classrooms.

E. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of 1 year since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.

F. Qualifications: For manufacturer, companies, Contractor and key personnel.

G. Checkout and Testing Forms: Submit a blank copy of the forms that will be used during Point-to-Point Checkout, Prefunctional Checkout, and Functional Performance Testing as outlined in Division 23 Section "Building Automation System (BAS) - Commissioning." Those forms should be structured to capture the following information at a minimum during each particular testing phase.

1. Point-to-Point Checkout Form containing the following information:
   a. Each point is addressed, labeled and that proper communication exists between the controller and the field device.

b. Documents that installed condition match the control drawings and that any changes or differences are noted on the drawings.

2. Pre-functional Checkout Forms containing the following information:
   a. Documents correct voltage and or current present as well as verifying circuits are free from grounds or faults for each control device.
   b. Obtain and Record Test and Balance settings and incorporate into the BAS. Information from the TAB contractor shall include:
   c. Water and air system differential pressure and flow settings.
   d. AHU minimum outside air control point or damper setting.
   e. Calibration data for all sensing and actuating devices recording final measured and displayed value. Record the type and model of the meter(s) that determined the measured value for analog inputs.
   f. For analog outputs record both the displayed output as well state of the receiving device.
   g. For digital input/outputs record the signal at the controller and the state of the sensing/control device.
   h. For actuators:
      1) Check to ensure that actuated device moves smoothly, and results are repeatable thru full range and seals tightly when the appropriate signal is applied to the operator.
      2) Check for appropriate fail position, and that the stroke and range is as required.
      3) For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges. Record final settings.
   i. For all valves and actuators, verify the actual position against the Operator Interface readout. Set pumps to normal operating mode. With command valve closed, verify that valve is closed, and adjust output zero signal as required. With command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't correspond correctly, replace actuator.
   j. Valve leak check: Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit.
   k. For air and water flow measuring stations the data recorded will include the independent flow measurement, area, and the independently measured output of the flow station. The BAS input from the flow station and any factors used to calculate the flow including area and any constants used in the calculation of flow. Two sets of data shall be collected. The first at design flow and the second at 50% of design flow. It is not acceptable to simply add a correction factor to address differences between the flow station and the independent reading.
   l. For Operator Interfaces and Web accessible display:
      1) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
      2) Output all specified BAS reports for review and approval.
      3) Verify that the alarm pop ups, printing, and logging are functional and in accordance with requirements.
      4) Verify that all points are trended and are archiving to disk. Provide a sample to the Commissioning Authority and CPS for review.
      5) Verify that paging/dial-out alarm annunciation is functional.

6) Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
7) Verify that required third party software applications required with the bid are installed and are functional.

m. For all actuating devices record final settings for device.
n. Document verification of point to graphics binding for all points displayed on the workstation and that webserver display have been mapped correctly and display the correct information.
o. Document that the webserver is on the CPS Enterprise LAN and can be viewed from off site (another school), and that the BAS is accessible via the current CPS web browsers without the use of any extra system runtimes (like java, flash, etc.).

3. Functional Performance Forms shall contain:
   a. List of all sequences, modes of operation and setpoint that initiates each sequence and/or mode. For each confirm that proper sequence of operation. Document any variance between designed sequence and actual condition.
   b. Record tuning parameters and response time for each control loop.
   c. Document all alarm and safeties test and final results.
   d. Results of trends including controlled points, setpoints, actual readings and other point defined by the Boards Authorized Representative.

H. Testing Plan:
1. Submit a plan for executing all phases of testing and completion of checkout forms. This includes the following: manufacturers' normal testing, point-to-point testing, pre-functional testing, and functional performance testing. The testing plan shall show the overall milestones of the controls work and testing of the controls system.
2. Provide the schedule for completing each phase of testing for each system or set of equipment including, but not limited to, air handlers, chillers, boilers, unit-vents, VAV boxes, network wiring, and operator workstations. Schedules shall show the time frame needed to complete the tasks.
3. The testing plan shall identify other trade milestones that impact the successful completion of during each phase of testing.
4. This plan is not meant to take precedence over any other plan but is intended to provide coordination assistance to all trades as the project is scheduled.

I. Open Protocol Information:
1. General: Provide all information necessary for review of the proposed system, including information required by the authority maintaining the protocol standard to determine if the product selected for implementation complies with the protocol standards specified.
2. BACnet Systems:
   a. BACnet object description, object ID, and device ID, for each I/O point.
   b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
   c. Submit PICS indicating the standardized BACnet device profile, functionality and configuration of each controller along with proof of BTL listing.

J. Framed or Laminated and digital Control Drawings: After completion of installation and check out, but prior to training, digital and laminated control drawings including system control schematics, sequences of operation, and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel. Digital control drawings will be accessible via the BAS front end.

K. Control Logic Documentation (to be received and updated prior to training):
   1. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.
   2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
   3. Include written description of each control sequence.
   4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters, and limits.
   5. Sheets shall be consecutively numbered.
   6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
   7. Include Table of Contents listing sheet titles and sheet numbers
   8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below.

L. Training Plan:
   1. Training shall be provided in eight, four-hour sessions and digitally recorded with CPS retaining a copy remitted to CPS upon completion via Google Drive and the graphic front end. This recording can be substituted for approved manufacturer training if CPS approves. A training plan is not required for opposite season or refresher training. Screen recording with voiceover is acceptable in lieu of digital recording.
   2. The material to be covered shall be further sub-divided into descriptions of the material to be covered in every 15 minutes. See Division 23 Section "Building Automation System (BAS) – Commissioning," for specific items to be addressed.
   3. The descriptions shall include not only the material to be covered but also its location in the Operation and Maintenance Manual or the Training Manual including Section and page number.

M. Operation and Maintenance Manual: (All documentation to be received and updated prior to training)
   1. In addition to other copies required, submit one copy of the materials directly to Chicago Public School's (CPS) projects management or operations staff.
   2. The reviewed and accepted version of this manual will also be available on the enterprise server for the project.
   3. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
   4. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
   5. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
   6. Include all as built submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions, and spare parts lists) in maintenance manual, in accordance with requirements of Division 01 Section "Operations and Maintenance Manual."

N. Training Manual: Submit training manual electronically for review. Once accepted, provide three hard copies and one electronic copy of the training manual at the start of training. Note only the initial 8 hours of training which include the Cheat Sheets will occur before the Cx demonstration is completed. Provide a link to the Training Manual must be available on the Operator's Interface. Include the following:

1. Cheat Sheets or quick reference section with step-by-step guidance with a level of detail that will allow someone with minimal experience with the control system to follow the instructions. The quick reference guidance can be provided one of two ways: screen prints with bubbled text describing the navigation required or written description of the steps to be taken with screen prints provided to facilitate the written explanation. This will also be stored on the enterprise server for the project. The required cheat sheets shall include:
    a. Logins and logoffs of the BAS System.
    b. Adjust and restore setpoints.
    c. Overrides and releasing overrides. Include instructions for running a report to list all points currently overridden.
    d. Start, group, plot and export Trends.
    e. Adjust and add schedules and add holidays.
    f. Processing of alarms including acknowledgement, review of alarm report, and clearing of alarm history.
    g. Backup and restoration of system BAS data.
    h. Demonstrate how to clear/reset all field devices that may require manual intervention.
    i. Demonstrate how to reset motor starter and the significance of Hand-Off-Auto switch position on motor starters.
    j. Demonstration of each input and output device. Provide a picture of each input or output device with a brief narrative on its operation.
    k. Demonstrate how to place the boiler or chiller system into manual control and boiler control, and how to restore the system to BAS control.
    l. Demonstrate how to reset variable speed or frequency drives.
2. Operating instructions including system startup and shutdown, seasonal and emergency instruction.
3. Trouble Shooting Guide. Include actions to be taken to trouble shoot problems with the OWS, PCU's CSS, and local control devices.
4. Setpoint Table
5. Preventative maintenance instructions.
6. Color print of each unique screen.
7. Final Sequence of Operations. This document shall be printed but shall also be provided electronically in Portable Document Format (PDF). The sequence shall provide not only the original design sequence from the specifications and drawings but also the any changes to the sequence.
8. Complete set of the design control drawings (on 11"x17" sheets). The manual will have a TAB for these drawings. List of all alarm points and alarm priority.

O. Video Training: The following training shall be recorded on a USB 3.0 thumb drive in a common video file format with screen capture software additionally it will be stored on the enterprise server for the project. The cadence of the video training shall be such that an inexperienced person can listen to the narrative and execute those steps on controls system while watching the Video. Include a screen view recording the actual video feed to the monitor for the workstation while narrating the associated steps. Provide a link on the graphics home page for the training archive that is playable by modern video player software.
    1. Quick reference procedures. The taping of these procedures must include both a screen view preferably recording the actual video feed to the monitor while narrating the associated steps.
        a. Login and logoff to the BAS system;

b. Adjust and restore setpoints.
c. Overrides and releasing overrides, as well as running a report to list all points currently overridden.
d. Start, group, plot and export Trends.
e. Adjust and add schedules and add holidays.
f. Processing of alarms including acknowledgement, review of alarm report and clearing of alarm history.
g. Demonstrate workstation menu penetration and broad overview of the various workstation features.
h. Demonstrate all operations and functions that can be performed at the supervisory or local controllers as well as system display artifacts such as the indication that a point has failed or lost communication.

P. Demonstration of portable operator interface device display capabilities.

Q. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.

R. Engineering Tools: All Front End and all Field Level programming tools shall be installed on the CPS Asset designated for the site. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. Contractor shall convey all software tools and their legal licenses at project close out.

1.08 LICENSING

A. Include licensing for all software packages at all required Control System Server (CSS Operator Work Stations (OWS) and Portable Operator Terminal (POT).

B. Any operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

C. Include licensing for all software packages at all required Web Server and OWS's and POT's. Licensing shall allow access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

D. All software should be available on all Web Servers and OWS's provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that CPS may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses. These backup disks will include a backup of all program data files, graphics etc. and shall allow the owner to completely restore the system in the case of a computer malfunction

E. Provide evidence of licensing including version and original software copies for each WEB Server OWS's and POT's. Licenses shall allow for access to any site device and shall not be restricted to accessing, database management, configuring, etc. the LANs included in this project. The licensing and registration proof will be provided when the system is installed on site.

F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period and provide a letter indicating the current release/version date at the end of the warranty.

1.09 PROJECT RECORD DOCUMENTS

A. The Project Record documents that have not already been submitted as part of the Operating and Maintenance Manual or Training Manual are to be submitted with the Record Documents. Any documents in the Operating and Maintenance Manual or Training Manual that have changed since they were submitted will need to be re-submitted as part of the Project record documents. All of these documents may be submitted electronically.

B. Record copies of product data and control shop drawings updated to reflect the final installed condition.

C. Graphic Software: Record copies of approved project specific graphic software on USB 3.0+ Thumb drives.

D. For BACnet systems provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description, and location information.

E. Include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address, device hostnames and drawing reference number.

F. Provide record riser diagram showing the location of all controllers.

G. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

1.10 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum five years of documented experience.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.11 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Contractor shall warranty all products and labor for a period of three (2) years after Final Acceptance.

C. Chicago Public Schools reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by CPS, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

D. At no cost to CPS, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in Division 23 Section "Direct - Digital Control System (BAS)" Sections. Service all equipment per the manufacturer’s recommendations. All devices shall be calibrated within the last month of the warranty period.
2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by CPS to the Contractor.
    a. Response to any request for service shall be provided within eight (8) hours of the initial request for service.
    b. In the event that the malfunction, failure, or defect is not corrected through the communication exchange, at least one (1) hardware and software technician,

trained in the system to be serviced, shall be dispatched to the site within eight (8) hours of the initial request for such services, as specified.

c. Emergency service shall be available on a 24-hour, 7-day-a-week, 365 days a year basis.

3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following notification by CPS to the Contractor.
   a. Response to any request for service shall be provided within one (1) working hour (contractor specified 40 hr/week normal working period) of the initial request for service.
   b. In the event that the malfunction, failure, or defect is not corrected through the communication exchange, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within three (3) working days of the initial request for such services, as specified.
4. Request for Service: Contractor shall provide up to three telephone numbers for CPS to call in the event of a need for service. At least one of the lines shall be attended 24 hours a day, 7 days a week. A technician shall respond to every call within 15 minutes.
5. Technical Support: Contractor shall provide technical support throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

1.12 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Board and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.
   5. All licenses direct to the Board.

PART 2 PRODUCTS

2.01 SYSTEM SOFTWARE-GENERAL

A. Functionality and Completeness: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

2.02 CONTROLLER SOFTWARE

A. All bindings, SNVT's, configuration values, addresses, calibration values, parameters, variables, tuning values, gains, test values, etc. for all software, programs, network configurations etc. shall be exposed and be available for setup, manipulation, adjustment, calibration, testing, etc. at all workstations, CSS's/OWS's, POT's for use as allowed via applicable password protection for all controllers and devices throughout all networks and the entire BAS.

B. Building Controller (BC) Software Residency: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:
   1. Real-Time Operating System software
   2. Real-Time Clock/Calendar and network time synchronization

3. BC diagnostic software
4. LAN Communication software/firmware
5. Direct Digital Control software
6. Alarm Processing and Buffering software
7. Energy Management software
8. Data Trending, Reporting, and Buffering software
9. I/O (physical and virtual) database
10. Remote Communication software

C. Advanced Application Controller (AAC) Application Specific Controller (ASC) Software Residency: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Division 23 Section "Building Automation System (BAS) - Communication Devices") with the restrictions/exceptions per application provided in Division 23 Section "Building Automation System (BAS) - Field Panels":
   1. Real-Time Operating System software
   2. AAC/ASC diagnostic software
   3. LAN Communication software
   4. Control software applicable to the unit it serves that will support a single mode of operation
   5. I/O (physical and virtual) database to support one mode of operation

D. Stand Alone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of stand alone functionality..

E. Operating System: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of the controller's operating system.

F. Network Communications: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:
   1. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
   2. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Gateways and LAN Interface Devices or CSS's/OWS's. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

G. Point Database/Summary Table: All points included in the typical equipment point list must be represented in a common, open protocol format. Naming conventions for these points and network addressing are discussed in PART 3 of this Section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System

software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in PART 3 of this Section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.

H. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

I. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.

J. Application Programs: CUs shall support and execute application programs as more fully specified below:
   1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) CPS programming.
   2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

K. Security: Controller software shall support multiple level password access restriction as more fully specified below.

L. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
   1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
   2. Two Position control (Hi or Low crossing with deadband)
   3. Single-Pole Double-Throw relay
   4. Delay Timer (delay-on-make, delay-on-break, and interval)
   5. Hi/Low Selection
   6. Reset or Scaling Module
   7. Logical Operators (And, Or, Not, Xor)

M. Psychrometric Parameters: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

N. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

O. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

P. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.

Q. Misc. Calculations: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog

inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.03 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. Point Definition: provide templates customized for point type, to support input of individual point information. For LON systems use standard LonWorks SNVTs.
2. Graphical Block Programming: Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
3. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
4. Line Programming: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.04 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Time-of-Day Scheduling
2. Calendar-Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
7. Economizer Control (enthalpy or dry-bulb)
8. Peak Demand Limiting and Load Shedding. The demand limiting function will use demand data as the basis for the function and the load shedding program will use space temperature adjustment or means acceptable to CPS to provide load shedding response. The function selected for a given school will be made by CPS.
9. Dead Band Control

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. For example the load shedding program will allow the operator to determine the spaces to be included in the load shed as well as the duration of the event. Programs shall be applied to building equipment as described in the Division 23 Section "Building Automation System (BAS) - Sequence of Operation."

2.05 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow the CPS's authorized BAS Administrator to limit workstation control, display and database manipulation

capabilities as deemed appropriate for each user, based upon an assigned user name with a unique password.

B. All passwords for the system shall be provided to CPS including administrator, dealer, or factory level passwords for the systems provided under this project.

C. Passwords shall restrict access to all Control Units.

D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 20 user names shall be supported and programmed per CPS's direction. Provide ability to deactivate passwords without removal of the login and password. CPS will be provided with the highest-level login and password so that CPS controls the administrative passwords.

F. Operators shall be able to perform only those commands available for the access level assigned to their user name.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line. This timer will not be the windows system screen saver feature.

2.06 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BC's ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. Alarm Descriptor: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
2. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with CPS on establishing alarm priority definitions.
3. Alarm Report Routing: Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
4. Auto-Dial Alarm Routing: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.

5. Alarm Acknowledgment: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.
6. Alarm Display: All alarms will popup as described in Alarm Acknowledgement. The owner will have the option to limit the pop up alarms based on alarm priority.

B. It shall be possible for any operator to receive a summary of all alarms, regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. Alarm Historical Database: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

2.07 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
1. Trends may be buffered in the BC as long as the trend data in the BC and the historical data stored on hard disk is displayed seamlessly.
2. Provide trends for all physical points, virtual points and calculated variables.
3. Trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
4. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
5. The sample rate and data selection shall be selectable by the operator.
6. The trended value range shall be selectable by the operator.
7. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. Data Buffering and Archiving: Trend data may be buffered at the BC, and uploaded to hard disk storage for archiving as needed based on the BC's memory constraints. All archived trends shall be transmitted to the on-site OWS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.

D. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

2.08 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

2.09 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.

B. Data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

2.10 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.11 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

C. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

D. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

E. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.12 POINT STRUCTURING AND NAMING

A. General: The intent of this Section is to require a consistent means of naming points across the CPS Enterprise. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project. The following requirement establishes a standard

for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The interface shall always use this naming convention. The naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by CPS.

B. Point Summary Table
   1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
   2. With each schematic, Contractor shall provide a Point Summary Table listing:
      a. Building number and abbreviation
      b. System type
      c. Equipment type
      d. Point suffix
      e. Full point name (see Point Naming Convention paragraph)
      f. English language point description
      g. Ethernet backbone network number,
      h. Network number
      i. Device ID
      j. Device MAC address
      k. Engineering units
   3. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).
   4. Point Summary Table shall also illustrate Network Variables/LonWorks Bindings.
   5. The Contractor shall coordinate with the CPS's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
   6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to CPS the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
   7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.
   8. Point Summary Table shall also illustrate Network Variables/BACnet Data Links/LonWorks Bindings.

Point Summary Table Example
Row Headers and Examples
(Transpose for a single point per row format)

Building Number	0006 (CPS 4 digit Building Code)
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
*Point Name (Object Name)	0006.COOLING.CHILLER.CHLR1KW
*Point Description (Object Description)	Chiller 1 kW

Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Point Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
* Represents information that shall reside in the property for the point	

C. Point Naming Convention

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS point, a specific and unique name shall be required.
2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a period to form the entire object name. Reference the paragraphs below for an example of these descriptors.
3. CPS shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the CPS WAN. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.
   a. Point Name Requirements

Descriptors	Comment
Building Number	0006
System	AIRHANDLINGEXHAUSTHEATINGCOOLINGUTILITYENDUSEMISC
Equipment	AHU-1BOILERSCHILLERSFACILITYTOWERSWEATHER
Point Suffix	See Input/Output point summary table for conventions

D. Examples: Within each point name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:

1. 0006.COOLING.CHILLERS.CHWP1ST
2. 0006.HEATING.BOILERS.BLR1CFH

E. Device Addressing Convention:

1. Lontalk - Network numbers and SNVT's shall be unique throughout the network.
2. BACnet - Network numbers and Device Object IDs shall be unique throughout the network.

3. BACnet - For each BAS object, a specific and unique BACnet object name shall be required.
4. All assignment of network numbers and Device Object IDs shall be coordinated with CPS.
5. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:
   a. **BBBFF**, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.
6. Each Device Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:
   a. **XXFFBBB**, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.
7. The Contractor shall coordinate with CPS or a designated representative to ensure that no duplicate Device Object IDs occur.
8. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by CPS.

2.13 OPERATOR INTERFACE GRAPHIC SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be CPS's Current Support Software Image Via ITS (Information and Technology Services).

E. The software shall allow for CPS creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

F. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or 'button' icons. All screens will be accessible out the use of outline type selection screens. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.

G. Dynamic Data Displays: Dynamic physical point values shall automatically update at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

H. Point Override Feature: Provide the following:
   1. An Operator from a work-station shall have the capability to place an end device under manual control, which shall prevent the control logic from making changes to the end device status, and provide the operator with the ability to position the end device. It

must be possible to put a point under manual control and command the point to a specific state or value from a graphic page. Once under manual control the point will be able to be released to automatic operation from the same graphics page. See the definition of Manual Control in the definition of terms Article in this Section.

2. An Operator from the operator work-station shall have the capability to place a sensor input into test mode. When in test mode, any changes from the physical sensor will no longer be recognized and the value reported to control logic shall take a value that is assigned to it by the operator from the operator work-station. It must be possible to put a point in test and assign a test value from a graphic page. See the definition of Test Mode in the definition of terms Article of this Section.
3. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection.

I. Dynamic Symbols: Provide a selection of standard symbols that change in appearance based on the value of an associated point.
   1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.
   2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.
   3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.

J. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays. The application of the graphic editing will be controlled by password level at the programmer level or higher.
   1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
   2. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:
      a. Define symbols
      b. Position items on graphic screens
      c. Attach physical or virtual points to a graphic
      d. Define background screens
      e. Define connecting lines and curves
      f. Locate, orient, and size descriptive text
      g. Define and display colors for all elements
      h. Establish correlation between symbols or text and associated system points or other displays.
      i. Create hot spots or link triggers to other graphic displays or other functions in the software.

2.14 APPROVED VENDORS AND THEIR PRODUCT LINES (NO SUBSTITUTIONS)

A. Automatic Building Control, Inc. – Approved For Distech Tridium Only
   1580 N. Northwest Highway
   Park Ridge, IL 60068

Contact: Mark Bevil
(847)-296-4000
Vendor # 22627

2.15 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. The distributed digital control (DDC) and building automation system (BAS) defined herein shall provide a complete open protocol Native BACnet® Building Automation System (BAS) for all mechanical systems and other facility systems as included in the project documents. The contractor shall provide a complete and operational system to perform all sequences of operations stated in the Article "Sequence of Operation" or as shown on the control drawings.

C. The BAS shall utilize open protocol BACnet hardware and software to provide full monitoring (visualization), programming and control of all DDC control systems on the building.

D. BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform the control sequences and functions specified. The BAS for this project shall consist of monitoring and control of the systems indicated.

E. The BAS system shall include a webserver (control system server CSS), a separate operator workstation (OWS), a laptop (portable operator terminal POT), all the software tools required to maintain or configure the server, OWS, and any local devices. A laptop will be provided by CPS with CPS's current compliant operating system. In addition, CPS will provide server hardware and software consistent with current standards of CPS organization for BAS system to be installed on. The BAS server will exist in CPS's data center on one of the existing Enterprise servers.

F. All interlock wiring for mechanical system equipment shall be by this contractor unless specifically stated otherwise. This shall include, but not be limited to, items such as thermostats for unit heaters, interlock wiring to central boiler control panels, chiller flow switches, and duct smoke detectors.

G. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without need for gateways.

H. All of the command able physical points shall be exposed to non-proprietary BACnet communication network bus for integration or expansion by the supervisory controller

I. All of the command able physical points shall be exposed from all field level network control devices up to the supervisor level communications bus for 100% Fully Open BAS integrations, two-way communication, and modification/expansion to the system architecture.

J. A "Fully Open BAS" selection defined from Section 1.5 of this document shall be made from the below outlined protocols.

1. The BAS shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135.
2. Wireless systems to be for student/faculty occupied areas. Wireless systems must be approved by CPS IT Infrastructure team.
3. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks).
4. 100% of the physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

K. The BAS shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks). 100% of the physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

L. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

M. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

N. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 .

O. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

P. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.16 SYSTEM ARCHITECTURE

A. Application of Open Protocols:

1. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing the following standards:

a. BACnet or Hybrid System: The system architecture shall consist of a BACnet IP Router, a single Local Area Network (LAN) or two-level LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. In no event shall there be more than two levels of LAN topology within the system, excluding wiring to sensors with no control intelligence.

B. The system provided shall incorporate hardware resources sufficient to meet the functional requirements specified. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

C. The system shall be configured as a distributed processing network(s) capable of expansion as specified below. Refer to the network architecture on the BAS drawings for other requirements and details.

D. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled that support PCUs, Operator Workstations (OWS), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. CPS Enterprise WAN: Intranet-based network connecting multiple facilities with a central data warehouse and server, accessible via CPS current standard web-browser(s). This is an existing infrastructure and contractor is not required to configure any components of this WAN.

2. Local BAS Supervisory LAN: The Local BAS Supervisory LAN shall be an Ethernet-based connected to CPS' Enterprise Network. The LAN serves as the inter-PCU gateway and OWS-to-PCU gateway and communications path and as the connection point for the CPS WAN. There is to be no vendor provided LAN/WAN network

equipment. Power-line carrier communication shall not be acceptable for communications. The higher-level layers of this network shall be the following:

a. BACnet Local Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet.

3. Primary Controller LAN ('Primary LAN'): High-speed, peer-to-peer communicating LAN used to connect and Primary Control (PCUs) and communicate exclusively control information. Acceptable technologies include:

a. BACnet: Network used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, or ARCnet in accordance with IEEE 802.4, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements. The primary network shall communicate at a minimum of 38 kbps. Each secondary network may support up to 32 communicating devices without segmentation or repeaters subject to the requirements for response time, trending, and bandwidth utilization.

E. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

F. Remote Data Access: The system shall support the following methods of remote access to the building data.

1. Browser-based access: A remote user, connecting via the CPS Enterprise WAN and using a CPS standard web browser shall be able access all control system facilities and graphics with proper username and password. The remote access user will not need to load Java or other runtimes to view the web pages.

G. Network Performance: The communication speed between the controllers, control LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. The performance will also include the trending of all AI, AO and DI points at 15-minute intervals. Generally, requirements do not apply when a remote connection must be established via modem:

1. 5 seconds between a Level 1 (critical) alarm occurrence and annunciation at operator workstation.
2. 10 seconds between a Level 2 alarm occurrence and annunciation at operator workstation.
3. 20 seconds between and a Level 3-5 alarm occurrence and annunciation at operator workstation.
4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
7. Graphic Display, 10 seconds between an operator selection of a graphic and it completely painting the screen and updating all points.
8. Graphic Refresh, every 15 seconds the graphic shall automatically refresh all graphic data.

H. The PCUs shall monitor, control, and provide the field interface for all points specified. Each PCU shall be capable of performing all specified energy management functions, and all DDC functions, independent of other PCUs and operator interface devices as more fully specified in Division 23 Section “Building Automation System (BAS) - Field Panels."

I. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or workstation on the CPS Enterprise Network. User tools provided to Chicago Public Schools shall allow configuring, updating, and maintaining current configurations and settings whether they are initiated at the server or the end device.
   1. Database Schema shall be published and provided to Chicago Public Schools to facilitate easy access to the data.
   2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

J. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

K. All line drivers, repeaters, terminators, signal boosters, and signal conditioners shall be provided as necessary for proper data communication.

L. Anytime any controller’s database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the OWS and CSS.

2.17 CONTROLLERS

A. Building Controllers:
   1. General:
      a. The BC is a Server that is either a physical server provided by CPS or a virtual machine provided by CPS to run the BAS software from connected to the CPS Enterprise WAN that can communicate with the vendor provided hardware / software.
      b. BC shall support interrogation, full control, and all utilities associated with all AACs and ASCs under the Primary Controller LAN.
      c. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device.
      d. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
      e. Provide sufficient memory to support controller's operating system, database, and programming requirements.
      f. Share data between networked controllers.
      g. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
      h. Utilize real-time clock for scheduling.
      i. Continuously check processor status and memory circuits for abnormal operation.
      j. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
      k. Communication with other network devices to be based on assigned protocol.
   2. Communication:
      a. Controller to reside on a BACNET over IP network using BACNET over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage standards

b. Perform routing when connected to a network of custom application and application specific controllers.
c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. External Input-Output (I-O) Data Bus:
   a. Input only modules.
   b. Output only modules.
   c. Variable frequency drives (VFD's).
   d. Universal I-O module (configurable).
   e. Access control module for single door.
   f. Specific wired and wireless data integration modules. NOTE: WIFI WIRELESS IS ONLY ACCEPTABLE IF IT IS A CPS APPROVED WIFI DEVICE
   g. DALI (Digital addressable lighting interface) modules.
   h. Motor control of devices like blinds, roller shutters, and sun protection systems.
   i. Multiple Input Output (I-O) Module:
      1) IAQ: Temperature, humidity, and CO2.
      2) Occupancy: Light and thermal sensing with multi-colored LED feedback.
      3) Wireless interfaced using Bluetooth per Bluetooth CS or Wi-Fi per IEEE 802.11abgn. NOTE: WIFI WIRELESS IS ONLY ACCEPTABLE IF IT IS A CPS APPROVED WIFI DEVICE
4. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
5. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. Advanced Application Controller:
1. General:
   a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   b. Share data between networked, microprocessor based controllers.
   c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   d. Utilize real-time clock for scheduling.
   e. Continuously check processor status and memory circuits for abnormal operation.

f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
g. Communication with other network devices to be based on assigned protocol.

2. Communication:
   a. Controller to reside on a BACnet over IP network using BACnet over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage standards.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:
   a. Diagnostic LED's for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. Application Specific Controllers:
1. General:
   a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
   b. Customized for operation within the confines of equipment served.
   c. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet over IP network using BACnet over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage specifications, see Division 27 Communications for requirements in blue conduit.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.
b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

D. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.
   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:

c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.18 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
   1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
   2. Limit connected loads to 80 percent of rated capacity.
   3. Match DC power supply to current output and voltage requirements.
   4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
   5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
   6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
   7. Operational Ambient Conditions: 32 to 120 degrees F.
   8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
   9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
   1. Provide external or internal transient voltage and surge suppression components for all workstations and controllers.
   2. Minimum surge protection attributes:
      a. Dielectric strength of 1000 volts minimum.
      b. Response time of 10 nanoseconds or less.
      c. Transverse mode noise attenuation of 65 dB or greater.
      d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.19 SYSTEM SOFTWARE

A. Operating System:
   1. Concurrent, multi-tasking capability.
      a. Common Software Applications Supported: Microsoft Excel.
   2. System Graphics:
      a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
      b. Animation displayed by shifting image files based on object status.
      c. Provide method for operator with password to perform the following:
         1) Move between, change size, and change location of graphic displays.
         2) Modify on-line.
         3) Add, delete, or change dynamic objects consisting of:
            (a) Analog and binary values.
            (b) Dynamic text.
            (c) Static text.
            (d) Animation files.

3. Custom Graphics Generation Package:
    a. Create, modify, and save graphic files and visio format graphics in PCX formats.
    b. HTML graphics to support web browser compatible formats.
    c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
    a. HVAC Equipment:
    b. Ancillary Equipment:

B. BAS Workstation System Applications (NOT COMPUTER):
1. Automatic System Database Save and Restore Functions:
    a. Current database copy of each Building Controller is automatically stored on the hard disk.
    b. Automatic update occurs upon change in any system panel.
    c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
    a. Save database from any system panel.
    b. Clear a panel database.
    c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
    a. Context-sensitive systems assist operator in operation and editing.
    b. Available for all applications.
    c. Relevant screen data provided for particular screen display.
    d. Additional help available via hypertext.
5. Security:
    a. Operator log-on requires username and password to view, edit, add, or delete data.
    b. System security selectable for each operator.
    c. System supervisor sets passwords and security levels for all other operators.
    d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
    e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
    f. All system security data stored in encrypted format.
6. System Diagnostics:
    a. Operations Automatically Monitored:
        1) Workstations.
        2) Printers.
        3) Modems.
        4) Network connections.
        5) Building management panels.
        6) Controllers.
    b. Device failure is announced to the operator.
7. Alarm Processing:
    a. All system objects are configurable to "alarm in" and "alarm out" of normal state.

b. Configurable Objects:
   1) Alarm limits.
   2) Alarm limit differentials.
   3) States.
   4) Reactions for each object.

8. Alarm Messages:
   a. Descriptor: English language.
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
   f. Paging.
   g. Providing audible annunciation.
   h. Displaying specific system graphics.
10. Custom Trend Logs:
   a. Definable for any data object in the system including interval, start time, and stop time.
   b. Trend Data:
      1) Sampled and stored on the building controller panel.
      2) Archivable on hard disk.
      3) Retrievable for use in reports, spreadsheets and standard database programs.
      4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
      5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
   a. View all system alarms and change of states from any system location.
   b. Events listed chronologically.
   c. Operator with proper security acknowledge and clears alarms.
   d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
   a. Provide a method to view, edit if applicable, the status of any object and property in the system.
   b. Status Available by the Following Methods:
      1) Menu.
      2) Graphics.
      3) Custom Programs.
13. Reports and Logs:
   a. Reporting Package:
      1) Allows operator to select, modify, or create reports.
      2) Definable as to data content, format, interval, and date.

3) Archivable to hard disk.

b. Real-time logs available by type or status such as alarm, lockout, normal, etc.

c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.

d. Set to be printed on operator command or specific time(s).

14. Reports:

a. Standard:

1) Objects with current values.

2) Current alarms not locked out.

3) Disabled and overridden objects, points and SNVTs.

4) Objects in manual or automatic alarm lockout.

5) Objects in alarm lockout currently in alarm.

6) Logs:

(a) Alarm History.

(b) System messages.

(c) System events.

(d) Trends.

b. Custom:

1) Daily.

2) Weekly.

3) Monthly.

4) Annual.

5) Time and date stamped.

6) Title.

7) Facility name.

c. Tenant Override:

1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.

2) Annual report showing override usage on a monthly basis.

d. Electrical, Fuel, and Weather:

1) Electrical Meter(s):

(a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

(b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):

(a) Monthly showing daily natural gas consumption for each meter.

(b) Annual summary showing monthly consumption for each meter.

3) Weather:

(a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

e. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:

1) Chilled water inlet and outlet temperature.

2) Chilled water flow.

3) Chilled water inlet and outlet pressure.

4) Evaporator refrigerant pressure and temperature.

5) Condenser refrigerant pressure and temperature.

6) Condenser refrigerant pressure and liquid temperature.

7) Condenser water flow.
8) Refrigerant levels.
9) Oil pressure and temperature.
10) Oil level.
11) Compressor refrigerant discharge temperature.
12) Refrigerant suction temperature.
13) Addition of refrigerant.
14) Addition of oil.
15) Vibration levels or observation that vibration is not excessive.
16) Motor amperes per phase.
17) Motor volts per phase.
18) PPM refrigerant monitor level.
19) Purge exhaust time or discharge count.
20) Ambient temperature (dry-bulb and wet-bulb).
21) Date and time logged.

C. Workstation Applications Editors:
1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
a. Configuration.
b. Name.
c. Control parameters.
d. Set-points.
4. Scheduling:
a. Monthly calendar indicates schedules, holidays, and exceptions.
b. Allows several related objects to be scheduled and copied to other objects or dates.
c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
b. Programming Features:
1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.20 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
B. System Security:
1. User access secured via user passwords and user names.
2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts are recorded.
4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
C. Object or Object Group Scheduling:
1. Weekly Schedules Based on Separate, Daily Schedules:
a. Include start, stop, optimal stop, and night economizer.
b. 10 events maximum per schedule.
c. Start/stop times adjustable for each group object.
2. Exception Schedules:
a. Based on any day of the year.
b. Defined up to one year in advance.
c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
3. Holiday or Special Schedules:
a. Capability to define up to 99 schedules.
b. Repeated annually.
c. Length of each period is operator defined.
D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
E. Alarms:
1. Binary object is set to alarm based on the operator specified state.
2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically and manually disabled.
4. Alarm Reporting:
a. Operator determines action to be taken for alarm event.
b. Alarms to be routed to appropriate workstation.
c. Reporting Options:
1) Start programs.
2) Print.
3) Logged.
4) Custom messaging.
5) Graphical displays.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.
H. PID Control Characteristics:
   1. Direct or reverse action.
   2. Anti-windup.
   3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
   4. User selectable controlled variable, set-point, and PED gains.
I. Staggered Start Application:
   1. Prevents all controlled equipment from simultaneously restarting after power outage.
   2. Order of equipment startup is user selectable.
J. Energy Calculations:
   1. Accumulated instantaneous power or flow rates are converted to energy use data.
   2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
   3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
K. Anti-Short Cycling:
   1. All binary output objects protected from short-cycling.
   2. Allows minimum on-time and off-time to be selected.
L. On-Off Control with Differential:
   1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
   2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
M. Run-Time Totalization:
   1. Totalize run-times for all binary input objects.
   2. Provides an operator with capability to assign a high run-time alarm.

2.21 HVAC CONTROL PROGRAMS - SEE SEQUENCE OF OPERATIONS WHERE ITEMS BELOW CONFLICT WITH PROJECTS SEQUENCE OF OPERATION, SEQUENCE OF OPERATION SHALL BE FOLLOWED.

A. General:
   1. Support Inch-pounds and SI (metric) units of measurement.
   2. Identify each HVAC Control system.
B. Optimal Run Time:
   1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
   2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
   3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
   4. Use outside air temperature to determine early shut down with ventilation override.
   5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
   6. Owner Operator commands:
      a. Define term schedule.
      b. Add/delete fan status point.

c. Add/delete outside air temperature point.
d. Add/delete mass temperature point.
e. Define heating/cooling parameters.
f. Define mass sensor heating/cooling parameters.
g. Lock/unlock program.
h. Request optimal run time control summary.
i. Request optimal run time mass temperature summary.
j. Request HVAC point summary.
k. Request HVAC saving profile summary.

7. Control Summary:
   a. HVAC Control system begin/end status.
   b. Optimal run time lock/unlock control status.
   c. Heating/cooling mode status.
   d. Optimal run time schedule.
   e. Start/Stop times.
   f. Selected mass temperature point ID.
   g. Optimal run time system normal start times.
   h. Occupancy and vacancy times.
   i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
   a. Mass temperature point type and ID.
   b. Desired and current mass temperature values.
   c. Calculated warm-up/cool-down time for each mass temperature.
   d. Heating/cooling season limits.
   e. Break point temperature for cooling mode analysis.
9. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and point.
   e. Calculated optimal start and stop times.
   f. Period start.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.
3. Owner Operator commands:
   a. Add/delete fan status point.
   b. Lock/unlock program.
   c. Request HVAC point summary.
   d. Add/Delete discharge controller point.
   e. Define discharge controller parameters.
   f. Add/delete air flow rate.
   g. Define space load and load parameters.

h. Request space load summary.

4. Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Deadband.
   g. Response timer.
   h. Reset times.
5. Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.
   j. Control discharge temperature point ID and status.
   k. Space load point ID and status.
   l. Air flow rate point ID and status.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
2. Owner Operator commands:
   a. Add/delete fan status point.
   b. Add/delete outside air temperature point.
   c. Add/delete discharge controller point.
   d. Define discharge controller parameters.
   e. Add/delete return air temperature point.
   f. Add/delete outside air dew point/humidity point.
   g. Add/delete return air dew point/humidity point.
   h. Add/delete damper switch.
   i. Add/delete minimum outside air.
   j. Add/delete atmospheric pressure.
   k. Add/delete heating override switch.
   l. Add/delete evaporative cooling switch.
   m. Add/delete air flow rate.
   n. Define enthalpy deadband.
   o. Lock/unlock program.
   p. Request control summary.
   q. Request HVAC point summary.
3. Control summary:
   a. HVAC control system begin/end status.
   b. Enthalpy switchover optimal system status.
   c. Optimal return time system status.

d. Current outside air enthalpy.
e. Calculated mixed air enthalpy.
f. Calculated cooling cool enthalpy using outside air.
g. Calculated cooling cool enthalpy using mixed air.
h. Calculated enthalpy difference.
i. Enthalpy switchover deadband.
j. Status of damper mode switch.

2.22 NETWORK CONNECTION

A. CPS Enterprise WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and Contractor is not required to configure any components of this WAN but the contractor needs to work with CPS Network Operations to properly configure the ports and switches for them. Contractor is however required to provide data and services via BACnet over IP to the CPS Enterprise WAN.

PART 3 EXECUTION

3.01 INSTALLERS

A. Reference Section 2.14 "Approved Vendors and Their Product Lines."

3.02 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.
C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.03 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequences of operation. If a sequence is not clear, in the contractors opinion, it is the Contractor's responsibility to request clarification..
B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.
C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of CPS and shall remain on the workstation(s)/server(s) at the completion of the project.

3.04 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:
1. Name
2. Address
3. Scanning frequency or COV threshold
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.

8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred. All default values will be provided in list format for evaluation by CPS.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:
1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:
1. Name
2. Address
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay
5. Message and alarm reporting as specified
6. Reporting of each change of state, and memory storage of the time of the last change of state
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:
1. Name
2. Address
3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on-time
7. Minimum off-time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.05 TRENDS

A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point. All dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like will be trended as directed by the CPS.

B. CPS will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (±) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When outputting to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by CPS, or their representative, upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system. The trend limit is 1 year from demonstration for LEED projects that require trend data for M&V purposes. The limit on the length of trend data will be a function of the storage capacity of the computer.

3.06 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Provide a legend identifying the line color and symbol along side the point noun name for each point in the trend. Also, indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.

D. The y-axis scales shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended except for control loop performance trends.

F. Allow point groups to be saved for future trends. For example, HW supply and return temperatures along with HX stm valve position and pump status.

3.07 ALARMS

A. Override Alarms: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a ‘Return-to-Normal’ message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Space temperature, except as otherwise stated in sequence of operation: Level 3
   a. Low alarm: 64°F
   b. Low return-to-normal: 68°F
   c. High alarm: 85°F
   d. High return-to-normal: 80°F
2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)
   a. Low alarm: 3°F below setpoint
   b. Low return-to-normal: 2°F below setpoint

c. High alarm: 3°F above setpoint
d. High return-to-normal: 2°F above setpoint.

3. AHU mixed air temperature: Level 4
   a. Low alarm: 45°F
   b. Low return-to-normal: 46°F
   c. High alarm: 90°F
   d. High return-to-normal: 89°F
4. Duct Pressure:
   a. Low alarm: 0.5”w.g. below setpoint
   b. Low return-to-normal: 0.25”w.g. below setpoint
   c. High alarm: 0.5”w.g. above setpoint
   d. High return-to-normal: 0.25”w.g. above setpoint
5. Space humidity:
   a. Low alarm: 35%
   b. Low return-to-normal: 40%
   c. High alarm: 75%
   d. High return-to-normal: 70%

C. Status versus Command Alarms: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the ‘Auto’ position. BAS shall enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present or vice versa:
   1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. Maintenance Alarms: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator.
   1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

E. See requirements for additional equipment-specific alarms specified in Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.08 GRAPHIC SCREENS

A. Main Screen: The Main screen will be the first screen displayed after login, no navigation required to get to the main screen (see Exhibit A for sample screens). This screen will have the following features:
   1. CPS will have the option of providing a picture of the school as background.
   2. There will be a link button to the floor plans, Summary screen, and system schematic screens. In the event that there are more 10 to 15 AHU, Boiler and Chiller screens a button to groups of AHU’s will be provided.
   3. Manufacturer/Installer Logo or information is not to be included in the screen.
   4. Provide a global command to open heating or cooling valves to facilitate Test Adjust and Balance. The command will be grouped so that an AHU can be balanced as well as total system balancing. The same function will apply for VAV AHU’s were all the boxes can be set at minimum or maximum flow.

B. Floor Plan Screens: The contract document drawings will be made available to the Contractor in AutoCAD format upon request. These drawings may be used only for developing backgrounds for specified graphic screens; however CPS does not guarantee the suitability of these drawings for the Contractor’s purpose (see Exhibit B for sample screens). .

1. Provide graphic floor plan screens for each floor and/or wing of the building. Indicate the location of all equipment that is not located on the equipment room screens.
    a. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.
    b. . Display the space temperature point adjacent to each temperature sensor symbol along with the room set point. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct background colors for each zone to demarcate the air-handling unit to which it is associated.
    c. Indicate room numbers as provided by CPS. Verify final room number/name assignments, as these are often different than initially assigned room numbers on the contract drawings.
    d. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding zone equipment schematic graphic screen. Because the area available for the floor plans varies from system to system, the size of text used to display data such as room number and temperature will be at least 1/8" high on the screen when the entire floor plan section is displayed.
    e. The floor plan graphics will also indicate the location of control panels. For control devices such as duct smoke detectors, system pressure or differential pressure sensors (water or air), airflow stations that are located outside the equipment rooms. All of these devices will be linked to the associated system graphic. For terminal units the link to the associated system graphic is sufficient and the associated unit control devices do not need to be located on the floor plan.
2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
3. Provide a graphic building key plan that will allow navigation at a floor level or from floor to floor. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
4. When there is more than one building, provide a graphic site plan with links to and from each building plan.

C. System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem (AHU) controlled with each I/O point in the project appearing on at least one graphic screen. System graphics shall be have the same look as the submittal diagrams (do not use three dimensional graphics) with status, setpoints, current analog input and output values, operator commands, etc. as applicable. Input/output devices shall be shown in their schematically correct locations with the associated value, noun name and engineering units. The position of valves or dampers will be % OPEN. For three way valves it will be %OPEN to the device. The noun name (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen. Similar AHU's will have the same organization of information. For example a single zone AHU will not put all the set points across the top and multizone put them on the side or bottom (see Exhibit C for sample screens).

1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupancy mode and heating, cooling, economizer etc based on the sequence of operations). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
2. Provide a graphic screen for each zone with the associated control devices or terminal unit with a link to the associated system schematic screen of the air handling unit that serves the zone.
3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link the chilled water and condenser water systems screens if they cannot fit onto one cooling plant graphic screen.
4. Link the heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
5. For each system schematic screen, including AHU, Boiler, Chiller and terminal unit screen, provide a button linked to a text version of the sequence of operation for the device or system. The sequence will be updated with the as-built sequence following completion of the demonstration.

D. System Summary Screens: On each graphic System Screen, provide drawing links to the graphic air handling unit schematic screens (see Exhibit D for sample screens).
1. Provide a chilled water valve screen showing the analog output signal of all chilled water valves with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
2. Provide a heating water valve screen showing the analog output signal of all air handling unit heating water valves with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.
3. When there are more than four AHU's on the system provide a summary screen with the following type of information for each AHU, each fan command, status, alarms (smoke, freeze, duct static), DAT and duct pressure if applicable. For the heating system provide status and supply water temp or steam pressure and for the chiller provide status and chilled water supply temperature.
4. Provide a BAS system summary screen using the control system riser diagram to show the communication status of all controllers (BC, AAC and ASC's) on the BAS as well as all interface devices such as VFD's, chillers and boiler panels etcetera. Use green board concept, green means communicating, red is not communicating.
5. Provide a terminal unit summary screen grouped by floor or AHU. If the summary is grouped by floor, then the AHU will be shown for each terminal unit and vice versa. The points shown will depend on the type of terminal unit and will include room name, floor or AHU, room set point and temperature, DAT, valve position, command status, alarm, and occupancy state.
6. Exhaust fans will be show in a table format showing the command signal, the status, the alarm condition, and the occupancy state.

E. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling

system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color. When an alarm first occurs, it shall "popup" over the current screen so that the operator is immediately aware of an alarm.

1. Maintenance Alarms
    a. Runtime alarm screen will list all equipment with a BAS status. For each piece of equipment the screen will display the current run time (since the last reset), the runtime alarm limit (adj.), its alarm status (red / green) and the total accumulated runtime. The total accumulated runtime would only be zeroed out if the equipment were replaced. For equipment with internal runtime meters ensure that the total accumulative runtime is synchronized.

F. Utility Metering: Provide a graphic for the gas, electric and water utility data required in the sequence of operations. This may entail multiple screens if submetering of the gas or electric usage is included in the project.

3.09 SYSTEM ACCESS

A. Provide a direct Ethernet connection to CPS Enterprise Network at each panel housing a controller or controllers, meaning all BAS controllers should be direct connected to the CPS Enterprise network via applicable low voltage specifications. If an installation cannot accommodate IP connection such as in an integration scenario CPS must be notified prior to bid otherwise it is assumed the vendor can accommodate and is liable if they cannot. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

B. Contractor shall closely coordinate with CPS Network Operations, or designated representative, to establish IP addresses and communications to assure proper operation of the building control system with the CPS Enterprise WAN, CSS's/OWS's , JACE's and OWSs.

3.10 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements specified.

C. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required and in sufficient quantity to meet the requirements of this Specification. This Contractor shall extend power to the DCS from an acceptable power panel. If the contractor wishes to further distribute panels to other locations, contractor is responsible for extending power to that location also. Furthermore, contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

D. Contractor shall locate DCSs as required. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list, trending requirements and sequence of operations.

E. Contractor shall provide the following, as a minimum:
    1. One DCS (including at least one controller) in each heating water and chilled water plant mechanical room.
    2. One DCS (including at least one controller) for each air handler located in an applicable mechanical room.
    3. One controller shall be provided for each terminal unit unless indicated otherwise.

F. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
G. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
H. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
   1. Extend all power source wiring required for operation of all equipment and devices provided under Division 23 Building Automation System (BAS) Sections and Sequences of Operation.
   2. Control panels shall not share a power circuit and should have Isolated Ground (IG) power. IG Power supplied to the panels shall have dedicated circuits and the circuit location shall be documented in the panel.
I. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.11 HARDWARE APPLICATION REQUIREMENTS

A. General: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. Specific requirements indicated below are required for the respective application. Manufacturer shall apply the most cost-effective unit that meets the requirement of that application.
B. Standalone Capability: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.
C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.
D. Application Category Type 0 (Distributed monitoring)
   1. Applications in this category include the following:
      a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.
   2. Points on BCs, AACs, and ASCs may be used in these applications as well as Ds and/or general-purpose I/O modules.
   3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
   4. LAN Restrictions: These points may reside on any controller
E. Application Category Type 1
   1. Applications in this category include the following:
      a. Fan Coil Units
      b. Airflow Control Boxes (VAV and Constant Volume Terminal Units)
      c. Terminal Control Dampers/Reheat Vales
      d. Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, and Water-Source Heat Pumps)
      e. Induction Units

2. Standalone Capability: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.
    a. Physical/Virtual Point — Default Value
    b. Scheduling Period — Normal
    c. Morning Warm-Up — Off (cold discharge air)
    d. Load Shed — Off (no shedding)
    e. Summer/Winter — Winter
    f. Trend Data — N/A
3. Mounting:
    a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
    b. ASCs that control equipment mounted in a mechanical room shall either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
    c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
    d. Contractor for this Section may furnish ASCs to the terminal unit manufacturer for factory mounting.
4. LAN Segment Restrictions:
    a. BACnet Systems: Limit the number of AAC's/ASC's servicing any one of these applications on the LAN Segment to 32.

F. Application Category Type 2
1. Applications in this category include the following:
    a. VAV Air Handlers
    b. Dual Duct Air Handlers
    c. Multizone Air Handlers with 5 or more zones
    d. Self Contained VAV Units
    e. Constant Volume Air Handlers
    f. Unitary Equipment >= 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
    g. Constant Volume Pump Start/Stop
    h. Misc. Equipment (Exhaust Fan) Start/Stop
    i. Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
    j. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device
    k. Multizone Air handlers with fewer than 5 zones
2. Standalone Capability: Only the following data (as applicable) may be acquired from other AACs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

	Physical/Virtual Point	Default Delay Time	Default Value
a.	Outside Air Temperature	3 minutes	80°F
b.	Outside Air Humidity	3 minutes	60%RH
c.	Outside Air Enthalpy	3 minutes	30 Btu/lb
d.	Trend Data		N/A
e.	Cooling/Heating Requests	3 minutes	None

3. Mounting:
   a. AACs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. AACs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. AACs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
4. LAN Segment Restrictions:
   a. BACnet Systems: Limit the number of AAC's servicing any one of these applications on the LAN Segment to 32.

G. Application Category Type 3
1. Applications in this category include the following:
   a. Central Cooling Plant
   b. Central Heating Plant
   c. Cooling Towers
   d. Sequenced or Variable Speed Pump Control
   e. Local Chiller Control (unit specific)
   f. Local Free Cooling Heat Exchanger Control
2. BACnet Systems: BCs shall be used in these applications.

3.12 STARTUP, COMMISSIONING AND TRAINING
A. Refer to Division 23 Section "Building Automation System (BAS) - Commissioning."

3.13 DEMONSTRATION AND INSTRUCTIONS
A. Refer to Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.14 MAINTENANCE
A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of energy management and control systems for two years from Date of Final Acceptance.
C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
D. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.15 IDENTIFICATION STANDARDS
A. Controller Identification. All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
B. Panel Identification. All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
C. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.

D. Panel Devices. All panel devices shall be identified by a typed label securely fastened to the backplane of the local control panel.

E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.

F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed

3.16 SCHEDULES

A. Input/Output Schedule:
   1. Point Description:
   2. Digital Input:
      a. Demand Meter (kW):
      b. Auxiliary Contact:
      c. Switches:
         1) Switch Closing:
         2) Flow Switch:
         3) Optical:
      d. Current:
      e. Pressure:
   3. Digital Output:
      a. Control Relay:
      b. Solenoid:
      c. Contactor:
   4. Analog Input:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure/Vacuum:
      d. Filter:
      e. Flow:
      f. Current:
      g. Liquid Level:
      h. Photocell:
   5. Analog Output:
      a. Pneumatic Transducer:
      b. 4-20 ma Module:
      c. 0-16 v DC:
   6. Alarm:

B. Input/Output Schedule:
   1. Point Description:
   2. Inputs:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure:
      d. Flow:
      e. Level:
      f. Position:

g. Energy:
h. Power:

3. Outputs:
   a. Status:
   b. Alarm:
   c. Pneumatic Position:
   d. Electronic Position:
   e. Set Point Adjust:
   f. Start/Stop:
   g. Off/Low/High:
4. Software Features:
   a. PID Control (DDC):
   b. High Limit:
   c. Low Limit:
   d. Run Time Totalization:
   e. Consumption Totalization:
   f. Program Start/Stop:
   g. Load Shed:
   h. Duty Cycle:
   i. Enthalpy Switchover:
   j. Optimal Run Time:
   k. Supply Air Reset:
   l. O.A. Interlock:
   m. O.A. Temperature Reset:
   n. Free Cooling Mode:
   o. Warm-up Mode:
   p. Boiler Interlock:
   q. Chiller Sequencing:
   r. Energy Calculation:

C. Alarm Schedule:
1. High Limit: A1.
2. Low Limit: A2.
3. Run Time: A3.
4. Maintenance: A4.
5. Status: A5.
6. Override: A6.
7. Freeze: A7.
8. Low Pressure: A8.

END OF SECTION

SECTION 23 09 23 (MEP)
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System description.
B. Controllers.
C. Power supplies and line filtering.
D. System software.
E. Controller software.
F. HVAC control programs.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2021).
B. ASHRAE Std 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems 2019, with Addendum (2020).
C. Bluetooth CS - Bluetooth Core Specification 2016, Addendum 2017.
D. CTA-709.1 - Control Network Protocol Specification Revision D, 2014.
E. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications 2020, with 2021 Amendments.
F. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests 2019h.
G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL (DIR) - Online Certifications Directory Current Edition.

1.03 DESCRIPTION OF WORK

A. Coordinate with existing control system that was provided by Automatic Building Controls, LLC in 2020. Provide new controls and reconfigure existing controls as required to accommodate the new mechanical equipment included within the scope of this project. Fully integrate all controls associated with the work of this project into the existing control systems. Provide graphics displays at the existing BAS for all new equipment and existing equipment where control modifications are being made. New graphics displays shall be similar in appearance and fully integrated into the existing BAS programming.
B. Contractor shall provide all interface devices and software to provide an integrated system connecting Advanced Application Controllers, Application Specific Controllers, Building Controllers, and Gateways. The Control System Server provided by CPS will also be connected to the CPS's WAN. Install all the cabling per CPS Spec.

1.04 APPLICATION OF OPEN PROTOCOLS

A. Subject to the detailed requirements provided throughout the specification, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing one of the following standards:
   1. BACnet: System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all BACnet building controllers (B-BC), advanced application controllers (B-AAC) and all application specific controllers (B-ASC). Gateways to other communication protocols are not acceptable. All controllers must be BACnet Testing Labs listed for their required profile (B-BC, B-AAC or B-ASC).
   2. Each component of the system, including the LANs and software, shall be in full compliance with ASHRAE Standard 135, commonly referred to as BACnet. The BAS

shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks). All physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

3. The contractor will provide all software licenses, software products, hardware connectors, hardware products to become self-maintainer if they choose to. CPS shall be free to direct the modification of any software license, regardless of supplier. In addition, CPS shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project. Any and all required Ids and passwords for access to any component or software program shall be provided to CPS.
4. CPS shall provide license naming detail to the contractor.

1.05 DEFINITIONS

A. Acknowledged: Data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.
B. Adjustable (ADJ): A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program.
C. Analog Calibration Offsets: For all analog input measured variables, with the exception of velocity pressure, the value measured by the hardware based analog input point shall be adjusted to match the value reported by a certified test instrument. An analog calibration offset is a parameter that can be added or subtracted from the raw value measured by the sensor to produce a calibrated value used by the control logic and reported to the operator workstations. The initial value of this parameter is set at zero and it is adjusted when the calibration process is executed. This adjustment is referred to as a single point calibration. These parameters are mandatory for all analog inputs except velocity pressure sensors. These offset values are configuration parameters and shall be written to EEPROM. It shall be possible to change the value of these parameters from a graphic page.
D. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications. A fully programmable control module. This control module shall be capable of certain advanced features found in Building Controllers (e.g. storing trends, and initiating read and write requests) but it shall not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet. A BACnet device to be used as an AAC will meet the requirements of ASHRAE 135, Annex L and will be listed as an AAC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.
E. AHU: A factory-made encased assembly consisting of a fan or fans and other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying and mixing of air
F. Application Programming Tool: A vendor unique software tool used to create applications for programmable controllers.
G. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and application user data (ISO 9545).

H. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). A pre-programmed control module, intended for use in a specific application. ASCs shall have limited configurability, allowing the user to select various pre-programmed options, but it shall not be fully customizable. A BACnet device used as an ASC will meet the requirements of ASHRAE 135, Annex L and will be listed as an ASC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.

I. BACnet/BACnet Standard: BACnet communication requirements, as defined by ASHRAE/ANSI 135, current version including all annexes and addenda.

J. Bandwidth Utilization: The average utilization of the network capacity. Network loading is controlled by the use of event driven broadcast based data propagation and the use of appropriate binding services.

K. Binding Services: When the network management tool within Niagara or Plexus is used to establish a binding, one of the following three types of binding services shall be selected:
   1. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. Used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.
   2. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. Used for most process control related data requiring timely receipt of the data.
   3. Acknowledged: The data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.

L. Binding: The concept of associating an output network variable from one device to the input network variable of a second device. There are three types of bindings:
   1. One to One: A single output network variable is bound to a single input network variable
   2. One to Many: A single output network variable is bound to input network variables on multiple devices.
   3. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

M. Broadcasting: The propagation of data from a device to the control network. Software objects that broadcast data to the network shall include the following parameters:

N. Building Automation System (BAS): The entire integrated energy management and control system.

O. Building Controller (BC): The BC is a Server that is either a physical server provided by CPS or a virtual machine provided by CPS to run the BAS software from connected to the CPS Enterprise WAN that can communicate with the vendor provided hardware / software.

P. Typically this controller is located on the Ethernet/IP backbone of the BAS. A BACnet device to be used as a BC shall meet the requirements of ASHRAE 135, Annex L and will be listed as a BC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.

Q. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-current version)

R. Client: A device that is the requester of services from a server. A client device makes requests of, and receives responses from, a server device.

S. Configuration Parameter: An input network variable to a controller that is written to the EEPROM.

T. Continuous Monitoring: Sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

U. Control System Server (CSS), Web Server (WS): Provides access to the control system. This device will allow access to the control system with a web browser over the CPS WAN. As the BAS network devices are on the CPS Enterprise Network, the CSS is not required for communications to occur. The webserver will be provided by Owner and connected to the CPS Enterprise Network on the same VLAN as the BAS network devices.

V. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and is a PCU.

W. CPS WAN: Reference to Chicago Public Schools Information Technology network, used for normal business-related e-mail and Internet communication.

X. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic

Y. Error Rate: A measurement of communication quality that assesses the number of defective data packets as a percentage of the total number of data packets. Defective data packets are generally the result of poor installation practices or improper cable selection.

Z. Event Driven Communication: A term used to describe the propagation of data from a device to the network based on broadcasting rather than polling. The send on delta parameter is used to define the event and the data propagation is further controlled by the minimum and maximum send time parameters.

AA. Fully Open BAS: Building Automation System that all materials, hardware, firmware, and software can be procured through open market non-proprietary vendor warehouse distribution channels, in addition to being installed and maintained by any Tridium Niagara Framework factory authorized/qualified Building Automation and Controls Company.

BB. Free Topology: A data wiring topology that allows for loops, tees, y-connections etc. When this topology is used only one terminator of a specific design is required and allowable cable lengths are significantly reduced.

CC. Functional Profile: A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.

DD. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-1995).

EE. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.

FF. Host-Based Controller: Applicable only to Lon-based controllers where the on-board Neuron chip is used solely as the Communications Interface and a processor independent from the Neuron chip to is used to execute Application control and I/O processes.

GG. JACE: Java Application Control Engine. Term used within the Niagara Framework to describe a component that serves several key functions:

HH. Serve as the LANID.

II. Transmission of data to operator workstations on the TCP/IP network.

JJ. Location for time schedules to support all of the devices.

KK. Location for trend logs for all data to be trended from the devices.

LL. Location for alarm handling software. The JACE shall process event broadcasted data from the devices (alarm indication) and enter the appropriate alarm information in the alarm reporting system at the TCP/IP level.

MM. Local Supervisory LAN Interface Device (LANID): Device used to facilitate communication and sharing of data throughout the BAS and CPS WAN

NN. Media Access Control address (MAC): Hardware address that uniquely identifies each node of a network. Each different type of network medium requires a different MAC layer.

OO. Managed Communication: Transmission of data from a controller to a data manager, which in turn re-broadcasts the data to a second controller.

PP. Manual Control: Where the operator takes control of an end device and forces a specific position or state. The manual mode and the desired manual position or states are parameters that are set by the operator.

QQ. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

RR. Maximum Send Time Parameter: Parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of the variable, a re-broadcast of the current value shall be executed. See also "Send on Delta" and "Maximum Send Time."

SS. Maximum Send Time: Adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.

TT. Minimum Send Time Parameter: Parameter used to control unnecessary broadcasting of data onto the network. Broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also "Send on Delta" and "Maximum Send Time" definitions.

UU. Minimum Send Time: Adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.

VV. Multiple Controller Integrated Control (MCIC): Where multiple controllers with I/O are used to control a single mechanical system, which is sub-divided into a collection of processes to be controlled. All primary measured variables and the end device associated with a single process along with the primary control logic for the process shall be contained within a single controller. Secondary data from one process that affects the control of another process may be sent from one controller to the primary controller controlling the process. When data is sent from one controller to another controller, broadcasting concepts as defined above must be used. If the data being received over the network only affects the general thermodynamic or psychometric performance of the process but does not have a significant affect on safety or equipment protection then unacknowledged repeated binding services shall be used. If the data being received over the network has a safety or equipment protection impact, then acknowledged repeated binding services shall be used. In both cases peer-to-peer communication is mandatory. All controllers must be on the same channel. Managed communication shall not be used to move data between the multiple controllers.

WW. One to Many: A single output network variable is bound to input network variables on multiple devices.

XX. One to One: A single output network variable is bound to a single input network variable.

YY. Open Database Connectivity (ODBC): Open standard application-programming interface (API) for accessing a database, making access to any data, regardless of which database management system (DBMS) is handling the data, possible.

ZZ. Operator Interface (OI): A device used by the operator to manage the BAS.

AAA. Operator Workstation (OWS): Used to interface with the BAS system.

BBB. Peer-to-Peer Communication: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.

CCC. Polling Communication: The concept of a control device requesting a network variable from a second control device at a specified interval. Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.

DDD. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller.

EEE. Primary Control Unit (PCU): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems.

FFF. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, identifying the particular options specified by BACnet that are implemented in the device.

GGG. Router: A device that connects two or more networks at the network layer.

HHH. Send on Delta Parameter: A parameter used to control unnecessary broadcasting of data onto the network. For binary data the send on delta parameter is assumed to be a change of state.

III. Send on Delta: Adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data this parameter defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met.

JJJ. Smart Device: A control I/O device such as a smart sensor (SS) or smart actuator (SA) that can directly communicate with the controller network to which it is connected rather than through a binary or analog signal.

KKK. Standardized Query Language (SQL): Standardized means for requesting information from a database.

LLL. Stand-Alone Controller: A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.

MMM. Supervisory Logic: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices.

NNN. Terminator: An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment. On a bus topology, a terminator is connected to each end of a segment. For a channel consisting of two bus topology segments, a total of 4 terminators are required, one at each end of each segment.

OOO. Test Mode: A concept where the operator from the operator workstation can interrupt the flow of data from a sensor to the control logic and insert a mandatory test value or test state to be used by the control logic. The test mode and the desired test value or states are parameters that are set by the operator.

PPP. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. This type of service shall be used for most process control related data requiring timely receipt of the data.

QQQ. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. This type of service shall be used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.

RRR. Web Server: Refer to "Control System Server."

SSS. WiFi: The facility allowing computers, smartphones, or other devices to connect to the Internet or communicate with one another wirelessly within a particular area.

TTT. Wireless: Refers to WiFi application to CPS WiFi Enterprise Network.

UUU. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium.

1.06 FUNCTIONAL INTENT

A. Where detailed functional or performance requirements are specified, products intended for the Project, conforming to the specified requirements, must be submitted to, and approved by, CPS prior to shipment to the Project site.

1.07 SUBMITTALS / DELIVERABLES

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.

1. Drawings and Diagrams: Shop drawings shall be provided on electronic media as an AutoCAD 2014 or later version drawing file and/or Adobe Portable Document Format file. All 'x reference' and font files must be provided with AutoCAD files.
2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format (PDF). Provide documents, such as Cheat Sheets and TroubleShooting Guide, in rich text format (rtf) or Microsoft Word format as required.

C. Product Data: For each control device, panel, and accessory indicated or furnished. Include dimensions, capacities, performance and electrical characteristics, and material finishes. Include installation and start-up instructions. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

D. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:

1. System Architecture and System Layout:
   a. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, thermostats/sensors, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, terminators, ground locations etc. shall be located on the diagram.
   b. Provide floor plans locating all control units, thermostats/sensors, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.

2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include contractor written description of sequence of operation.
3. All physical and virtual points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Division 23 Section “Building Automation System (BAS) - Software and Programming," PART 3 for additional requirements.
5. Label each control device with setting.
6. Label each input and output with the appropriate range.
7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable. Also identify the specification section and specification reference.
8. Provide a valve or damper and the associated actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal (fail) positions of spring return valves and dampers. This is the valve or damper position with no power to the actuator.
9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, boiler burner, chiller, RTU, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed. For all devices with safety circuits, including burners and chillers, field wiring will be labeled and all added devices will be properly mounted. Any internal wiring changes shall be approved by the manufacturer in writing. If for example a gas booster needs to be tied into the burner circuit the manufacturer shall identify the terminal points and provide an updated control diagram.
10. Sample Operator Interface Graphic Screens for each unique type of system, with final screens to be received 60 days prior to system startup.
11. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
12. Sheets shall be consecutively numbered.
13. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
14. Table of Contents listing sheet titles and sheet numbers.
15. Legend and list of abbreviations.
16. Provide an operating schedule for review. The schedule will have a schedule for each AHU/RTU and the associated equipment. Terminal units serving the principal’s office and associated administrative areas will have a separate schedule from the classrooms.

E. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of 1 year since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.

F. Qualifications: For manufacturer, companies, Contractor and key personnel.

G. Checkout and Testing Forms: Submit a blank copy of the forms that will be used during Point-to-Point Checkout, Prefunctional Checkout, and Functional Performance Testing as outlined in Division 23 Section "Building Automation System (BAS) - Commissioning." Those forms should be structured to capture the following information at a minimum during each particular testing phase.

1. Point-to-Point Checkout Form containing the following information:
   a. Each point is addressed, labeled and that proper communication exists between the controller and the field device.
   b. Documents that installed condition match the control drawings and that any changes or differences are noted on the drawings.
2. Pre-functional Checkout Forms containing the following information:
   a. Documents correct voltage and or current present as well as verifying circuits are free from grounds or faults for each control device.
   b. Obtain and Record Test and Balance settings and incorporate into the BAS. Information from the TAB contractor shall include:
   c. Water and air system differential pressure and flow settings.
   d. AHU minimum outside air control point or damper setting.
   e. Calibration data for all sensing and actuating devices recording final measured and displayed value. Record the type and model of the meter(s) that determined the measured value for analog inputs.
   f. For analog outputs record both the displayed output as well state of the receiving device.
   g. For digital input/outputs record the signal at the controller and the state of the sensing/control device.
   h. For actuators:
      1) Check to ensure that actuated device moves smoothly, and results are repeatable thru full range and seals tightly when the appropriate signal is applied to the operator.
      2) Check for appropriate fail position, and that the stroke and range is as required.
      3) For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges. Record final settings.
   i. For all valves and actuators, verify the actual position against the Operator Interface readout. Set pumps to normal operating mode. With command valve closed, verify that valve is closed, and adjust output zero signal as required. With command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't correspond correctly, replace actuator.
   j. Valve leak check: Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit.
   k. For air and water flow measuring stations the data recorded will include the independent flow measurement, area, and the independently measured output of the flow station. The BAS input from the flow station and any factors used to calculate the flow including area and any constants used in the calculation of flow. Two sets of data shall be collected. The first at design flow and the second at 50% of design flow. It is not acceptable to simply add a correction factor to address differences between the flow station and the independent reading.

l. For Operator Interfaces and Web accessible display:
   1) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
   2) Output all specified BAS reports for review and approval.
   3) Verify that the alarm pop ups, printing, and logging are functional and in accordance with requirements.
   4) Verify that all points are trended and are archiving to disk. Provide a sample to the Commissioning Authority and CPS for review.
   5) Verify that paging/dial-out alarm annunciation is functional.
   6) Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
   7) Verify that required third party software applications required with the bid are installed and are functional.

m. For all actuating devices record final settings for device.

n. Document verification of point to graphics binding for all points displayed on the workstation and that webserver display have been mapped correctly and display the correct information.

o. Document that the webserver is on the CPS Enterprise LAN and can be viewed from off site (another school), and that the BAS is accessible via the current CPS web browsers without the use of any extra system runtimes (like java, flash, etc.).

3. Functional Performance Forms shall contain:
   a. List of all sequences, modes of operation and setpoint that initiates each sequence and/or mode. For each confirm that proper sequence of operation. Document any variance between designed sequence and actual condition.
   b. Record tuning parameters and response time for each control loop.
   c. Document all alarm and safeties test and final results.
   d. Results of trends including controlled points, setpoints, actual readings and other point defined by the Boards Authorized Representative.

H. Testing Plan:
   1. Submit a plan for executing all phases of testing and completion of checkout forms. This includes the following: manufacturers' normal testing, point-to-point testing, pre-functional testing, and functional performance testing. The testing plan shall show the overall milestones of the controls work and testing of the controls system.
   2. Provide the schedule for completing each phase of testing for each system or set of equipment including, but not limited to, air handlers, chillers, boilers, unit-vents, VAV boxes, network wiring, and operator workstations. Schedules shall show the time frame needed to complete the tasks.
   3. The testing plan shall identify other trade milestones that impact the successful completion of during each phase of testing.
   4. This plan is not meant to take precedence over any other plan but is intended to provide coordination assistance to all trades as the project is scheduled.

I. Open Protocol Information:
   1. General: Provide all information necessary for review of the proposed system, including information required by the authority maintaining the protocol standard to determine if the product selected for implementation complies with the protocol standards specified.
   2. BACnet Systems:

a. BACnet object description, object ID, and device ID, for each I/O point.
b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
c. Submit PICS indicating the standardized BACnet device profile, functionality and configuration of each controller along with proof of BTL listing.

J. Framed or Laminated and digital Control Drawings: After completion of installation and check out, but prior to training, digital and laminated control drawings including system control schematics, sequences of operation, and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel. Digital control drawings will be accessible via the BAS front end.

K. Control Logic Documentation (to be received and updated prior to training):
1. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.
2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
3. Include written description of each control sequence.
4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters, and limits.
5. Sheets shall be consecutively numbered.
6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
7. Include Table of Contents listing sheet titles and sheet numbers
8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below.

L. Training Plan:
1. Training shall be provided in eight, four-hour sessions and digitally recorded with CPS retaining a copy remitted to CPS upon completion via Google Drive and the graphic front end. This recording can be substituted for approved manufacturer training if CPS approves. A training plan is not required for opposite season or refresher training. Screen recording with voiceover is acceptable in lieu of digital recording.
2. The material to be covered shall be further sub-divided into descriptions of the material to be covered in every 15 minutes. See Division 23 Section "Building Automation System (BAS) – Commissioning," for specific items to be addressed.
3. The descriptions shall include not only the material to be covered but also its location in the Operation and Maintenance Manual or the Training Manual including Section and page number.

M. Operation and Maintenance Manual: (All documentation to be received and updated prior to training)
1. In addition to other copies required, submit one copy of the materials directly to Chicago Public School's (CPS) projects management or operations staff.
2. The reviewed and accepted version of this manual will also be available on the enterprise server for the project.
3. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.

4. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
5. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
6. Include all as built submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions, and spare parts lists) in maintenance manual, in accordance with requirements of Division 01 Section "Operations and Maintenance Manual."

N. Training Manual: Submit training manual electronically for review. Once accepted, provide three hard copies and one electronic copy of the training manual at the start of training. Note only the initial 8 hours of training which include the Cheat Sheets will occur before the Cx demonstration is completed. Provide a link to the Training Manual must be available on the Operator's Interface. Include the following:
   1. Cheat Sheets or quick reference section with step-by-step guidance with a level of detail that will allow someone with minimal experience with the control system to follow the instructions. The quick reference guidance can be provided one of two ways: screen prints with bubbled text describing the navigation required or written description of the steps to be taken with screen prints provided to facilitate the written explanation. This will also be stored on the enterprise server for the project. The required cheat sheets shall include:
      a. Logins and logoffs of the BAS System.
      b. Adjust and restore setpoints.
      c. Overrides and releasing overrides. Include instructions for running a report to list all points currently overridden.
      d. Start, group, plot and export Trends.
      e. Adjust and add schedules and add holidays.
      f. Processing of alarms including acknowledgement, review of alarm report, and clearing of alarm history.
      g. Backup and restoration of system BAS data.
      h. Demonstrate how to clear/reset all field devices that may require manual intervention.
      i. Demonstrate how to reset motor starter and the significance of Hand-Off-Auto switch position on motor starters.
      j. Demonstration of each input and output device. Provide a picture of each input or output device with a brief narrative on its operation.
      k. Demonstrate how to place the boiler or chiller system into manual control and boiler control, and how to restore the system to BAS control.
      l. Demonstrate how to reset variable speed or frequency drives.
   2. Operating instructions including system startup and shutdown, seasonal and emergency instruction.
   3. Trouble Shooting Guide. Include actions to be taken to trouble shoot problems with the OWS, PCU's CSS, and local control devices.
   4. Setpoint Table
   5. Preventative maintenance instructions.
   6. Color print of each unique screen.
   7. Final Sequence of Operations. This document shall be printed but shall also be provided electronically in Portable Document Format (PDF). The sequence shall

provide not only the original design sequence from the specifications and drawings but also the any changes to the sequence.

8. Complete set of the design control drawings (on 11”x17” sheets). The manual will have a TAB for these drawings. List of all alarm points and alarm priority.

O. Video Training: The following training shall be recorded on a USB 3.0 thumb drive in a common video file format with screen capture software additionally it will be stored on the enterprise server for the project. The cadence of the video training shall be such that an inexperienced person can listen to the narrative and execute those steps on controls system while watching the Video. Include a screen view recording the actual video feed to the monitor for the workstation while narrating the associated steps. Provide a link on the graphics home page for the training archive that is playable by modern video player software.

1. Quick reference procedures. The taping of these procedures must include both a screen view preferably recording the actual video feed to the monitor while narrating the associated steps.
   a. Login and logoff to the BAS system;
   b. Adjust and restore setpoints.
   c. Overrides and releasing overrides, as well as running a report to list all points currently overridden.
   d. Start, group, plot and export Trends.
   e. Adjust and add schedules and add holidays.
   f. Processing of alarms including acknowledgement, review of alarm report and clearing of alarm history.
   g. Demonstrate workstation menu penetration and broad overview of the various workstation features.
   h. Demonstrate all operations and functions that can be performed at the supervisory or local controllers as well as system display artifacts such as the indication that a point has failed or lost communication.

P. Demonstration of portable operator interface device display capabilities.

Q. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.

R. Engineering Tools: All Front End and all Field Level programming tools shall be installed on the CPS Asset designated for the site. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. Contractor shall convey all software tools and their legal licenses at project close out.

1.08 **LICENSING**

A. Include licensing for all software packages at all required Control System Server (CSS Operator Work Stations (OWS) and Portable Operator Terminal (POT).

B. Any operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

C. Include licensing for all software packages at all required Web Server and OWS’s and POT’s. Licensing shall allow access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install

the system or needed to operate the system to its full capabilities shall be licensed and provided to Chicago Public Schools (CPS).

D. All software should be available on all Web Servers and OWS's provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that CPS may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses. These backup disks will include a backup of all program data files, graphics etc. and shall allow the owner to completely restore the system in the case of a computer malfunction

E. Provide evidence of licensing including version and original software copies for each WEB Server OWS's and POT's. Licenses shall allow for access to any site device and shall not be restricted to accessing, database management, configuring, etc. the LANs included in this project. The licensing and registration proof will be provided when the system is installed on site.

F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period and provide a letter indicating the current release/version date at the end of the warranty.

1.09 PROJECT RECORD DOCUMENTS

A. The Project Record documents that have not already been submitted as part of the Operating and Maintenance Manual or Training Manual are to be submitted with the Record Documents. Any documents in the Operating and Maintenance Manual or Training Manual that have changed since they were submitted will need to be re-submitted as part of the Project record documents. All of these documents may be submitted electronically.

B. Record copies of product data and control shop drawings updated to reflect the final installed condition.

C. Graphic Software: Record copies of approved project specific graphic software on USB 3.0+ Thumb drives.

D. For BACnet systems provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description, and location information.

E. Include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address, device hostnames and drawing reference number.

F. Provide record riser diagram showing the location of all controllers.

G. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

1.10 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum five years of documented experience.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.11 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Contractor shall warranty all products and labor for a period of three (2) years after Final Acceptance.

C. Chicago Public Schools reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by CPS, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

D. At no cost to CPS, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in Division 23 Section "Direct - Digital Control System (BAS)" Sections. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.
2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by CPS to the Contractor.
    a. Response to any request for service shall be provided within eight (8) hours of the initial request for service.
    b. In the event that the malfunction, failure, or defect is not corrected through the communication exchange, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within eight (8) hours of the initial request for such services, as specified.
    c. Emergency service shall be available on a 24-hour, 7-day-a-week, 365 days a year basis.
3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following notification by CPS to the Contractor.
    a. Response to any request for service shall be provided within one (1) working hour (contractor specified 40 hr/week normal working period) of the initial request for service.
    b. In the event that the malfunction, failure, or defect is not corrected through the communication exchange, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within three (3) working days of the initial request for such services, as specified.
4. Request for Service: Contractor shall provide up to three telephone numbers for CPS to call in the event of a need for service. At least one of the lines shall be attended 24 hours a day, 7 days a week. A technician shall respond to every call within 15 minutes.
5. Technical Support: Contractor shall provide technical support throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

1.12 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Board and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

5. All licenses direct to the Board.

PART 2 PRODUCTS

2.01 SYSTEM SOFTWARE-GENERAL

A. Functionality and Completeness: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

2.02 CONTROLLER SOFTWARE

A. All bindings, SNVT's, configuration values, addresses, calibration values, parameters, variables, tuning values, gains, test values, etc. for all software, programs, network configurations etc. shall be exposed and be available for setup, manipulation, adjustment, calibration, testing, etc. at all workstations, CSS's/OWS's, POT's for use as allowed via applicable password protection for all controllers and devices throughout all networks and the entire BAS.

B. Building Controller (BC) Software Residency: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software
2. Real-Time Clock/Calendar and network time synchronization
3. BC diagnostic software
4. LAN Communication software/firmware
5. Direct Digital Control software
6. Alarm Processing and Buffering software
7. Energy Management software
8. Data Trending, Reporting, and Buffering software
9. I/O (physical and virtual) database
10. Remote Communication software

C. Advanced Application Controller (AAC) Application Specific Controller (ASC) Software Residency: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Division 23 Section "Building Automation System (BAS) - Communication Devices") with the restrictions/exceptions per application provided in Division 23 Section "Building Automation System (BAS) - Field Panels":

1. Real-Time Operating System software
2. AAC/ASC diagnostic software
3. LAN Communication software
4. Control software applicable to the unit it serves that will support a single mode of operation
5. I/O (physical and virtual) database to support one mode of operation

D. Stand Alone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of stand alone functionality..

E. Operating System: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of the controller's operating system.

F. Network Communications: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:
   1. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
   2. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Gateways and LAN Interface Devices or CSS's/OWS's. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

G. Point Database/Summary Table: All points included in the typical equipment point list must be represented in a common, open protocol format. Naming conventions for these points and network addressing are discussed in PART 3 of this Section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in PART 3 of this Section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.

H. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

I. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.

J. Application Programs: CUs shall support and execute application programs as more fully specified below:
   1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) CPS programming.
   2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

K. Security: Controller software shall support multiple level password access restriction as more fully specified below.

L. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
   1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
   2. Two Position control (Hi or Low crossing with deadband)
   3. Single-Pole Double-Throw relay
   4. Delay Timer (delay-on-make, delay-on-break, and interval)

5. Hi/Low Selection
6. Reset or Scaling Module
7. Logical Operators (And, Or, Not, Xor)

M. Psychrometric Parameters: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

N. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

O. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

P. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.

Q. Misc. Calculations: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.03 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. Point Definition: provide templates customized for point type, to support input of individual point information. For LON systems use standard LonWorks SNVTs.
2. Graphical Block Programming: Manipulation of graphic icon ‘blocks’, each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
3. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via ‘fill-in-the-blanks’ edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
4. Line Programming: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.04 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:
   1. Time-of-Day Scheduling
   2. Calendar-Based Scheduling
   3. Holiday Scheduling
   4. Temporary Schedule Overrides
   5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
   6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
   7. Economizer Control (enthalpy or dry-bulb)
   8. Peak Demand Limiting and Load Shedding. The demand limiting function will use demand data as the basis for the function and the load shedding program will use space temperature adjustment or means acceptable to CPS to provide load shedding response. The function selected for a given school will be made by CPS.
   9. Dead Band Control

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. For example the load shedding program will allow the operator to determine the spaces to be included in the load shed as well as the duration of the event. Programs shall be applied to building equipment as described in the Division 23 Section "Building Automation System (BAS) - Sequence of Operation."

2.05 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow the CPS's authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as deemed appropriate for each user, based upon an assigned user name with a unique password.

B. All passwords for the system shall be provided to CPS including administrator, dealer, or factory level passwords for the systems provided under this project.

C. Passwords shall restrict access to all Control Units.

D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 20 user names shall be supported and programmed per CPS's direction. Provide ability to deactivate passwords without removal of the login and password. CPS will be provided with the highest-level login and password so that CPS controls the administrative passwords.

F. Operators shall be able to perform only those commands available for the access level assigned to their user name.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line. This timer will not be the windows system screen saver feature.

2.06 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BC's ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. Alarm Descriptor: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
2. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with CPS on establishing alarm priority definitions.
3. Alarm Report Routing: Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
4. Auto-Dial Alarm Routing: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.
5. Alarm Acknowledgment: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.
6. Alarm Display: All alarms will popup as described in Alarm Acknowledgement. The owner will have the option to limit the pop up alarms based on alarm priority.

B. It shall be possible for any operator to receive a summary of all alarms, regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. Alarm Historical Database: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

2.07 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
   1. Trends may be buffered in the BC as long as the trend data in the BC and the historical data stored on hard disk is displayed seamlessly.
   2. Provide trends for all physical points, virtual points and calculated variables.

3. Trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
4. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
5. The sample rate and data selection shall be selectable by the operator.
6. The trended value range shall be selectable by the operator.
7. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. Data Buffering and Archiving: Trend data may be buffered at the BC, and uploaded to hard disk storage for archiving as needed based on the BC's memory constraints. All archived trends shall be transmitted to the on-site OWS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.

D. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

2.08 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

2.09 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.

B. Data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

2.10 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the

documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.11 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

C. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

D. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

E. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.12 POINT STRUCTURING AND NAMING

A. General: The intent of this Section is to require a consistent means of naming points across the CPS Enterprise. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The interface shall always use this naming convention. The naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by CPS.

B. Point Summary Table

1. The term ‘Point’ is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
2. With each schematic, Contractor shall provide a Point Summary Table listing:
   a. Building number and abbreviation
   b. System type
   c. Equipment type
   d. Point suffix
   e. Full point name (see Point Naming Convention paragraph)
   f. English language point description
   g. Ethernet backbone network number,
   h. Network number
   i. Device ID
   j. Device MAC address
   k. Engineering units
3. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).

4. Point Summary Table shall also illustrate Network Variables/LonWorks Bindings.
5. The Contractor shall coordinate with the CPS's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to CPS the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.
8. Point Summary Table shall also illustrate Network Variables/BACnet Data Links/LonWorks Bindings.

Point Summary Table Example
Row Headers and Examples
(Transpose for a single point per row format)

Building Number	0006 (CPS 4 digit Building Code)
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
*Point Name (Object Name)	0006.COOLING.CHILLER.CHLR1KW
*Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Point Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
* Represents information that shall reside in the property for the point	

C. Point Naming Convention
1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS point, a specific and unique name shall be required.
2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a period to form

the entire object name. Reference the paragraphs below for an example of these descriptors.

3. CPS shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the CPS WAN. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.
   a. Point Name Requirements

Descriptors	Comment
Building Number	0006
System	AIRHANDLINGEXHAUSTHEATINGCOOLINGUTILITYENDUSEMISC
Equipment	AHU-1BOILERSCHILLERSFACILITYTOWERSWEATHER
Point Suffix	See Input/Output point summary table for conventions

D. Examples: Within each point name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:
   1. 0006.COOLING.CHILLERS.CHWP1ST
   2. 0006.HEATING.BOILERS.BLR1CFH

E. Device Addressing Convention:
   1. Lontalk - Network numbers and SNVT's shall be unique throughout the network.
   2. BACnet - Network numbers and Device Object IDs shall be unique throughout the network.
   3. BACnet - For each BAS object, a specific and unique BACnet object name shall be required.
   4. All assignment of network numbers and Device Object IDs shall be coordinated with CPS.
   5. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:
      a. **BBBFF**, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.
   6. Each Device Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:
      a. **XXFFBBB**, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.
   7. The Contractor shall coordinate with CPS or a designated representative to ensure that no duplicate Device Object IDs occur.
   8. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by CPS.

2.13 OPERATOR INTERFACE GRAPHIC SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be CPS's Current Support Software Image Via ITS (Information and Technology Services).

E. The software shall allow for CPS creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

F. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or 'button' icons. All screens will be accessible out the use of outline type selection screens. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.

G. Dynamic Data Displays: Dynamic physical point values shall automatically update at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

H. Point Override Feature: Provide the following:

1. An Operator from a work-station shall have the capability to place an end device under manual control, which shall prevent the control logic from making changes to the end device status, and provide the operator with the ability to position the end device. It must be possible to put a point under manual control and command the point to a specific state or value from a graphic page. Once under manual control the point will be able to be released to automatic operation from the same graphics page. See the definition of Manual Control in the definition of terms Article in this Section.
2. An Operator from the operator work-station shall have the capability to place a sensor input into test mode. When in test mode, any changes from the physical sensor will no longer be recognized and the value reported to control logic shall take a value that is assigned to it by the operator from the operator work-station. It must be possible to put a point in test and assign a test value from a graphic page. See the definition of Test Mode in the definition of terms Article of this Section.
3. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection.

I. Dynamic Symbols: Provide a selection of standard symbols that change in appearance based on the value of an associated point.
   1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.
   2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.
   3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.

J. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays. The application of the graphic editing will be controlled by password level at the programmer level or higher.
   1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
   2. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:
      a. Define symbols
      b. Position items on graphic screens
      c. Attach physical or virtual points to a graphic
      d. Define background screens
      e. Define connecting lines and curves
      f. Locate, orient, and size descriptive text
      g. Define and display colors for all elements
      h. Establish correlation between symbols or text and associated system points or other displays.
      i. Create hot spots or link triggers to other graphic displays or other functions in the software.

2.14 APPROVED VENDORS AND THEIR PRODUCT LINES (NO SUBSTITUTIONS)

A. Automatic Building Control, Inc. – Approved For Distech Tridium Only
   1580 N. Northwest Highway
   Park Ridge, IL 60068
   Contact: Mark Bevil
   (847)-296-4000
   Vendor # 22627

2.15 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. The distributed digital control (DDC) and building automation system (BAS) defined herein shall provide a complete open protocol Native BACnet® Building Automation System (BAS) for all mechanical systems and other facility systems as included in the project documents. The contractor shall provide a complete and operational system to perform all sequences of operations stated in the Article "Sequence of Operation" or as shown on the control drawings.

C. The BAS shall utilize open protocol BACnet hardware and software to provide full monitoring (visualization), programming and control of all DDC control systems on the building.

D. BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform the control sequences and functions specified. The BAS for this project shall consist of monitoring and control of the systems indicated.

E. The BAS system shall include a webserver (control system server CSS), a separate operator workstation (OWS), a laptop (portable operator terminal POT), all the software tools required to maintain or configure the server, OWS, and any local devices. A laptop will be provided by CPS with CPS's current compliant operating system. In addition, CPS will provide server hardware and software consistent with current standards of CPS organization for BAS system to be installed on. The BAS server will exist in CPS's data center on one of the existing Enterprise servers.

F. All interlock wiring for mechanical system equipment shall be by this contractor unless specifically stated otherwise. This shall include, but not be limited to, items such as thermostats for unit heaters, interlock wiring to central boiler control panels, chiller flow switches, and duct smoke detectors.

G. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC, lighting, and security devices should easily coexist on the same network channel without need for gateways.

H. All of the command able physical points shall be exposed to non-proprietary BACnet communication network bus for integration or expansion by the supervisory controller

I. All of the command able physical points shall be exposed from all field level network control devices up to the supervisor level communications bus for 100% Fully Open BAS integrations, two-way communication, and modification/expansion to the system architecture.

J. A "Fully Open BAS" selection defined from Section 1.5 of this document shall be made from the below outlined protocols.

   1. The BAS shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135.
   2. Wireless systems to be for student/faculty occupied areas. Wireless systems must be approved by CPS IT Infrastructure team.
   3. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks).
   4. 100% of the physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

K. The BAS shall use native BACnet MS/TP, BACnet TCP/IP (wired and wireless to CPS' wireless Enterprise network) architecture and be in strict accordance with ASHRAE Standard 135. All controllers shall be BACnet Testing Labs (BTL) Certified. All BACnet points shall only use native BACnet BTL Certified standardized PICS (Protocol Implementation Conformance Statement) and BIBBS (BACNET Interoperability Building Blocks). 100% of the physical and virtual points shall be programmed as BACnet Objects and Events without any exceptions.

L. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

M. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

N. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 .

O. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

P. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.16 SYSTEM ARCHITECTURE

A. Application of Open Protocols:

1. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing the following standards:
   a. BACnet or Hybrid System: The system architecture shall consist of a BACnet IP Router, a single Local Area Network (LAN) or two-level LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. In no event shall there be more than two levels of LAN topology within the system, excluding wiring to sensors with no control intelligence.

B. The system provided shall incorporate hardware resources sufficient to meet the functional requirements specified. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

C. The system shall be configured as a distributed processing network(s) capable of expansion as specified below. Refer to the network architecture on the BAS drawings for other requirements and details.

D. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled that support PCUs, Operator Workstations (OWS), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. CPS Enterprise WAN: Intranet-based network connecting multiple facilities with a central data warehouse and server, accessible via CPS current standard web-browser(s). This is an existing infrastructure and contractor is not required to configure any components of this WAN.
2. Local BAS Supervisory LAN: The Local BAS Supervisory LAN shall be an Ethernet-based connected to CPS' Enterprise Network. The LAN serves as the inter-PCU gateway and OWS-to-PCU gateway and communications path and as the connection point for the CPS WAN. There is to be no vendor provided LAN/WAN network equipment. Power-line carrier communication shall not be acceptable for communications. The higher-level layers of this network shall be the following:
   a. BACnet Local Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet.
3. Primary Controller LAN ('Primary LAN'): High-speed, peer-to-peer communicating LAN used to connect and Primary Control (PCUs) and communicate exclusively control information. Acceptable technologies include:
   a. BACnet: Network used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, or ARCnet in accordance with IEEE 802.4, in addition to those allowed for Primary Controller LANs. Network speed vs. the

number of controllers on the LAN shall be dictated by the response time and trending requirements. The primary network shall communicate at a minimum of 38 kbps. Each secondary network may support up to 32 communicating devices without segmentation or repeaters subject to the requirements for response time, trending, and bandwidth utilization.

E. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

F. Remote Data Access: The system shall support the following methods of remote access to the building data.
   1. Browser-based access: A remote user, connecting via the CPS Enterprise WAN and using a CPS standard web browser shall be able access all control system facilities and graphics with proper username and password. The remote access user will not need to load Java or other runtimes to view the web pages.

G. Network Performance: The communication speed between the controllers, control LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. The performance will also include the trending of all AI, AO and DI points at 15-minute intervals. Generally, requirements do not apply when a remote connection must be established via modem:
   1. 5 seconds between a Level 1 (critical) alarm occurrence and annunciation at operator workstation.
   2. 10 seconds between a Level 2 alarm occurrence and annunciation at operator workstation.
   3. 20 seconds between and a Level 3-5 alarm occurrence and annunciation at operator workstation.
   4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
   5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
   6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
   7. Graphic Display, 10 seconds between an operator selection of a graphic and it completely painting the screen and updating all points.
   8. Graphic Refresh, every 15 seconds the graphic shall automatically refresh all graphic data.

H. The PCUs shall monitor, control, and provide the field interface for all points specified. Each PCU shall be capable of performing all specified energy management functions, and all DDC functions, independent of other PCUs and operator interface devices as more fully specified in Division 23 Section “Building Automation System (BAS) - Field Panels."

I. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or workstation on the CPS Enterprise Network. User tools provided to Chicago Public Schools shall allow configuring, updating, and maintaining current configurations and settings whether they are initiated at the server or the end device.

1. Database Schema shall be published and provided to Chicago Public Schools to facilitate easy access to the data.
2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

J. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

K. All line drivers, repeaters, terminators, signal boosters, and signal conditioners shall be provided as necessary for proper data communication.

L. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the OWS and CSS.

2.17 CONTROLLERS

A. Building Controllers:

1. General:
   a. The BC is a Server that is either a physical server provided by CPS or a virtual machine provided by CPS to run the BAS software from connected to the CPS Enterprise WAN that can communicate with the vendor provided hardware / software.
   b. BC shall support interrogation, full control, and all utilities associated with all AACs and ASCs under the Primary Controller LAN.
   c. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device.
   d. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
   e. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   f. Share data between networked controllers.
   g. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   h. Utilize real-time clock for scheduling.
   i. Continuously check processor status and memory circuits for abnormal operation.
   j. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
   k. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACNET over IP network using BACNET over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage standards
   b. Perform routing when connected to a network of custom application and application specific controllers.
   c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. External Input-Output (I-O) Data Bus:
   a. Input only modules.
   b. Output only modules.
   c. Variable frequency drives (VFD's).

d. Universal I-O module (configurable).
e. Access control module for single door.
f. Specific wired and wireless data integration modules. NOTE: WIFI WIRELESS IS ONLY ACCEPTABLE IF IT IS A CPS APPROVED WIFI DEVICE
g. DALI (Digital addressable lighting interface) modules.
h. Motor control of devices like blinds, roller shutters, and sun protection systems.
i. Multiple Input Output (I-O) Module:
   1) IAQ: Temperature, humidity, and CO2.
   2) Occupancy: Light and thermal sensing with multi-colored LED feedback.
   3) Wireless interfaced using Bluetooth per Bluetooth CS or Wi-Fi per IEEE 802.11abgn. NOTE: WIFI WIRELESS IS ONLY ACCEPTABLE IF IT IS A CPS APPROVED WIFI DEVICE

4. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
5. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. Advanced Application Controller:
1. General:
   a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   b. Share data between networked, microprocessor based controllers.
   c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   d. Utilize real-time clock for scheduling.
   e. Continuously check processor status and memory circuits for abnormal operation.
   f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
   g. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet over IP network using BACnet over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage standards.

b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:
   a. Diagnostic LED's for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. Application Specific Controllers:
1. General:
   a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
   b. Customized for operation within the confines of equipment served.
   c. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet over IP network using BACnet over IP protocol connected to the cps Enterprise network homerun to the MDF/IDF rooms and or nearest concentrator box in accordance to CPS's low voltage specifications, see Division 27 Communications for requirements in blue conduit.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.
b. Perform orderly shutdown below 80 percent of nominal voltage.
c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

D. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
a. Allow monitoring of On/Off signals from remote devices.
b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
b. Outputs provided with three position (On/Off/Auto) override switches.
c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.

b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.18 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression components for all workstations and controllers.
2. Minimum surge protection attributes:
   a. Dielectric strength of 1000 volts minimum.
   b. Response time of 10 nanoseconds or less.
   c. Transverse mode noise attenuation of 65 dB or greater.
   d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.19 SYSTEM SOFTWARE

A. Operating System:

1. Concurrent, multi-tasking capability.
   a. Common Software Applications Supported: Microsoft Excel.
2. System Graphics:
   a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
   b. Animation displayed by shifting image files based on object status.
   c. Provide method for operator with password to perform the following:
      1) Move between, change size, and change location of graphic displays.
      2) Modify on-line.
      3) Add, delete, or change dynamic objects consisting of:
         (a) Analog and binary values.
         (b) Dynamic text.
         (c) Static text.
         (d) Animation files.
3. Custom Graphics Generation Package:
   a. Create, modify, and save graphic files and visio format graphics in PCX formats.
   b. HTML graphics to support web browser compatible formats.
   c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:

a. HVAC Equipment:
b. Ancillary Equipment:

B. BAS Workstation System Applications (NOT COMPUTER):
1. Automatic System Database Save and Restore Functions:
a. Current database copy of each Building Controller is automatically stored on the hard disk.
b. Automatic update occurs upon change in any system panel.
c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
a. Save database from any system panel.
b. Clear a panel database.
c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
a. Context-sensitive systems assist operator in operation and editing.
b. Available for all applications.
c. Relevant screen data provided for particular screen display.
d. Additional help available via hypertext.
5. Security:
a. Operator log-on requires username and password to view, edit, add, or delete data.
b. System security selectable for each operator.
c. System supervisor sets passwords and security levels for all other operators.
d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
f. All system security data stored in encrypted format.
6. System Diagnostics:
a. Operations Automatically Monitored:
1) Workstations.
2) Printers.
3) Modems.
4) Network connections.
5) Building management panels.
6) Controllers.
b. Device failure is announced to the operator.
7. Alarm Processing:
a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
b. Configurable Objects:
1) Alarm limits.
2) Alarm limit differentials.
3) States.

4) Reactions for each object.

8. Alarm Messages:
   a. Descriptor: English language.
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
   f. Paging.
   g. Providing audible annunciation.
   h. Displaying specific system graphics.
10. Custom Trend Logs:
   a. Definable for any data object in the system including interval, start time, and stop time.
   b. Trend Data:
      1) Sampled and stored on the building controller panel.
      2) Archivable on hard disk.
      3) Retrievable for use in reports, spreadsheets and standard database programs.
      4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
      5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
   a. View all system alarms and change of states from any system location.
   b. Events listed chronologically.
   c. Operator with proper security acknowledge and clears alarms.
   d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
   a. Provide a method to view, edit if applicable, the status of any object and property in the system.
   b. Status Available by the Following Methods:
      1) Menu.
      2) Graphics.
      3) Custom Programs.
13. Reports and Logs:
   a. Reporting Package:
      1) Allows operator to select, modify, or create reports.
      2) Definable as to data content, format, interval, and date.
      3) Archivable to hard disk.
   b. Real-time logs available by type or status such as alarm, lockout, normal, etc.

c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
d. Set to be printed on operator command or specific time(s).

14. Reports:
    a. Standard:
        1) Objects with current values.
        2) Current alarms not locked out.
        3) Disabled and overridden objects, points and SNVTs.
        4) Objects in manual or automatic alarm lockout.
        5) Objects in alarm lockout currently in alarm.
        6) Logs:
            (a) Alarm History.
            (b) System messages.
            (c) System events.
            (d) Trends.
    b. Custom:
        1) Daily.
        2) Weekly.
        3) Monthly.
        4) Annual.
        5) Time and date stamped.
        6) Title.
        7) Facility name.
    c. Tenant Override:
        1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
        2) Annual report showing override usage on a monthly basis.
    d. Electrical, Fuel, and Weather:
        1) Electrical Meter(s):
            (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
            (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
        2) Fuel Meter(s):
            (a) Monthly showing daily natural gas consumption for each meter.
            (b) Annual summary showing monthly consumption for each meter.
        3) Weather:
            (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
    e. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:
        1) Chilled water inlet and outlet temperature.
        2) Chilled water flow.
        3) Chilled water inlet and outlet pressure.
        4) Evaporator refrigerant pressure and temperature.
        5) Condenser refrigerant pressure and temperature.
        6) Condenser refrigerant pressure and liquid temperature.
        7) Condenser water flow.

8) Refrigerant levels.
9) Oil pressure and temperature.
10) Oil level.
11) Compressor refrigerant discharge temperature.
12) Refrigerant suction temperature.
13) Addition of refrigerant.
14) Addition of oil.
15) Vibration levels or observation that vibration is not excessive.
16) Motor amperes per phase.
17) Motor volts per phase.
18) PPM refrigerant monitor level.
19) Purge exhaust time or discharge count.
20) Ambient temperature (dry-bulb and wet-bulb).
21) Date and time logged.

C. Workstation Applications Editors:
1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
a. Configuration.
b. Name.
c. Control parameters.
d. Set-points.
4. Scheduling:
a. Monthly calendar indicates schedules, holidays, and exceptions.
b. Allows several related objects to be scheduled and copied to other objects or dates.
c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
b. Programming Features:
1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.20 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
B. System Security:
   1. User access secured via user passwords and user names.
   2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
   3. User Log On/Log Off attempts are recorded.
   4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
C. Object or Object Group Scheduling:
   1. Weekly Schedules Based on Separate, Daily Schedules:
      a. Include start, stop, optimal stop, and night economizer.
      b. 10 events maximum per schedule.
      c. Start/stop times adjustable for each group object.
   2. Exception Schedules:
      a. Based on any day of the year.
      b. Defined up to one year in advance.
      c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
   3. Holiday or Special Schedules:
      a. Capability to define up to 99 schedules.
      b. Repeated annually.
      c. Length of each period is operator defined.
D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
E. Alarms:
   1. Binary object is set to alarm based on the operator specified state.
   2. Analog object to have high/low alarm limits.
   3. All alarming is capable of being automatically and manually disabled.
   4. Alarm Reporting:
      a. Operator determines action to be taken for alarm event.
      b. Alarms to be routed to appropriate workstation.
      c. Reporting Options:
         1) Start programs.
         2) Print.
         3) Logged.
         4) Custom messaging.

5) Graphical displays.

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.

H. PID Control Characteristics:
1. Direct or reverse action.
2. Anti-windup.
3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
4. User selectable controlled variable, set-point, and PED gains.

I. Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
2. Provides an operator with capability to assign a high run-time alarm.

2.21 HVAC CONTROL PROGRAMS - SEE SEQUENCE OF OPERATIONS WHERE ITEMS BELOW CONFLICT WITH PROJECTS SEQUENCE OF OPERATION, SEQUENCE OF OPERATION SHALL BE FOLLOWED.

A. General:
1. Support Inch-pounds and SI (metric) units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
6. Owner Operator commands:

a. Define term schedule.
b. Add/delete fan status point.
c. Add/delete outside air temperature point.
d. Add/delete mass temperature point.
e. Define heating/cooling parameters.
f. Define mass sensor heating/cooling parameters.
g. Lock/unlock program.
h. Request optimal run time control summary.
i. Request optimal run time mass temperature summary.
j. Request HVAC point summary.
k. Request HVAC saving profile summary.

7. Control Summary:
   a. HVAC Control system begin/end status.
   b. Optimal run time lock/unlock control status.
   c. Heating/cooling mode status.
   d. Optimal run time schedule.
   e. Start/Stop times.
   f. Selected mass temperature point ID.
   g. Optimal run time system normal start times.
   h. Occupancy and vacancy times.
   i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
   a. Mass temperature point type and ID.
   b. Desired and current mass temperature values.
   c. Calculated warm-up/cool-down time for each mass temperature.
   d. Heating/cooling season limits.
   e. Break point temperature for cooling mode analysis.
9. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and point.
   e. Calculated optimal start and stop times.
   f. Period start.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.
3. Owner Operator commands:
   a. Add/delete fan status point.
   b. Lock/unlock program.
   c. Request HVAC point summary.
   d. Add/Delete discharge controller point.

e. Define discharge controller parameters.
f. Add/delete air flow rate.
g. Define space load and load parameters.
h. Request space load summary.

4. Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Deadband.
   g. Response timer.
   h. Reset times.
5. Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.
   j. Control discharge temperature point ID and status.
   k. Space load point ID and status.
   l. Air flow rate point ID and status.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
2. Owner Operator commands:
   a. Add/delete fan status point.
   b. Add/delete outside air temperature point.
   c. Add/delete discharge controller point.
   d. Define discharge controller parameters.
   e. Add/delete return air temperature point.
   f. Add/delete outside air dew point/humidity point.
   g. Add/delete return air dew point/humidity point.
   h. Add/delete damper switch.
   i. Add/delete minimum outside air.
   j. Add/delete atmospheric pressure.
   k. Add/delete heating override switch.
   l. Add/delete evaporative cooling switch.
   m. Add/delete air flow rate.
   n. Define enthalpy deadband.
   o. Lock/unlock program.
   p. Request control summary.
   q. Request HVAC point summary.

3. Control summary:
    a. HVAC control system begin/end status.
    b. Enthalpy switchover optimal system status.
    c. Optimal return time system status.
    d. Current outside air enthalpy.
    e. Calculated mixed air enthalpy.
    f. Calculated cooling cool enthalpy using outside air.
    g. Calculated cooling cool enthalpy using mixed air.
    h. Calculated enthalpy difference.
    i. Enthalpy switchover deadband.
    j. Status of damper mode switch.

2.22 NETWORK CONNECTION

A. CPS Enterprise WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and Contractor is not required to configure any components of this WAN but the contractor needs to work with CPS Network Operations to properly configure the ports and switches for them. Contractor is however required to provide data and services via BACnet over IP to the CPS Enterprise WAN.

PART 3 EXECUTION

3.01 INSTALLERS

A. Reference Section 2.14 "Approved Vendors and Their Product Lines."

3.02 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.03 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally meet the intent of the written sequences of operation. If a sequence is not clear, in the contractors opinion, it is the Contractor’s responsibility to request clarification..

B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.

C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of CPS and shall remain on the workstation(s)/server(s) at the completion of the project.

3.04 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:
    1. Name
    2. Address
    3. Scanning frequency or COV threshold
    4. Engineering units

5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred. All default values will be provided in list format for evaluation by CPS.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:
1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:
1. Name
2. Address
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay
5. Message and alarm reporting as specified
6. Reporting of each change of state, and memory storage of the time of the last change of state
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:
1. Name
2. Address
3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on-time
7. Minimum off-time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.05 TRENDS

A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point. All dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like will be trended as directed by the CPS.

B. CPS will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (±) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When outputting to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by CPS, or their representative, upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system. The trend limit is 1 year from demonstration for LEED projects that require trend data for M&V purposes. The limit on the length of trend data will be a function of the storage capacity of the computer.

3.06 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Provide a legend identifying the line color and symbol along side the point noun name for each point in the trend. Also, indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.

D. The y-axis scales shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended except for control loop performance trends.

F. Allow point groups to be saved for future trends. For example, HW supply and return temperatures along with HX stm valve position and pump status.

3.07 ALARMS

A. Override Alarms: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Space temperature, except as otherwise stated in sequence of operation: Level 3
   a. Low alarm: 64°F
   b. Low return-to-normal: 68°F

c. High alarm: 85°F
d. High return-to-normal: 80°F

2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)
   a. Low alarm: 3°F below setpoint
   b. Low return-to-normal: 2°F below setpoint
   c. High alarm: 3°F above setpoint
   d. High return-to-normal: 2°F above setpoint.
3. AHU mixed air temperature: Level 4
   a. Low alarm: 45°F
   b. Low return-to-normal: 46°F
   c. High alarm: 90°F
   d. High return-to-normal: 89°F
4. Duct Pressure:
   a. Low alarm: 0.5”w.g. below setpoint
   b. Low return-to-normal: 0.25”w.g. below setpoint
   c. High alarm: 0.5”w.g. above setpoint
   d. High return-to-normal: 0.25”w.g. above setpoint
5. Space humidity:
   a. Low alarm: 35%
   b. Low return-to-normal: 40%
   c. High alarm: 75%
   d. High return-to-normal: 70%

C. Status versus Command Alarms: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the ‘Auto’ position. BAS shall enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present or vice versa:
   1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. Maintenance Alarms: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator.
   1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

E. See requirements for additional equipment-specific alarms specified in Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.08 GRAPHIC SCREENS

A. Main Screen: The Main screen will be the first screen displayed after login, no navigation required to get to the main screen (see Exhibit A for sample screens). This screen will have the following features:
   1. CPS will have the option of providing a picture of the school as background.
   2. There will be a link button to the floor plans, Summary screen, and system schematic screens. In the event that there are more 10 to 15 AHU, Boiler and Chiller screens a button to groups of AHU’s will be provided.
   3. Manufacturer/Installer Logo or information is not to be included in the screen.

4. Provide a global command to open heating or cooling valves to facilitate Test Adjust and Balance. The command will be grouped so that an AHU can be balanced as well as total system balancing. The same function will apply for VAV AHU's were all the boxes can be set at minimum or maximum flow.

B. Floor Plan Screens: The contract document drawings will be made available to the Contractor in AutoCAD format upon request. These drawings may be used only for developing backgrounds for specified graphic screens; however CPS does not guarantee the suitability of these drawings for the Contractor's purpose (see Exhibit B for sample screens). .

1. Provide graphic floor plan screens for each floor and/or wing of the building. Indicate the location of all equipment that is not located on the equipment room screens.
    a. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.
    b. . Display the space temperature point adjacent to each temperature sensor symbol along with the room set point. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct background colors for each zone to demarcate the air-handling unit to which it is associated.
    c. Indicate room numbers as provided by CPS. Verify final room number/name assignments, as these are often different than initially assigned room numbers on the contract drawings.
    d. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding zone equipment schematic graphic screen. Because the area available for the floor plans varies from system to system, the size of text used to display data such as room number and temperature will be at least 1/8" high on the screen when the entire floor plan section is displayed.
    e. The floor plan graphics will also indicate the location of control panels. For control devices such as duct smoke detectors, system pressure or differential pressure sensors (water or air), airflow stations that are located outside the equipment rooms. All of these devices will be linked to the associated system graphic. For terminal units the link to the associated system graphic is sufficient and the associated unit control devices do not need to be located on the floor plan.
2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
3. Provide a graphic building key plan that will allow navigation at a floor level or from floor to floor. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
4. When there is more than one building, provide a graphic site plan with links to and from each building plan.

C. System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem (AHU) controlled with each I/O point in the project appearing on at least one graphic screen. System graphics shall be have the same look as the submittal diagrams (do not use three dimensional graphics) with status, setpoints, current analog input and

output values, operator commands, etc. as applicable. Input/output devices shall be shown in their schematically correct locations with the associated value, noun name and engineering units. The position of valves or dampers will be % OPEN. For three way valves it will be %OPEN to the device. The noun name (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen. Similar AHU's will have the same organization of information. For example a single zone AHU will not put all the set points across the top and multizone put them on the side or bottom (see Exhibit C for sample screens).

1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupancy mode and heating, cooling, economizer etc based on the sequence of operations). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
2. Provide a graphic screen for each zone with the associated control devices or terminal unit with a link to the associated system schematic screen of the air handling unit that serves the zone.
3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link the chilled water and condenser water systems screens if they cannot fit onto one cooling plant graphic screen.
4. Link the heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
5. For each system schematic screen, including AHU, Boiler, Chiller and terminal unit screen, provide a button linked to a text version of the sequence of operation for the device or system. The sequence will be updated with the as-built sequence following completion of the demonstration.

D. System Summary Screens: On each graphic System Screen, provide drawing links to the graphic air handling unit schematic screens (see Exhibit D for sample screens).

1. Provide a chilled water valve screen showing the analog output signal of all chilled water valves with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
2. Provide a heating water valve screen showing the analog output signal of all air handling unit heating water valves with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.
3. When there are more than four AHU's on the system provide a summary screen with the following type of information for each AHU, each fan command, status, alarms (smoke, freeze, duct static), DAT and duct pressure if applicable. For the heating system provide status and supply water temp or steam pressure and for the chiller provide status and chilled water supply temperature.
4. Provide a BAS system summary screen using the control system riser diagram to show the communication status of all controllers (BC, AAC and ASC's) on the BAS as well as all interface devices such as VFD's, chillers and boiler panels etcetera. Use green board concept, green means communicating, red is not communicating.

5. Provide a terminal unit summary screen grouped by floor or AHU. If the summary is grouped by floor, then the AHU will be shown for each terminal unit and vice versa. The points shown will depend on the type of terminal unit and will include room name, floor or AHU, room set point and temperature, DAT, valve position, command status, alarm, and occupancy state.
6. Exhaust fans will be show in a table format showing the command signal, the status, the alarm condition, and the occupancy state.

E. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color. When an alarm first occurs, it shall "popup" over the current screen so that the operator is immediately aware of an alarm.

1. Maintenance Alarms
   a. Runtime alarm screen will list all equipment with a BAS status. For each piece of equipment the screen will display the current run time (since the last reset), the runtime alarm limit (adj.), its alarm status (red / green) and the total accumulated runtime. The total accumulated runtime would only be zeroed out if the equipment were replaced. For equipment with internal runtime meters ensure that the total accumulative runtime is synchronized.

F. Utility Metering: Provide a graphic for the gas, electric and water utility data required in the sequence of operations. This may entail multiple screens if submetering of the gas or electric usage is included in the project.

3.09 SYSTEM ACCESS

A. Provide a direct Ethernet connection to CPS Enterprise Network at each panel housing a controller or controllers, meaning all BAS controllers should be direct connected to the CPS Enterprise network via applicable low voltage specifications. If an installation cannot accommodate IP connection such as in an integration scenario CPS must be notified prior to bid otherwise it is assumed the vendor can accommodate and is liable if they cannot. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

B. Contractor shall closely coordinate with CPS Network Operations, or designated representative, to establish IP addresses and communications to assure proper operation of the building control system with the CPS Enterprise WAN, CSS's/OWS's , JACE's and OWSs.

3.10 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements specified.

C. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required and in sufficient quantity to meet the requirements of this Specification. This Contractor shall extend power to the DCS from an acceptable power panel. If the contractor wishes to further distribute panels to other locations, contractor is responsible for extending power to that location also. Furthermore, contractor is

responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

D. Contractor shall locate DCSs as required. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list, trending requirements and sequence of operations.

E. Contractor shall provide the following, as a minimum:
   1. One DCS (including at least one controller) in each heating water and chilled water plant mechanical room.
   2. One DCS (including at least one controller) for each air handler located in an applicable mechanical room.
   3. One controller shall be provided for each terminal unit unless indicated otherwise.

F. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

G. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

H. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
   1. Extend all power source wiring required for operation of all equipment and devices provided under Division 23 Building Automation System (BAS) Sections and Sequences of Operation.
   2. Control panels shall not share a power circuit and should have Isolated Ground (IG) power. IG Power supplied to the panels shall have dedicated circuits and the circuit location shall be documented in the panel.

I. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.11 HARDWARE APPLICATION REQUIREMENTS

A. General: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. Specific requirements indicated below are required for the respective application. Manufacturer shall apply the most cost-effective unit that meets the requirement of that application.

B. Standalone Capability: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.

C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

D. Application Category Type 0 (Distributed monitoring)
   1. Applications in this category include the following:
      a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.
   2. Points on BCs, AACs, and ASCs may be used in these applications as well as Ds and/or general-purpose I/O modules.

3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
4. LAN Restrictions: These points may reside on any controller

E. Application Category Type 1
1. Applications in this category include the following:
   a. Fan Coil Units
   b. Airflow Control Boxes (VAV and Constant Volume Terminal Units)
   c. Terminal Control Dampers/Reheat Vales
   d. Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, and Water-Source Heat Pumps)
   e. Induction Units
2. Standalone Capability: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.
   a. Physical/Virtual Point — Default Value
   b. Scheduling Period — Normal
   c. Morning Warm-Up — Off (cold discharge air)
   d. Load Shed — Off (no shedding)
   e. Summer/Winter — Winter
   f. Trend Data — N/A
3. Mounting:
   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. ASCs that control equipment mounted in a mechanical room shall either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
   d. Contractor for this Section may furnish ASCs to the terminal unit manufacturer for factory mounting.
4. LAN Segment Restrictions:
   a. BACnet Systems: Limit the number of AAC's/ASC's servicing any one of these applications on the LAN Segment to 32.

F. Application Category Type 2
1. Applications in this category include the following:
   a. VAV Air Handlers
   b. Dual Duct Air Handlers
   c. Multizone Air Handlers with 5 or more zones
   d. Self Contained VAV Units
   e. Constant Volume Air Handlers

f. Unitary Equipment >= 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
g. Constant Volume Pump Start/Stop
h. Misc. Equipment (Exhaust Fan) Start/Stop
i. Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
j. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device
k. Multizone Air handlers with fewer than 5 zones

2. Standalone Capability: Only the following data (as applicable) may be acquired from other AACs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

	Physical/Virtual Point	Default Delay Time	Default Value
a.	Outside Air Temperature	3 minutes	80°F
b.	Outside Air Humidity	3 minutes	60%RH
c.	Outside Air Enthalpy	3 minutes	30 Btu/lb
d.	Trend Data		N/A
e.	Cooling/Heating Requests	3 minutes	None

3. Mounting:
   a. AACs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. AACs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. AACs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
4. LAN Segment Restrictions:
   a. BACnet Systems: Limit the number of AAC's servicing any one of these applications on the LAN Segment to 32.

G. Application Category Type 3
1. Applications in this category include the following:
   a. Central Cooling Plant
   b. Central Heating Plant
   c. Cooling Towers
   d. Sequenced or Variable Speed Pump Control
   e. Local Chiller Control (unit specific)
   f. Local Free Cooling Heat Exchanger Control
2. BACnet Systems: BCs shall be used in these applications.

3.12 STARTUP, COMMISSIONING AND TRAINING
A. Refer to Division 23 Section "Building Automation System (BAS) - Commissioning."

3.13 DEMONSTRATION AND INSTRUCTIONS
A. Refer to Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.14 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of energy management and control systems for two years from Date of Final Acceptance.
C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
D. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.15 IDENTIFICATION STANDARDS

A. Controller Identification. All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
B. Panel Identification. All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
C. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.
D. Panel Devices. All panel devices shall be identified by a typed label securely fastened to the backplane of the local control panel.
E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed

3.16 SCHEDULES

A. Input/Output Schedule:
    1. Point Description:
    2. Digital Input:
        a. Demand Meter (kW):
        b. Auxiliary Contact:
        c. Switches:
            1) Switch Closing:
            2) Flow Switch:
            3) Optical:
        d. Current:
        e. Pressure:
    3. Digital Output:
        a. Control Relay:
        b. Solenoid:
        c. Contactor:
    4. Analog Input:
        a. Temperature:
        b. Relative Humidity:
        c. Pressure/Vacuum:
        d. Filter:
        e. Flow:
        f. Current:

g. Liquid Level:
h. Photocell:

5. Analog Output:
   a. Pneumatic Transducer:
   b. 4-20 ma Module:
   c. 0-16 v DC:
6. Alarm:

B. Input/Output Schedule:
1. Point Description:
2. Inputs:
   a. Temperature:
   b. Relative Humidity:
   c. Pressure:
   d. Flow:
   e. Level:
   f. Position:
   g. Energy:
   h. Power:
3. Outputs:
   a. Status:
   b. Alarm:
   c. Pneumatic Position:
   d. Electronic Position:
   e. Set Point Adjust:
   f. Start/Stop:
   g. Off/Low/High:
4. Software Features:
   a. PID Control (DDC):
   b. High Limit:
   c. Low Limit:
   d. Run Time Totalization:
   e. Consumption Totalization:
   f. Program Start/Stop:
   g. Load Shed:
   h. Duty Cycle:
   i. Enthalpy Switchover:
   j. Optimal Run Time:
   k. Supply Air Reset:
   l. O.A. Interlock:
   m. O.A. Temperature Reset:
   n. Free Cooling Mode:
   o. Warm-up Mode:
   p. Boiler Interlock:
   q. Chiller Sequencing:
   r. Energy Calculation:

C. Alarm Schedule:

1. High Limit: A1.
2. Low Limit: A2.
3. Run Time: A3.
4. Maintenance: A4.
5. Status: A5.
6. Override: A6.
7. Freeze: A7.
8. Low Pressure: A8.

END OF SECTION

SECTION 23 09 26 (LNK)

BUILDING AUTOMATION SYSTEM (BAS) - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Air Handling Units.
2. Terminal Units.
3. Central Heating System.
4. Pumps.
5. Mechanical systems with automatic control.

1.2 SYSTEM DESCRIPTION

A. Refer to Division 23 Section "Building Automation System (BAS)" for a description of the systems to be controlled.

B. This Section defines the manner and method by which controls function.

1.3 SUBMITTALS

A. Refer to Division 23 Section "Building Automation System (BAS)" and Division 01 Sections for requirements for control shop drawings, product data, Users Manual, etc.

B. Programming Manual: Provide DDC system programming manual as well as documentation of site specific programming prior to the start of Acceptance Phase.

1.4 PROJECT RECORD DOCUMENTS

A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual setpoints and tuning parameters as existed at acceptance.

B. Record documents shall be modified control drawings with the actual installed information. Drawings shall be delivered in both reproducible hard copy and electronic format in AutoCAD v13 or later. Provide all supporting files, blocks, fonts, etc. required by the drawings.

C. Provide final points list

D. Provide final detailed wiring diagrams with all wire numbers and termination points indicated

E. Accurately record final sequences and control logic made after submission of shop drawings.Definitions/Abbreviations

F. Absolute Minimum OA: Minimum flow rate setpoint to which the OA or primary air may throttle down. This value is acceptable as long as CO_2 levels are within acceptable limits.

G. AHU: Air Handling Unit

H. CHW: Chilled Water

I. CHWS: Chilled Water Supply

J. CHWR: Chilled Water Return

K. DDC: Direct Digital Control

L. Design Minimum OA: Minimum flow rate setpoint based on code requirements or designed system and coil capacities.

M. BAS: Building Automation System

N. MVR: Minimum required ventilation rate

O. OA: Outdoor Air

P. CHW: chilled water

Q. HW: heating water

R. Physical Point: A point on the BAS that is physically connected to an I/O device such that a hardware point exists

S. Virtual Point: A point to store values (i.e.: a setpoint) that do not represent a physical device

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.

B. When an air handling unit is not in operation, control devices shall remain in their “off” positions. “Off” positions may differ from the “normal” (meaning failed) position. Except as specified otherwise, “off” and “normal” positions of control devices shall be as follows:

Device	“Off” Position	“Normal” Position
Heating coil valves	closed/ controlling	open
Cooling coil valves	Closed	closed
Outside air damper	Closed	closed
Return air damper	Open	open
Exhaust/relief air damper	Closed	closed
Var. Freq. Drive	Off	Min. Speed

C. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified "proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.

D. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:

1. Occupied Period: period of time when the building is in use and occupied. Generally systems will be fully operational throughout this period and ventilation air shall be continuously introduced. Space temperature setpoints will generally be in the "normal" range of 69°-76°F.
2. Unoccupied period: period of time when the building or zone is not in use and unoccupied. Ventilation air shall not be introduced.
3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to "normal" or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling. Time period shall be determined by an optimum start strategy unless otherwise specified.
4. Setback Period: Setback start will typically coincide with the end of the occupied period and end with the start of the preoccupacy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a "setback" temperature.

E. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.

F. Alarm messages specified throughout the sequences are assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports.

G. All setpoints shall be adjustable (adj.), they shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

H. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:

1. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
3. [Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.]

I. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. space temperature) setpoint. The reset increment shall be determined by the quantity of “need heat” or “need cool” requests from individual terminal units. A terminal unit’s “need heat” virtual point shall activate whenever the zone’s space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A terminal unit’s “need cool” virtual point shall activate whenever the zone’s space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.

J. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. The BAS analog output value shall be acceptable as indicating the position of the control device.
2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point shall increment by one unit each time a zone’s valve/damper position rises to greater than 95%. The quantity of “need heat” or “need cool” points shall then be the basis for reset.

K. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS, after an adjustable time delay & after the device is commanded to operate (feedback delay,) confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm shall be enunciated audibly and via an alarm message at the operator interface and print at the alarm printers. A descriptive message shall be attached to the alarm message indicating the nature of the alarm and actions to be taken. Contractor shall provide messages to meet this intent.

L. The BAS shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:

1. Speed control of variable speed drives
2. Chiller supply water temperature setpoint reset
3. Chiller demand limit
4. Travel rate of tower isolation and chiller isolation valves

M. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) the BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

N. Some sequences rely on integration with third-party manufacturer control equipment. See the control equipment specifications, equipment schedules and equipment specifications for more information on this integration.

3.2 AIR HANDLING UNITS - GENERAL

A. Logic Strategies: The BAS shall fully control the air handlers. Generally, the BAS shall energize the AH (start the fans and activate control loops) as dictated for each air handler. The following indicates when and how the BAS shall energize the AHs and control various common aspects of them. The following "logic strategies" shall be included by reference with each air handler with any specific clarifications required:

1. Scheduled Occupancy: BAS shall determine the occupancy periods (occupied, unoccupied, preoccupancy, and setback) as defined above. The following details the common control aspects related to the scheduled occupancy.

   a. Occupied Period: BAS shall energize the AHU during all occupied periods.
   b. Setback Period: the BAS shall deenergize the unit except as required to maintain a setback temperature of 55°F with a 5°F cycle differential. Generally, where setback temperatures apply in multiple zones, the worst zone shall control the system. Setback setpoints generally apply except during preoccupancy and night purge. If, during the unoccupied period, there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.
   c. Preoccupancy: BAS shall energize the AHU continuously during the preoccupancy period. Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. "Normal" setpoints shall apply. Preoccupancy duration shall be one of the following as specified by reference:

      1) Fixed: The duration of the preoccupancy period shall be fixed as scheduled by the operator.
      2) Optimum: The duration of the morning warm-up period shall vary according to outside air temperature and space temperature such that the space temperature rises to occupied period heating setpoint at the beginning of, but not before, the scheduled occupied period. The duration of the cool-down period shall vary according to outside air temperature and space temperature such that the space temperature falls to the occupied period cooling setpoint at the beginning of, but not before, the scheduled occupied period

2. Night Purge Cycle: The night purge cycle shall be allowed only when manually enabled via a graphic icon. Night purge cycle shall start and stop as listed below during the unoccupied mode to maintain the zone(s) at setpoint using OA only (economizer) for cooling. Mechanical cooling and heating shall be disabled during the night purge mode.

   a. Night Purge Cycle Start: While the mode is enabled and during the unoccupied period, the BAS shall initiate the night purge cycle when:

      1) The OA temperature falls to 10°F (adj.) below the space temperature(s) (highest space temperature served by the AHU if not a single zone unit)
      2) And any (or an adjustable minimum number of) space temperature(s) is at least 5°F (adj.) above its normal occupied cooling setpoint
      3) And all space temperatures (served by the AHU if not a single zone unit) are greater than their occupied heating setpoint
      4) And outdoor air temperature is below 60°F (adj.).

b. Night Purge Cycle Stop: BAS shall disable the mode and deenergize AHU when:

1) The space temperature (highest space temperature for AHUs served by the AHU if not a single zone unit) falls to within 5°F (adj.) of OA temperature
2) Or any space temperature(s) fall(s) below its occupied heating setpoint.
3) Or all space temperatures fall below their occupied cooling setpoint.
4) Or the outdoor air temperature rises above the night cycle setpoint (60˚F [adj.]) by 5°F.

3. Sequenced Heating and Cooling: BAS shall control the heating and cooling coils and air side economizer detailed for the particular AH. Program logic shall directly prohibit the heating and cooling valves as well as the heating valve and economizer damper to be open (or above minimum) simultaneously. This does not apply to cooling and reheat valves that are used simultaneously for dehumidification.

B. Safeties

1. Freeze Safety: Upon operation of a freezestat, unit shall be deenergized with the exception of the heating loops. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock[and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms]. OA dampers shall close and heating loops shall remain active.
2. Software Low-Limit Safety: Upon detection by the BAS of a unit supply temperature below a low limit setpoint (40°F unless specifically stated otherwise), unit shall be deenergized with the exception of the heating loops. BAS shall enunciate appropriate alarm and remove and lock out the start command]]. OA dampers shall close and heating loops shall remain active. Once disabled, unit shall require a manual reset via the Operator Interface before it is allowed to restart.
3. Smoke Safety: Upon indication of smoke by a duct smoke detector the unit will shut down via hard-wired interlock and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms]. OA dampers shall close and heating loops shall remain active.
4. High or Low Pressure Safety: In VAV systems, upon activation of a high or low pressure safety switch, AHU shall be deenergized, fans shall be deenergized via a hard wired interlock[, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms].
5. The detailed “Safety logic strategies” above shall be required by reference to them in each of the individual sequences specified below.

C. Diagnostics

1. Diagnostic Strategies: In addition to the standard alarm limits specified for all sensed variables the BAS monitor and diagnose anomalies in the operation of the air handlers. The following “diagnostic strategies” shall be included by reference with each air handler with any specific clarifications required:

a. Run Time Limit: BAS shall accumulate the runtime of the status of associated rotating equipment and enunciate a level 5 alarm to indicate that the unit is in need of service.
b. DP Switch Filter Monitoring: BAS shall monitor the differential pressure switch across the filter bank(s). An alarm shall be reported when pressure drop exceeds the switch’s setting.

c. DP Transmitter Filter Monitoring: BAS shall monitor the differential pressure across the filter bank(s). An alarm shall be reported when pressure drop exceeds the alarm setting.

2. System Condition Alarming: BAS shall monitor the following parameters and enunciate an alarm under any of the following conditions in addition to other monitor and alarm functions specified above. These may not be specifically referenced in the individual sequences, but shall be provided wherever applicable.

a. Enunciate a Level 2 alarm when any active (air flowing) discharge temperature goes above or below its setpoint plus ±8°F (adj.) for 15 min. continuously as follows:

1) Sensor XXX is indicating that the discharge temperature is outside of acceptable limits.

b. Enunciate a Level 2 alarm when any active (air flowing) heating duct or heating coil leaving temperature falls below its setpoint minus 8°F (adj.) for 15 min. continuously as follows:

1) Sensor XXX is indicating that the heating air temperature is below acceptable limits.

c. Enunciate a Level 2 alarm when any active (air flowing) cooling duct or cooling coil leaving temperature exceeds setpoint plus 8°F (adj.) for 5 min. continuously as follows:

1) Sensor XXX is indicating that the cooling air temperature is above acceptable limits.

d. During the occupied period, enunciate a Level 2 alarm when any space temperature exceeds its active cooling setpoint plus 5°F (adj.) for 15 min. or falls below its active heating setpoint minus 5°F (adj.) for 15 min. continuously.

1) Zone XXX appears to be outside of acceptable limits.

e. Enunciate a Level 2 alarm when any active (air flowing) CO_2 reading rises above 1,200 PPM for 10 min. continuously as follows:

1) Sensor XXX is indicating that the CO_2 levels are above acceptable limits.

3.3 RTU VARIABLE VOLUME - GAS HEAT AND DX COOLING (RTU-L)

A. General: The packaged rooftop unit shall include integral controls and a BACnet interface for communication to the BAS. Space temperature sensors, duct smoke detectors, duct static pressure sensors, duct temperature sensors, outside airflow monitoring station, return air CO2 sensor, building pressure sensors and field control wiring shall be provided by this contractor. All remaining devices shall be provided by the rooftop unit manufacturer. The BAS Contractor and RTU Manufacturer shall review this sequence in detail, including the division of scope between the BAS Contractor and RTU Manufacturer, and clearly identify anything they take exception to during the shop drawing phase.

B. The BAS shall execute the following control strategies, as defined in detail in following paragraphs, and relay the necessary setpoints to the RTU internal controls.

1. enable / disable with scheduled occupancy with optimum preoccupancy
2. discharge temperature control
3. economizer minimum damper postion, including reset

C. Safeties: BAS shall execute the following safety logic strategies:

1. Smoke Safety: Provide ul-listed, electronically supervised air duct smoke detector in the return air duct. Smoke detection shall activate a “smoke” alarm and de-energize all associated hvac equipment and return all dampers and valves to their indicated “normal” positions. Smoke detection shall also initiate a “smoke alarm” condition at the building fire alarm panel. Coordinate with fire alarm contractor.
2. Software Low Temperature Limit Safety
3. Supply Air High Pressure Safety
4. Initiate an alarm at the user interface for RTU failure signal from the RTU integral controls.

D. Diagnostics: BAS execute the following diagnostic strategies:

1. DP Transmitter Filter Monitoring
2. Monitoring of RTU alarms
3. Monitoring of RTU Economizer Fault Detections and Diagnosis

E. Adjustable Setpoints: Setpoints indicated to be adjustable shall be adjustable through the rooftop unit's integral controller, other than those specifically identified to include a BAS interface.

F. Space Temperature Setpoints: See "Series FPB Hot Water Reheat" Control.

G. Discharge Temperature Control: The discharge temperature setpoint shall be determined as follows

1. During the occupied period, the discharge temperature shall be reset from 55°F to 65°F to maintain the number of active cooling requests from the served FPB boxes at 2 with all values being adjustable.
2. During the occupied period, the discharge temperature shall be overridden from a high of 65°F to a low of 55°F as the return air humidity rises from 50% to 60%. Reset shall be via a slow acting PID loop.
3. When the unit is energized for setback heating during the unoccupied period, the rooftop unit gas heating shall modulate to control for a discharge temperature setpoint of 75°F (adj.). The DX cooling and economizer shall be disabled.
4. When the unit is energized for morning cool-down or setback cooling, the discharge setpoint shall be the warmest zone temperature, minus 15°F. The gas heat shall be disabled.
5. The RTU controls shall stage cooling comperessors, enable heating stages and utilize air economizer modes to maintain the discharge air setpoint.

H. Set air economizer minimum OA setpoint during occupied modes to the scheduled airflow and to 0 cfm during unoccupied & preoccupancy modes.

1. Minimum Damper Position (reset): During the occupied period, the minimum position of the economizer dampers shall be reset between absolute minimum and design minimum so as to maintain return air CO_2 below a setpoint of 1000ppm (adj.) as follows:

   a. During the occupied period, the economizer dampers shall never be positioned less than the position set for the required absolute minimum OA ventilation rate.

b. On an increase in return air CO_2 above setpoint, the minimum position shall be reset up to the position set for the design minimum OA ventilation rate via a PID loop output. On a decrease in return air CO_2, the minimum position shall be reset back down to absolute minimum position.
c. The OA flow shall be measured by an OA flow station located in the RTU OA intake opening. OA flow setpoint shall be as scheduled on the contract drawings.
d. The Minimum Damper position shall not be reset below the sum of the running exhaust fans associated with the building areas served by the RTU.
e. Measured: The OA flow shall be measured directly by an OA flow station provided at the RTU OA intake opening.

I. The RTU internal controls shall achieve the following operating sequence:

1. Shutdown of the system supply fan for any reason, including manual shutdown, shall cause the integral relief fan to stop and the exhaust & outside air dampers shall close.
2. Set air economizer minimum OA setpoint to the minimum OA airflow setpoint as calculated by the BAS.
3. The RTU shall run continuously during occupied modes & morning warm-up modes and shall be allowed to cycle during unoccupied modes as required to maintain the unoccupied mode space temperature setpoint.
4. The BAS shall signal the rooftop unit to be in heating, cooling or ventilation modes as described above and the unit shall react accordingly to achieve the BAS dictated discharge air setpoint.

    a. Discharge air temperature shall be limited to operate between 50 deg f (adj) and 95 deg f (adj).

5. VAV Supply Fan Capacity Control: Control the output of the supply fan as follows:

    a. VSD Control: Whenever the fan is energized, control the speed of the VSD to maintain the supply duct static pressure setpoint. On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits. BAS shall monitor a common alarm output from the drive and enunciate a level 2 alarm when an alarm is indicated.
    b. Supply Duct Static Pressure Setpoint: Setpoint shall be determined using the following strategy:

        1) Reset: from 0.5” w.c. (adj.) to 1.25” w.c. (adj.) to maintain the number of requests for static pressure sent from the FPB boxes at 2 (adj.). A request for static pressure shall be sent from a FPB box to the Parent RTU whenever the primary air damper is open greater than 90%.

6. VAV Relief Fan Capacity Control: Control the output of the exhaust fan as follows:

    a. VSD Control: Whenever the fan is energized, control the speed of the VSD to maintain the building pressure offset (+0.05" wc between the (2) entry vestibules and outdoors, adj.). On start and stop, the VSD shall ramp to speed and slow down within adjustable acceleration and deceleration limits.
    b. During the unoccupied & preoccupancy modes the RTU economizer minimum shall be set to 0 cfm and the exhaust fan shall be off and the exhaust damper shall be closed.

7. Across the unit’s filter bank provide an adjustable pressure switch to energize an alarm at the user interface upon sensing filter pressure drop in excess of 1.0” w.c.

3.4 CABINET UNIT HEATER HOT WATER (BAS-UH-01)

A. General: See Series FPB Hot Water Reheat sequence.

3.5 SERIES FPB HOT WATER REHEAT

A. General: Control shall be pressure independent with minimum and maximum flow setpoints, scheduled occupancy with optimum preoccupancy. Schedule shall be the same as the parent AHU.

B. Space Temperature Control: Three setpoints shall apply. Normal (72°F adj.)), setback heating (65°F (adj.)), and setback cooling (85°F). These three values shall be the only values changed by the operator to adjust space temperatures. All other deadbands, differentials, etc. shall be calculated in the program logic (unless another means is provided to prohibit overlap of the heating and cooling loops and ensure a dead band such as function block templates that restrict the setpoint input). During the normal periods, separate heating and cooling setpoints shall be calculated.

1. Normal space cooling setpoint: shall be the normal space temperature plus 2°F (adj.)
2. Use the following paragraph when the system does have the capability of globally resetting SCU cooling setpoints down during night purge mode to take advantage of free cooling.
3. Normal space heating setpoint: shall be the normal space temperature minus 2°F (adj.)

C. Zone Damper: Zone damper shall modulate to maintain zone volume setpoint. Zone volume setpoint shall be reset between maximum and minimum volume settings to maintain space temperature cooling setpoint with a 2°F (adj.) reset range. Zone volume setpoint go to the heating volume setpoint whenever the space temperature falls below the heating space temperature setpoint.

1. Cooling Minimum Volume setpoint shall be as scheduled on the drawings during the occupied period and shall be set to zero otherwise.
2. Heating Minimum Volume Setpoint: Whenever heating is requested from the box in any period, the minimum volume shall be set to an adjustable heating setpoint airflow.

D. Hydronic Reheat: N.O. Zone reheat coil valve shall modulate in a PI loop to maintain space temperature heating setpoint as defined above with a 2°F throttling range.

E. For spaces that also have a cabinet unit heater, the cabinet unit heater fan shall be activated when the FPB reheat coil valve is commanded open 50% and greater.

F. Fan Cycling: Fan shall be energized and run continuously whenever the parent AHU is energized. During the unoccupied period before preoccupancy, unit shall cycle on below and cycle off at 2°F (adj.) above the setback heating temperature. AHU shall not be requested for night setback heating by fan powered VAV's with reheat.

G. Heating Request: This terminal shall issue a "heating request" as follows"

1. Whenever the reheat output is at 100%, or
2. Whenever the space temperature falls below the throttling range of the heating loop

H. Cooling Request: This terminal shall issue a "cooling request" as follows"

1. Whenever the zone damper output is at 100% (full cooling), or
2. Whenever the space temperature rises above the throttling range of the cooling loop

3.6 STEAM TO HOT WATER HEAT EXCHANGER, VV PUMPS (BAS-BLR-05)

A. **General**: BAS shall control the hot water systems and equipment and provide monitoring and diagnostic information for management purposes.

1. Heating Enable: Heating shall be enabled when:

a. Any hot water valve opens more than 50% continuously for 10 min. (adj.).
b. OR, the OAT is less than 20°F (adj.)
c. OR whenever manually enabled by the operator at the operator interface.
d. Whenever the Heating Water System is started automatically (does not apply to a manual enable) by the BAS, it shall run for a minimum of 1 hour.

2. Heating Disable: Heating shall be disabled [[when:

a. All hot water valves are opens to less than 5% continuously for 10 min. (adj.).
b. AND, the OAT is greater than 25°F (adj.)
c. AND the system has been enabled for at least an 1 hour as stated above.
d. OR whenever manually disabled by the operator at the operator interface.

B. HW Pump Enable

1. One HW pump shall run continuously whenever heating system is enabled.
2. BAS shall prove operation of the pump. Upon failure of the pump, the standby shall be started.
3. BAS shall monitor pump status and accumulate runtime of the pumps. The lead pump shall be rotated to equalize runtime between the pumps.

C. Pump Speed Control

1. Required total system flow rate shall be determined by summing the flow rates through all of the associated heating terminal Pressure Independent Control Valves plus the design flow rates through the associated heating terminal wild coils.
2. BAS shall vary the speed of the enabled pump to achieve the required system total flow rate.
3. The speed of the pump shall be modulated from 0-100% as the PID loop output varies from 0-100%. However, the speed of the pump shall never fall below the minimum speed of the drive (initially 20%.). Heating terminal with wild coils shall provide the minimum flow.

D. Heating Water Supply Temperature Setpoint: The BAS shall reset the hot water supply temperature setpoint from 150°F (adj.) to 100°F (adj.) as the OA temperature rises from 10°F (adj.) to 50°F (adj.) requests via a signal to the heat exchanger steam control valves.

E. Heating Water Supply Temperature Control:

1. The BAS shall modulate the 1/3 and 2/3 steam valves to the Heat Exchanger in series via PID loop to maintain the HW supply temperature setpoint.
2. The valves shall remain closed until pump status is proven.
3. Steam supply temperature and pressure to the Heat Exchanger shall be monitored by the BAS

3.7 FANS (BAS-EF-01)

A. Exhaust fans E-34 (Pool Equipment Room): shall run continuously with its speed set at a local wall mounted controller. Whenever the fan runs, its associated EA damper shall open and when the fan stops the EA damper will close.

B. Exhaust fans E-35 (Electric Room): shall be controlled by a thermostat to maintain a maximum of 85°F. Whenever the fan runs, its associated EA damper shall open and when the fan stops the EA damper will close.

C. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime for all new exhaust fans. Upon failure of the exhaust fan, the BAS shall enunciate an alarm as specified above.

3.8 GLYCOL FILL SYSTEM

A. Glycol Fill pump will be controlled by its own package system.

B. Provide a separate ball float to monitor the low level of the tank through the BAS. The low level monitored by the BAS will be above the low level permissive for the gycol pump.

END OF SECTION

SECTION 23 09 26 (MEP)

BUILDING AUTOMATION SYSTEM (BAS) - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Air Handling Units.
2. Mechanical systems with automatic control.

1.2 SYSTEM DESCRIPTION

A. Refer to Division 23 Section "Building Automation System (BAS)" for a description of the systems to be controlled.

B. This Section defines the manner and method by which controls function.

1.3 SUBMITTALS

A. Refer to Division 23 Section "Building Automation System (BAS)" and Division 01 Sections for requirements for control shop drawings, product data, Users Manual, etc.

B. Programming Manual: Provide DDC system programming manual as well as documentation of site specific programming prior to the start of Acceptance Phase.

1.4 PROJECT RECORD DOCUMENTS

A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual setpoints and tuning parameters as existed at acceptance.

B. Record documents shall be modified control drawings with the actual installed information. Drawings shall be delivered in both reproducible hard copy and electronic format in AutoCAD v13 or later. Provide all supporting files, blocks, fonts, etc. required by the drawings.

C. Provide final points list

D. Provide final detailed wiring diagrams with all wire numbers and termination points indicated

E. Accurately record final sequences and control logic made after submission of shop drawings.

1.5 DEFINITIONS/ABBREVIATIONS

A. Absolute Minimum OA: Minimum flow rate setpoint to which the OA or primary air may throttle down. This value is acceptable as long as CO_2 levels are within acceptable limits.

B. AHU: Air Handling Unit

C. CHW: Chilled Water

D. CHWS: Chilled Water Supply

E. CHWR: Chilled Water Return

F. DDC: Direct Digital Control

G. Design Minimum OA: Minimum flow rate setpoint based on code requirements or designed system and coil capacities.

H. BAS: Building Automation System

I. MVR: Minimum required ventilation rate

J. OA: Outdoor Air

K. CHW: chilled water

L. HW: heating water

M. Physical Point: A point on the BAS that is physically connected to an I/O device such that a hardware point exists

N. Virtual Point: A point to store values (i.e.: a setpoint) that do not represent a physical device

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.

B. When an air handling unit is not in operation, control devices shall remain in their “off” positions. “Off” positions may differ from the “normal” (meaning failed) position. Except as specified otherwise, “off” and “normal” positions of control devices shall be as follows:

Device	“Off” Position	“Normal” Position
Heating coil valves	closed/ controlling	open
Cooling coil valves	Closed	closed
Outside air damper	Closed	closed
Return air damper	Open	open
Exhaust/relief air damper	Closed	closed
Var. Freq. Drive	Off	Min. Speed

C. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified

"proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.

D. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:

1. Occupied Period: period of time when the building is in use and occupied. Generally systems will be fully operational throughout this period and ventilation air shall be continuously introduced. Space temperature setpoints will generally be in the "normal" range of 69°-76°F.
2. Unoccupied period: period of time when the building or zone is not in use and unoccupied. Ventilation air shall not be introduced.
3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to "normal" or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling. Time period shall be determined by an optimum start strategy unless otherwise specified.
4. Setback Period: Setback start will typically coincide with the end of the occupied period and end with the start of the preoccupacy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a "setback" temperature.

E. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.

F. Alarm messages specified throughout the sequences are assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports.

G. All setpoints shall be adjustable (adj.), they shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

H. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:

1. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
3. [Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.]

I. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. space temperature) setpoint. The reset increment shall be determined by the quantity of “need heat” or “need cool” requests from individual terminal units. A terminal unit’s “need heat” virtual point shall activate whenever the zone’s space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A terminal unit’s “need cool” virtual point shall activate whenever the zone’s space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.

J. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. The BAS analog output value shall be acceptable as indicating the position of the control device.
2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point shall increment by one unit each time a zone’s valve/damper position rises to greater than 95%. The quantity of “need heat” or “need cool” points shall then be the basis for reset.

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4. Travel rate of tower isolation and chiller isolation valves

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N. Some sequences rely on integration with third-party manufacturer control equipment. See the control equipment specifications, equipment schedules and equipment specifications for more information on this integration.

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A. Logic Strategies: The BAS shall fully control the air handlers. Generally, the BAS shall energize the AH (start the fans and activate control loops) as dictated for each air handler. The following indicates when and how the BAS shall energize the AHs and control various common aspects of them. The following “logic strategies” shall be included by reference with each air handler with any specific clarifications required:

1. Scheduled Occupancy: BAS shall determine the occupancy periods (occupied, unoccupied, preoccupancy, and setback) as defined above. The following details the common control aspects related to the scheduled occupancy.

    a. Occupied Period: BAS shall energize the AHU during all occupied periods.
    b. Setback Period: the BAS shall deenergize the unit except as required to maintain a setback temperature of 55°F with a 5°F cycle differential. Generally, where setback temperatures apply in multiple zones, the worst zone shall control the system. Setback setpoints generally apply except during preoccupancy and night purge. If, during the unoccupied period, there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.
    c. Preoccupancy: BAS shall energize the AHU continuously during the preoccupancy period. Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. “Normal” setpoints shall apply. Preoccupancy duration shall be one of the following as specified by reference:

        1) Fixed: The duration of the preoccupancy period shall be fixed as scheduled by the operator.
        2) Optimum: The duration of the morning warm-up period shall vary according to outside air temperature and space temperature such that the space temperature rises to occupied period heating setpoint at the beginning of, but not before, the scheduled occupied period. The duration of the cool-down period shall vary according to outside air temperature and space temperature such that the space temperature falls to the occupied period cooling setpoint at the beginning of, but not before, the scheduled occupied period

2. Occupancy override. Space temperature sensors in normally occupied spaces (classrooms, offices, multipurpose, etc.) shall include occupancy override buttons. Upon activation of the occupancy override button when the system is not scheduled to be in the Occupied Period, the system shall revert to the Occupied Mode for a period of 2 hours (adjustable).
3. Night Purge Cycle: The night purge cycle shall be allowed only when manually enabled via a graphic icon. Night purge cycle shall start and stop as listed below during the unoccupied mode to maintain the zone(s) at setpoint using OA only (economizer) for cooling. Mechanical cooling and heating shall be disabled during the night purge mode.

    a. Night Purge Cycle Start: While the mode is enabled and during the unoccupied period, the BAS shall initiate the night purge cycle when:

        1) The OA temperature falls to 10°F (adj.) below the space temperature(s) (highest space temperature served by the AHU if not a single zone unit)
        2) And any (or an adjustable minimum number of) space temperature(s) is at least 5°F (adj.) above its normal occupied cooling setpoint

3) And all space temperatures (served by the AHU if not a single zone unit) are greater than their occupied heating setpoint
4) And outdoor air temperature is below 60°F (adj.).

b. Night Purge Cycle Stop: BAS shall disable the mode and deenergize AHU when:

1) The space temperature (highest space temperature for AHUs served by the AHU if not a single zone unit) falls to within 5°F (adj.) of OA temperature
2) Or any space temperature(s) fall(s) below its occupied heating setpoint.
3) Or all space temperatures fall below their occupied cooling setpoint.
4) Or the outdoor air temperature rises above the night cycle setpoint (60˚F [adj.]) by 5°F.

4. Sequenced Heating and Cooling: BAS shall control the heating and cooling coils and air side economizer detailed for the particular AH. Program logic shall directly prohibit the heating and cooling valves (or DX cooling) as well as the heating valve and economizer damper to be open (or above minimum) simultaneously. This does not apply to cooling and reheat valves that are used simultaneously for dehumidification.

B. Safeties

1. Freeze Safety: Upon operation of a freezestat, unit shall be deenergized with the exception of the heating loops. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock[and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms]. OA dampers shall close and heating loops shall remain active.
2. Software Low-Limit Safety: Upon detection by the BAS of a unit supply temperature below a low limit setpoint (40°F unless specifically stated otherwise), unit shall be deenergized with the exception of the heating loops. BAS shall enunciate appropriate alarm and remove and lock out the start command]]. OA dampers shall close and heating loops shall remain active. Once disabled, unit shall require a manual reset via the Operator Interface before it is allowed to restart.
3. Smoke Safety: Upon indication of smoke by a duct smoke detector the unit will shut down via hard-wired interlock and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms]. OA dampers shall close and heating loops shall remain active.
4. High or Low Pressure Safety: In VAV systems, upon activation of a high or low pressure safety switch, AHU shall be deenergized, fans shall be deenergized via a hard wired interlock[, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms].
5. The detailed “Safety logic strategies” above shall be required by reference to them in each of the individual sequences specified below.

C. Diagnostics

1. Diagnostic Strategies: In addition to the standard alarm limits specified for all sensed variables the BAS monitor and diagnose anomalies in the operation of the air handlers. The following “diagnostic strategies” shall be included by reference with each air handler with any specific clarifications required:

a. Run Time Limit: BAS shall accumulate the runtime of the status of associated rotating equipment and enunciate a level 5 alarm to indicate that the unit is in need of service.

b. DP Switch Filter Monitoring: BAS shall monitor the differential pressure switch across the filter bank(s). An alarm shall be reported when pressure drop exceeds the switch's setting.
c. DP Transmitter Filter Monitoring: BAS shall monitor the differential pressure across the filter bank(s). An alarm shall be reported when pressure drop exceeds the alarm setting.

2. System Condition Alarming: BAS shall monitor the following parameters and enunciate an alarm under any of the following conditions in addition to other monitor and alarm functions specified above. These may not be specifically referenced in the individual sequences, but shall be provided wherever applicable.

a. Enunciate a Level 2 alarm when any active (air flowing) discharge temperature goes above or below its setpoint plus ±8°F (adj.) for 15 min. continuously as follows:

1) Sensor XXX is indicating that the discharge temperature is outside of acceptable limits.

b. Enunciate a Level 2 alarm when any active (air flowing) heating duct or heating coil leaving temperature falls below its setpoint minus 8°F (adj.) for 15 min. continuously as follows:

1) Sensor XXX is indicating that the heating air temperature is below acceptable limits.

c. Enunciate a Level 2 alarm when any active (air flowing) cooling duct or cooling coil leaving temperature exceeds setpoint plus 8°F (adj.) for 5 min. continuously as follows:

1) Sensor XXX is indicating that the cooling air temperature is above acceptable limits.

d. During the occupied period, enunciate a Level 2 alarm when any space temperature exceeds its active cooling setpoint plus 5°F (adj.) for 15 min. or falls below its active heating setpoint minus 5°F (adj.) for 15 min. continuously.

1) Zone XXX appears to be outside of acceptable limits.

e. Enunciate a Level 2 alarm when any active (air flowing) CO_2 reading rises above 1,200 PPM for 10 min. continuously as follows:

1) Sensor XXX is indicating that the CO_2 levels are above acceptable limits.

3.3 MULTIZONE PACKAGE UNIT AHU-9 (BAS-MZ-06)

A. General: The air handler shall be fully controlled by the BAS. For details on the referenced logic strategies refer to item 3.2 Air Handling Units General: Logic Strategies. Air handler control logic strategies shall include Air handler control logic strategies shall include:

1. scheduled occupancy with optimum preoccupancy
2. night purge

B. Supply/ Return Fan Enable: BAS shall control the supply fan as follows:

1. Start/Stop: BAS shall command the operation of the fan and it shall run continuously in occupied and night purge modes.] Unit shall cycle on as needed during the night setback mode.
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the fan, the BAS shall enunciate an alarm as specified above.

C. Space Temperature Control: The space temperatures shall be controlled via individual zone dampers as specified below. The setback setpoint for cycling the unit shall be 60°F (adj.) for heating based on the worst zone. Ensure that these setpoints are outside the control range of all box control loops.

D. Steam Preheating Section (AHU-9 only): When the AHU is enabled, the BAS shall modulate the steam preheat valve via a PID loop to maintain the unit cold deck discharge temperature setpoint - 3°F (adj.).

E. Cold Deck Discharge Temperature Setpoint:

1. Whenever the AH is energized in the occupied mode, the supply air temperature setpoint shall be reset between the range of 55°F to 65°F as follows:

    a. The initial setpoint shall be 55°F.
    b. This setpoint shall be reset up slowly to a maximum of 65°F if all zone dampers are less than 60% (adj.) open to the cold deck.
    c. This setpoint shall be reset down slowly to a minimum of 55°F if any zone damper is more than 85% (adj.) open to the cold deck.

2. During the occupied mode only and when the outside air temperature is less than 65°F (adj.), the cold deck temperature setpoint shall reset down from 65°F to 55°F to maintain the return air humidity at 50% (adj.). The BAS shall use the lower of the setpoint calculated here for dehumidification and the setpoint calculated above for cooling. The dehumidification mode shall not be active during any unoccupied mode or when the unit is not enabled.

    a. AHU-9 includes zone dehumidification. A reading of 65% (adj) at any zone exhaust humidistat shall also reset cold deck temperature following the sequence described for return air humidity indicated above.

3. Whenever the AH is energized in the night setback mode, the cold deck cooling control shall be disabled.
4. Whenever the AH is energized in the night-purge mode, the cold deck temperature setpoint shall be 55°F. This setpoint shall be used for control of the economizer only during the night-purge mode. The cold deck condensing unit shall remain off during the night purge mode.

F. Return/Exhaust/OA Dampers: BAS shall control the dampers as follows:

1. Closed: When AH is deenergized, dampers shall remain in their “off” positions. When the unit is energized during the unoccupied period, the minimum damper position/ flow rate shall be 0% / 0cfm.
2. Minimum OA Flow Control (constant): During the occupied period, the Return and Exhaust air dampers shall modulate via PID loop to maintain the scheduled minimum OA flow at setpoint as follows:

    a. On a decrease in OA flow below setpoint, the relief air damper shall modulate open as the return air damper modulates closed.

b. On an increase in OA flow above setpoint, the relief air damper shall modulate closed as the return air damper modulates open.
c. Measured: The OA flow shall be measured directly by an OA flow station

3. Airside Economizer: BAS shall modulate the mixing dampers to provide “free cooling” when conditions merit. The free cooling shall generally be staged before any mechanical cooling. While conditions merit, dampers shall be modulated in a PID loop to maintain the mixed air temperature at its setpoint. The mixed air temperature setpoint shall be equal to the cold deck temperature setpoint - 1°F (adj.). Economizer logic shall remain enabled during night purge where applicable. Economizer mode shall be active while the unit is energized AND outside air temperature falls below the switching setpoint of 70°F (adj.) (with 5°F cycle differential). Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

G. Cold Deck Cooling Control:

1. When the AHU is enabled, the BAS shall send the applicable supply air temperature reset signal to the condensing unit and the condensing unit internal controls shall stage compressors and modulate the hot gas bypass control as required to maintain the cold deck temperature setpoint.
2. The cold deck mechanical cooling shall remain off if the economizer is enabled and the dampers are not 100% open.
3. Whenever the AH is energized in the night-purge mode, the cold deck mechanical cooling shall be disabled.
4. Whenever the AH is energized in the night setback mode, the cold deck mechanical cooling shall be disabled.

H. Hot Deck Setpoint

1. Whenever the AH is energized in the occupied mode, the hot deck discharge temperature setpoint shall be reset independently between the range of 75°F to 110°F as follows:

a. The initial setpoint shall be 75°F.
b. This setpoint shall be reset up slowly to a maximum of 110°F if any zone damper is more than 85% (adj.) open to the hot deck.
c. This setpoint shall be reset down slowly to a minimum of 75°F if all zone dampers are less than 60% (adj.) open to the hot deck.

2. Whenever the AH is energized in the night setback mode, the hot deck discharge temperature setpoint shall be a 110°F.

I. Hot Deck Valve Control:

1. Whenever AH is energized, the steam valves shall modulate via a PID loop to maintain the hot deck temperature at setpoint.
2. Whenever the AH is energized in the night-purge mode, the hot deck valve control shall be disabled.

J. Zone Damper Control:

1. The BAS shall modulate the zone damper via a PID loop to maintain the space heating setpoint as follows:

a. On an increase in space temperature above setpoint, the zone damper shall modulate open to the cold deck and closed to the hot deck.
b. On a decrease in space temperature below setpoint, the zone damper shall modulate open to the hot deck and closed to the cold deck.
c. AHU-9 Zone Humidity Control: Upon sensing of humidity levels greater than 50% (adj.) in the zone return air duct or 65% (adj.) in the zone exhaust duct the zone damper shall modulate open to cold deck and closed to the hot deck, and upon proof of airflow the associated electric reheat shall be modulated to maintain the space temperature setpoint.

1) Each zone is to include a single corresponding duct humidistat except for Zone 9-5 that includes two exhaust duct humidistats. For Zone 9-5, the higher of the two humidistat readings shall control. The dehumidification mode shall not be active during any unoccupied mode or when the unit is not enabled.
2) The zone reheats shall also be available as a second stage of heat at any time that the hot deck supply air temperature is unable to maintain the space temperature setpoint.

2. During the night purge mode, the damper shall remain 100% open to the bypass deck

K. Safeties: BAS shall execute the following safety logic strategies as detailed in item 3.2 Air Handling Units General: Safeties. Safety Logic strategies shall include:

1. Freeze Safety
2. Software Low Limit Safety
3. Smoke Safety

L. Diagnostics: BAS shall execute the following diagnostic strategies as detailed in item 3.2 Air Handling Units General: Diagnostics. Diagnostic Logic strategies shall include:

1. Run Time Limit
2. DP Transmitter Filter Monitoring

3.4 MULTIZONE PACKAGE UNIT AHU-10 AND AHU-11 (BAS-MZ-06 MODIFIED)

A. General: The air handler shall be fully controlled by the BAS. For details on the referenced logic strategies refer to item 3.2 Air Handling Units General: Logic Strategies. Air handler control logic strategies shall include Air handler control logic strategies shall include:

1. scheduled occupancy with optimum preoccupancy
2. night purge

B. Supply/ Return Fan Enable: BAS shall control the supply fan as follows:

1. Start/Stop: BAS shall command the operation of the fan and it shall run continuously in occupied and night purge modes.] Unit shall cycle on as needed during the night setback mode.
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the fan, the BAS shall enunciate an alarm as specified above.

C. Space Temperature Control: The space temperatures shall be controlled via individual zone dampers and fan speed as specified below. The setback setpoint for cycling the unit shall be 60°F (adj.) for heating based on the worst zone. Ensure that these setpoints are outside the control range of all box control loops.

D. Cold Deck Discharge Temperature Setpoint:

1. Whenever the AH is energized in the occupied mode, the supply air temperature setpoint shall be reset between the range of 57°F (adj) to 65°F (adj) as follows:

    a. The initial setpoint shall be 57°F.
    b. This setpoint shall be reset up slowly to a maximum of 65°F if all zone dampers are less than 60% (adj.) open to the cold deck.
    c. This setpoint shall be reset down slowly to a minimum of 57°F if any zone damper is more than 85% (adj.) open to the cold deck.

2. During the occupied mode only and when the outside air temperature is less than 65°F (adj.), the cold deck temperature setpoint shall reset down from 65°F to 57°F to maintain the return air humidity at 50% (adj.). The BAS shall use the lower of the setpoint calculated here for dehumidification and the setpoint calculated above for cooling. The dehumidification mode shall not be active during any unoccupied mode or when the unit is not enabled.
3. Whenever the AH is energized in the night setback mode, the cold deck cooling control shall be disabled.
4. Whenever the AH is energized in the night-purge mode, the cold deck temperature setpoint shall be 55°F. This setpoint shall be used for control of the economizer only during the night-purge mode. The cold deck condensing unit shall remain off during the night purge mode.

E. Return/Exhaust/OA Dampers: BAS shall control the dampers as follows:

1. Closed: When AH is deenergized, dampers shall remain in their “off” positions. When the unit is energized during the unoccupied period, the minimum damper position/ flow rate shall be 0% / 0cfm.
2. Minimum Damper Position (reset): During the occupied period, the minimum position of the economizer dampers shall be reset between absolute minimum (AHU-10 absolute minim = 540 cfm, AHU-11 absolute minimum = 1000 cfm) and design minimum so as to maintain return air CO_2 below a setpoint of 1000ppm (adj.) as follows:

    a. During the occupied period, the economizer dampers shall never be positioned less than the position set for the required absolute minimum OA ventilation rate.
    b. On an increase in return air CO_2 above setpoint, the minimum position shall be reset up to the position set for the design minimum OA ventilation rate via a PID loop output. On a decrease in return air CO_2, the minimum position shall be reset back down to absolute minimum.
    c. Measured: The OA flow shall be measured directly by an OA flow station associated with the AHU.
    d. A graphical button on the BAS shall allow the user to enable / disable active demand control ventilation (minimum damper reset) and the design minimum OA shall remain in effect.

3. Airside Economizer: BAS shall modulate the mixing dampers to provide “free cooling” when conditions merit. The free cooling shall generally be staged before any mechanical cooling. While conditions merit, dampers shall be modulated in a PID loop to maintain the mixed air temperature at its setpoint. The mixed air temperature setpoint shall be equal to the cold deck temperature setpoint - 1°F (adj.). Economizer logic shall remain enabled during night purge where applicable. Economizer mode shall be active while the unit is energized AND outside air temperature falls below the switching setpoint of 70°F (adj.) (with 5°F cycle differential). Economizer mode shall be inactive when outside air

temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

F. Cold Deck Cooling Control:

1. When the AHU is enabled, the BAS shall send the applicable supply air temperature reset signal to the condensing unit and the condensing unit internal controls shall stage compressors and modulate the hot gas bypass control as required to maintain the cold deck temperature setpoint.
2. The cold deck mechanical cooling shall remain off if the economizer is enabled and the dampers are not 100% open.
3. Whenever the AH is energized in the night-purge mode, the cold deck mechanical cooling shall be disabled.
4. Whenever the AH is energized in the night setback mode, the cold deck mechanical cooling shall be disabled.

G. Hot Deck Setpoint

1. Whenever the AH is energized in the occupied mode, the hot deck discharge temperature setpoint shall be reset independently between the range of 75°F to 110°F as follows:

    a. The initial setpoint shall be 75°F.
    b. This setpoint shall be reset up slowly to a maximum of 110°F if any zone damper is more than 85% (adj.) open to the hot deck.
    c. This setpoint shall be reset down slowly to a minimum of 75°F if all zone dampers are less than 60% (adj.) open to the hot deck.

2. Whenever the AH is energized in the night setback mode, the hot deck discharge temperature setpoint shall be a 110°F.

H. Hot Deck Valve Control:

1. Whenever AH is energized, the steam valves shall modulate via a PID loop to maintain the hot deck temperature at setpoint.
2. Whenever the AH is energized in the night-purge mode, the hot deck valve control shall be disabled.

I. Zone Damper Control:

1. The BAS shall modulate the zone damper via a PID loop to maintain the space heating setpoint as follows:

    a. On an increase in space temperature above setpoint, the zone damper shall modulate open to the cold deck and closed to the hot deck.
    b. On a decrease in space temperature below setpoint, the zone damper shall modulate open to the hot deck and closed to the cold deck.

2. In addition to zone damper control, the system fan speeds shall be modulated based on the zone the zone damper positions. Supply fan shall modulate through the minimum and maximum speed (airflow) range setpoint to maintain the space temperature (described below). Speed adjustment shall be slow action to avoid hunting of variable frequency drives.

a. Deadband: When the space temperature heating & cooling setpoints are satisfied the AHU controls shall revert to ventilation only mode. The zone dampers shall be positioned to provide neutral air to the space with the fan operating at a minimum airflow (50%, adj.). Neutral air shall be defined as a supply air within + / - 2°F (adj) of the room setpoint as measured by the zone discharge air sensor. At such time that the zone damper is postioned to provide neutral air, that zone shall be considered to have it's setpoint satisfied.
b. If a zone space temperature starts to drift beyond its heating or cooling setpoint the associated zone damper shall modulate open to the appropriate deck. Hot and cold deck temperatures shall remain controlled to their setpoints. At such time that the any zone damper postions to 90% open to the hot or cold deck, the fan speed shall be gradually increased so as to increase the heating or cooling airflow to the spaces. The fan speed shall be controlled via a PID loop to maintain a maximum 90% damper position (hot or cold deck) in all zones. Maximum fan speed shall be limitted to that required to achieve the system design airflow. When the fans speed reaches it's maximum, zone dampers shall continue to open beyond 90% as required to maintain the space temperature setpoint. As all zone damper positions drop below 90% open to the hot or cold deck, the reverse shall occur until the unit returns to Deadband mode.

3. During the night purge mode, the damper shall remain 100% open to the bypass deck

J. Safeties: BAS shall execute the following safety logic strategies as detailed in item 3.2 Air Handling Units General: Safeties. Safety Logic strategies shall include:

1. Freeze Safety
2. Software Low Limit Safety
3. Smoke Safety

K. Diagnostics: BAS shall execute the following diagnostic strategies as detailed in item 3.2 Air Handling Units General: Diagnostics. Diagnostic Logic strategies shall include:

1. Run Time Limit
2. DP Transmitter Filter Monitoring

3.5 EXHAUST FANS (BAS-EF-01)

A. Locker Room Exhaust fan E-36: BAS shall control the starting and stopping of these fans as follows.

1. Start/Stop: BAS shall command the operation of the Exhaust fan and it shall run continuously during the occupied period. Whenever the fan runs, its associated exhaust damper shall open. Whenever the fan stops, the damper shall close.
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the exhaust fan, the BAS shall enunciate an alarm as specified above.

B. Electric Room Exhaust fan E-35: shall be controlled by a thermostat to maintain a maximum of 85°F. Whenever the fan runs, its associated exhaust damper shall open and when the fan stops the exhaust damper will close.

1. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the exhaust fan, the BAS shall enunciate an alarm as specified above.

END OF SECTION

SECTION 23 09 27 (LNK)

BUILDING AUTOMATION SYSTEM (BAS) – COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning of the Building Automation System (BAS).

1.2 GENERAL DESCRIPTION

A. Section defines responsibilities of the Controls Contractor to commission the BAS.

B. Chicago Public Schools (CPS), at CPS expense, shall retain a Commissioning Authority (CA) who shall work with the Contractor to ensure that the systems, equipment, and interfaces are installed, tested, and operate in accordance with the design intent; that the systems are adequately documented; and that CPS is adequately trained on system intent, operation, and maintenance.

C. The BAS contractor will provide support the commissioning authority in the form of information, both written and verbal, concerning the installation and operation of the control system.

D. The BAS contractor shall allow time and allocate resources to conduct their own testing including; Point-to-Point Testing, Prefunctional Performances Testing, Functional Performance Testing and finally Demonstration Testing, to the Owner's designated personnel and Commissioning Agent, the operation of all sequences of operation and other control system functions described in this specification, its attachments or drawing references. The tests are intended to provide documentation that all aspects of the temperature control system have been properly installed to meet the design intent of the Owner. The contractor performs all testing, documents all the testing, and submits the documentation prior to approval for conducting Demonstration Testing to the Owner.

E. Air and water balancing shall be completed, and discrepancies resolved prior to conducting Demonstration Testing. Controls contractor will coordinate with the Testing & Balancing Contractor if their support is required for the demonstration. The completed testing forms shall be presented to the Owner's representative upon completion of each commissioning step.

1.3 CONTRACTOR RESPONSIBILITIES

A. Perform all testing. This will generally include the following:

1. Attend Commissioning (Cx) progress and coordination meetings.
2. Prepare and submit required draft forms and systems information as required by specification.
3. Establish trend logs and graphs of system operation as specified herein.
4. Demonstrate system operation.
5. Manipulate systems and equipment to facilitate testing.
6. Provide instrumentation necessary for verification and performance testing.
7. Manipulate control systems to facilitate verification and demonstration testing.
8. Train CPS Representatives as specified in PART 3 of this Section.

B. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of 4 hours Refer to PART 3 for a description of the software optimization.

C. Compensation for Retesting: Contractor shall compensate CPS for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-site time for retesting, will be considered actual damages to the CPS. All parties under contract with the CPS who are affected by the retesting shall be included in the contract modification.

1.4 GENERAL MILESTONES – TEMPERATURE CONTROL WORK

A. The following list outlines the general sequence of events for Temperature Controls commissioning throughout the project:

1. Submittals:

a. Submit product data, including manufacturers' installation and startup procedures, and shop drawings, and receive approval.
b. Submit BAS logic documentation, and receive approval.
c. Submit sample testing forms, and receive approval.
d. Submit O&M Manuals.
e. Submit Training Plan with schedule for approval.
f. Submit "The Testing Plan" for review and receive approval.
g. Submit "CPS BAS Verification Form" (See Attachment at the Section) – This is to be submitted prior CX BAS demonstration testing and training.

2. Construction:

a. Begin system installation.
b. Conduct Point-to-Point Testing.
c. Conduct Prefunctional Performance Testing.
d. Work with TAB contractor to complete checking of systems.
e. Conduct Functional Performance Testing.
f. Initiate trend logs.
g. Compile all testing documentation for submission to the Commissioning authority for approval.
h. Conduct Demonstration testing.

3. Acceptance Period:

a. Begin Training.
b. Submit final As-built documentation.
c. Schedule Opposite season testing.
d. Complete training.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

2.2 TAB & COMMISSIONING – PORTABLE OPERATORS TERMINAL

A. Contractor shall provide a portable operators terminal or hand-held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up.

B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box.

PART 3 - EXECUTION

3.1 BAS START-UP, TESTING, ADJUSTING, AND CALIBRATION

A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Verify that all devices were installed in accordance with the manufacturer's written installation instructions.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB subcontractor, and CxA to obtain and fine-tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:

    a. Optimum duct static pressure setpoints for VAV air handling units.
    b. Minimum outside air damper settings for air handling units.
    c. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.

        1) BAS contractor shall provide hand-held device as a minimum to the TAB to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.

5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start Up Report.
6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:

    a. Check for adequate installation including free travel throughout range and adequate seal.
    b. Where loops are sequenced, check for proper control without overlap.

8. For Actuators:

a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.
b. Check for appropriate fail position, and that the stroke and range is as required.
c. For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate in accordance with manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.
d. For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges.

9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
10. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

    a. Duct Air Temperature: ±1 deg F.
    b. Space Temperature: ±2 deg F.
    c. Hot Water Temperature: ±3 deg F.
    d. Duct Pressure: ± 0.25-inches w.g.
    e. Water Pressure: ±1 psid.
    f. Duct or Space Humidity: ±5%.
    g. Air Flow Control: ±5% of setpoint velocity.
    h. Space Pressurization (on active control systems): ±0.05-inches w.g. with no door or window movements.

14. Interface and DDC Control Panels:

    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
    c. Check power supplies for proper voltage ranges and loading.
    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
    e. Check for adequate signal strength on communication networks.
    f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
    g. Ensure that all outputs and devices fail to their proper positions/states.
    h. Ensure that buffered and/or volatile information is held through power outage.

i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
j. Check for adequate grounding of all DDC panels and devices.

15. For Operator Interfaces:

a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
b. Output all specified BAS reports for review and approval.
c. Verify that the alarm, printing, and logging are functional and in accordance with requirements.
d. Verify that trends are archiving to disk and provide a sample to the Commissioning Authority for review.
e. Verify that paging/dial-out alarm annunciation is functional.
f. Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
g. Verify that required third party software applications required with the bid are installed and are functional.

16. Start-up and check out control air compressors, air drying, and filtering systems in accordance with the appropriate Section and with manufacturer's instructions.
17. Verify proper interface with fire alarm system.

B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Preliminary Acceptance or Substantial Completion.

3.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 deg F of each other for temperature and within a tolerance equal to ±2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors Without Transmitters – Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
2. Sensors With Transmitters – Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Division 23 Section, "Building Automation System (BAS) - Basic Materials, Interface Devices, and Sensors."

3.3 COIL VALVE LEAK CHECK

A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5 deg F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3 deg F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.4 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.5 BAS DEMONSTRATION

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and CPS. Schedule the demonstration with the CPS representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration, Contractor shall reimburse CPS for costs of subsequent Commissioning Authority site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments and ladders. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the CPS.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

4. Demonstrate proper installation and functionality of the entire control system. The contractor shall successfully demonstrate using similar techniques used in conducting their own testing the following:

    a. Point-to-Point Testing: A maximum of 10% of all points will be demonstrated to the commissioning authority. Testing. The commissioning authority will randomly select points to be tested.
    b. Prefunctional performance testing: A maximum of 10% of the Prefunctional Checkout Testing will be demonstrated to the commissioning authority. The commissioning authority will randomly select points to be tested.
    c. Functional Performance Testing: A Maximum of 10% of each of the systems: AHU's, VAV, Unit Ventilators, chillers, boilers, etc shall be tested for proper functional performance. Each selected system shall successfully demonstrate all modes of operation as specified in the sequence of operations. The commissioning authority will randomly select which pieces of equipment will be tested.

5. Upon failure of any device or system to meet the specified end-to-end accuracy, an additional 10 percent of those tests shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected point and sequences have been demonstrated to meet specified end-to-end accuracy.
6. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
7. Demonstrate that all DDC programs accomplish the specified sequences of operation.
8. Demonstrate that commands can be initiated through the operator's workstation.
9. Demonstrate that the panels automatically recover from power failures, as specified.
10. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements specified.
11. Identify access to equipment. Demonstrate that access is sufficient to perform required maintenance.
12. Demonstrate that required trend graphs and trend logs are set up in accordance with the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Preliminary Acceptance or Substantial Completion.

F. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

3.6 TREND LOGS

A. Contractor shall configure and analyze all trends required under Division 23 Section "Building Automation System (BAS) - Software and Programming."

3.7 TREND GRAPHS

A. Trend graphs as specified in Division 23 Section "Building Automation System (BAS) - Software and Programming" shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.

B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.8 Warranty Phase BAS OPPOSITE SEASON Trending and Testing:

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the Commissioning Authority/CPS for review upon Commissioning Authority/CPS request. Commissioning Authority/CPS will review these and notify contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Work, Commissioning Authority/CPS shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

3.9 BAS OPERATOR TRAINING AND O&M MANUALS

A. Training Sessions: Training sessions will be in increments of 4 hours with a maximum of one session with in a 48 hour period. Owner's designated personal will coordinate the training sessions. Training cannot be scheduled until the "CPS BAS Verification Form" is completed and approved.

B. Attendees: The training shall be provided to the Owner's designated personnel.

C. Intent: The intent of the training sessions is to clearly and completely instruct the Owner's personnel on all of the functions of the system, with a particular focus on operation of, and troubleshooting capabilities of, the control system.

1. The BAS contractor shall provide a training plan or syllabus for each four-hour session and the entire plan must be submitted and accepted by the commissioning agent prior to the beginning of training. In addition to the syllabus the contractor shall assemble a training manual for use during the training. This manual shall contain all the information used during the training session. The manual shall contain the following:

    a. TRAINING PLAN: The training plan shall be structured as follows:

        1) Format shall be an outline broken up into four-hour sessions. There is no training plan for the Opposite Season training.
        2) The material to be covered shall then be further sub-divided into descriptions of the material to be covered every 15 minutes.
        3) The descriptions shall include not only the material to be covered but also its location in the Training Manual including section and page number.

    b. TRAINING MANUAL: Refer to Division 23 Section, "Building Automation System (BAS)."

2. Training Performance: During any training session, should the BAS fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated. If during any training session, the trainer debugs more than three (3) items or for longer than 20 minutes total, the training session shall be terminated, and the contractor shall not be credited for training that day. The session shall be rescheduled for another date. The re-scheduled training session shall be carried out for the full four hours at no additional cost to the Owner.
3. Documentation of training: After each four-hour session the engineer shall initial and date the items on the test plan that were covered that day. A copy of the documentation shall be maintained in the engineers Training Manual and the contractor shall keep a copy.

Follow the requirements of Division 1 for documenting the training. Training will not be complete until the associated documentation from is submitted to the Owner's Representative.

Attachment 1: CPS BAS Verification Form
Submittal Checklist: Verification of readiness for BAS Demonstration Testing

In accordance with BAS Specification 23 09 20 the contractor is required to complete and confirm completion of the following prior to scheduling demonstration testing. The contractor has completed all required testing of the BAS and has verified that the BAS performs as required in the contract documents. This includes:

Yes	No	Description	Mechanical	TeleCom	Electrical
		Air and water balancing has been completed and discrepancies resolved prior to conducting Demonstration Testing.			
		The contractor will incorporated values from the approved TAB report into the BAS including duct static pressure set points for VAV air handling units, minimum outside air damper settings for air handling units and optimum differential pressure set points for variable speed pumping systems.			
		Record calibration parameters for flow control devices such as VAV boxes and flow measuring stations.			
		Verify all safety devices trip and cause required system response.			
		Verification of operator work station functions including trending and archiving of all points, web server on line, point override capability and alarms are in place, graphics have been provided to AOR/CxA for reviewed and all comments resolved, and all point and graphic binding has been verified. Webserver IP address, login and password for CxA have been provided and are operating properly. This includes displaying all trends. All systems controlled by the BAS have been verified to operate per the BAS sequence of operation. The basis for this verification must be at least two weeks of trend data that shows the systems operating per the sequence of operation. The contractor is to identify the date range that verified the sequences. Note: Trending data must be collected when there is a significant building load. For heating, this			

		would mean the outside air temperature was below 32F for most of the trend period and for cooling, the daily highs are above 80F. The trend data used by the contractor must be available from the operator workstation and web server during demonstration testing. If the trending is not available on the OWS/webserver, it is a test failure for the affected system.)			
		Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems.			
		Training documentation and submittals shall be at the job site. This includes the most current as-built control systems documents.			
		All loops are tuned to obtain the fastest stable response without hunting, offset or overshoot refer 23 09 20 Building Automation System (BAS) for acceptable tolerances.			
		Sensors are calibrated, valve leak and damper setup and stroke checks have been performed.			

The above list of requirements is a summary from specification 23 09 20 Building Automation System (BAS) identifying the major requirements to establish readiness of the Building Automation System for Demonstration Testing. The consequences of testing failures during Demonstration Testing include additional testing and retesting of failed tests as well as the potential for charges from CPS to cover the cost of additional testing and retesting. Because of the potential for CPS to recover retesting costs the contractor asked to confirm the the BAS system has met all the requirements identified in the contract documents and is ready for Demonstration Testing. Your signature is required below:

BAS Team	**Signature, Company and Title**	Initial	Date
Mechanical			
Temperature Controls			
General Contractor			

Attachment 2:
Process for proceeding with BAS Training Requirements.

1. Contractor will submit a Training Plan to the O/R for acceptance by the OR and AOR/EOR; this plan should provide a level of detail that follows the spec. The commissioning agent will review and provide comments on the plan.

2. The training manual must also be submitted for review. Tt is recommended that the contractors submit a manual via PDF and on a thumb drive to minimize the amount of paper that they need to produce.

3. The contractor is to complete the control installation in accordance with the contract drawings and the EOR is to accept the installation (including completion of punch list items).

4. The OR notifies the Department of Operations and sends an approved copy of the training plan one week prior to the start of training. This is to be the same practice for all mechanical training conducted by the contractor (chillers, boilers, generators, etc.) and not just the BAS.

5. CPS will supply a list of the attendees and a location for the training.

6. The CPS Director of Operations will sign off on completed training.

END OF SECTION

SECTION 23 09 27 (MEP)

BUILDING AUTOMATION SYSTEM (BAS) – COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning of the Building Automation System (BAS).

1.2 GENERAL DESCRIPTION

A. Section defines responsibilities of the Controls Contractor to commission the BAS.

B. Chicago Public Schools (CPS), at CPS expense, shall retain a Commissioning Authority (CA) who shall work with the Contractor to ensure that the systems, equipment, and interfaces are installed, tested, and operate in accordance with the design intent; that the systems are adequately documented; and that CPS is adequately trained on system intent, operation, and maintenance.

C. The BAS contractor will provide support the commissioning authority in the form of information, both written and verbal, concerning the installation and operation of the control system.

D. The BAS contractor shall allow time and allocate resources to conduct their own testing including; Point-to-Point Testing, Prefunctional Performances Testing, Functional Performance Testing and finally Demonstration Testing, to the Owner's designated personnel and Commissioning Agent, the operation of all sequences of operation and other control system functions described in this specification, its attachments or drawing references. The tests are intended to provide documentation that all aspects of the temperature control system have been properly installed to meet the design intent of the Owner. The contractor performs all testing, documents all the testing, and submits the documentation prior to approval for conducting Demonstration Testing to the Owner.

E. Air and water balancing shall be completed, and discrepancies resolved prior to conducting Demonstration Testing. Controls contractor will coordinate with the Testing & Balancing Contractor if their support is required for the demonstration. The completed testing forms shall be presented to the Owner's representative upon completion of each commissioning step.

1.3 CONTRACTOR RESPONSIBILITIES

A. Perform all testing. This will generally include the following:

1. Attend Commissioning (Cx) progress and coordination meetings.
2. Prepare and submit required draft forms and systems information as required by specification.
3. Establish trend logs and graphs of system operation as specified herein.
4. Demonstrate system operation.
5. Manipulate systems and equipment to facilitate testing.
6. Provide instrumentation necessary for verification and performance testing.
7. Manipulate control systems to facilitate verification and demonstration testing.
8. Train CPS Representatives as specified in PART 3 of this Section.

B. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of 4 hours Refer to PART 3 for a description of the software optimization.

C. Compensation for Retesting: Contractor shall compensate CPS for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-site time for retesting, will be considered actual damages to the CPS. All parties under contract with the CPS who are affected by the retesting shall be included in the contract modification.

1.4 GENERAL MILESTONES – TEMPERATURE CONTROL WORK

A. The following list outlines the general sequence of events for Temperature Controls commissioning throughout the project:

1. Submittals:

a. Submit product data, including manufacturers' installation and startup procedures, and shop drawings, and receive approval.
b. Submit BAS logic documentation, and receive approval.
c. Submit sample testing forms, and receive approval.
d. Submit O&M Manuals.
e. Submit Training Plan with schedule for approval.
f. Submit "The Testing Plan" for review and receive approval.
g. Submit "CPS BAS Verification Form" (See Attachment at the Section) – This is to be submitted prior CX BAS demonstration testing and training.

2. Construction:

a. Begin system installation.
b. Conduct Point-to-Point Testing.
c. Conduct Prefunctional Performance Testing.
d. Work with TAB contractor to complete checking of systems.
e. Conduct Functional Performance Testing.
f. Initiate trend logs.
g. Compile all testing documentation for submission to the Commissioning authority for approval.
h. Conduct Demonstration testing.

3. Acceptance Period:

a. Begin Training.
b. Submit final As-built documentation.
c. Schedule Opposite season testing.
d. Complete training.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

2.2 TAB & COMMISSIONING – PORTABLE OPERATORS TERMINAL

A. Contractor shall provide a portable operators terminal or hand-held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up.

B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box.

PART 3 - EXECUTION

3.1 BAS START-UP, TESTING, ADJUSTING, AND CALIBRATION

A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Verify that all devices were installed in accordance with the manufacturer's written installation instructions.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB subcontractor, and CxA to obtain and fine-tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:

    a. Optimum duct static pressure setpoints for VAV air handling units.
    b. Minimum outside air damper settings for air handling units.
    c. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.

        1) BAS contractor shall provide hand-held device as a minimum to the TAB to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.

5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start Up Report.
6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:

    a. Check for adequate installation including free travel throughout range and adequate seal.
    b. Where loops are sequenced, check for proper control without overlap.

8. For Actuators:

a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.
b. Check for appropriate fail position, and that the stroke and range is as required.
c. For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate in accordance with manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.
d. For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges.

9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
10. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

    a. Duct Air Temperature: ±1 deg F.
    b. Space Temperature: ±2 deg F.
    c. Hot Water Temperature: ±3 deg F.
    d. Duct Pressure: ± 0.25-inches w.g.
    e. Water Pressure: ±1 psid.
    f. Duct or Space Humidity: ±5%.
    g. Air Flow Control: ±5% of setpoint velocity.
    h. Space Pressurization (on active control systems): ±0.05-inches w.g. with no door or window movements.

14. Interface and DDC Control Panels:

    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
    c. Check power supplies for proper voltage ranges and loading.
    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
    e. Check for adequate signal strength on communication networks.
    f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
    g. Ensure that all outputs and devices fail to their proper positions/states.
    h. Ensure that buffered and/or volatile information is held through power outage.

i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
j. Check for adequate grounding of all DDC panels and devices.

15. For Operator Interfaces:

a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
b. Output all specified BAS reports for review and approval.
c. Verify that the alarm, printing, and logging are functional and in accordance with requirements.
d. Verify that trends are archiving to disk and provide a sample to the Commissioning Authority for review.
e. Verify that paging/dial-out alarm annunciation is functional.
f. Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
g. Verify that required third party software applications required with the bid are installed and are functional.

16. Start-up and check out control air compressors, air drying, and filtering systems in accordance with the appropriate Section and with manufacturer's instructions.
17. Verify proper interface with fire alarm system.

B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Preliminary Acceptance or Substantial Completion.

3.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 deg F of each other for temperature and within a tolerance equal to ±2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors Without Transmitters – Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
2. Sensors With Transmitters – Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Division 23 Section, "Building Automation System (BAS) - Basic Materials, Interface Devices, and Sensors."

3.3 COIL VALVE LEAK CHECK

A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5 deg F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3 deg F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.4 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.5 BAS DEMONSTRATION

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and CPS. Schedule the demonstration with the CPS representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration, Contractor shall reimburse CPS for costs of subsequent Commissioning Authority site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments and ladders. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the CPS.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

4. Demonstrate proper installation and functionality of the entire control system. The contractor shall successfully demonstrate using similar techniques used in conducting their own testing the following:

    a. Point-to-Point Testing: A maximum of 10% of all points will be demonstrated to the commissioning authority. Testing. The commissioning authority will randomly select points to be tested.
    b. Prefunctional performance testing: A maximum of 10% of the Prefunctional Checkout Testing will be demonstrated to the commissioning authority. The commissioning authority will randomly select points to be tested.
    c. Functional Performance Testing: A Maximum of 10% of each of the systems: AHU's, VAV, Unit Ventilators, chillers, boilers, etc shall be tested for proper functional performance. Each selected system shall successfully demonstrate all modes of operation as specified in the sequence of operations. The commissioning authority will randomly select which pieces of equipment will be tested.

5. Upon failure of any device or system to meet the specified end-to-end accuracy, an additional 10 percent of those tests shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected point and sequences have been demonstrated to meet specified end-to-end accuracy.
6. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
7. Demonstrate that all DDC programs accomplish the specified sequences of operation.
8. Demonstrate that commands can be initiated through the operator's workstation.
9. Demonstrate that the panels automatically recover from power failures, as specified.
10. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements specified.
11. Identify access to equipment. Demonstrate that access is sufficient to perform required maintenance.
12. Demonstrate that required trend graphs and trend logs are set up in accordance with the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Preliminary Acceptance or Substantial Completion.

F. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

3.6 TREND LOGS

A. Contractor shall configure and analyze all trends required under Division 23 Section "Building Automation System (BAS) - Software and Programming."

3.7 TREND GRAPHS

A. Trend graphs as specified in Division 23 Section "Building Automation System (BAS) - Software and Programming" shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.

B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.8 Warranty Phase BAS OPPOSITE SEASON Trending and Testing:

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the Commissioning Authority/CPS for review upon Commissioning Authority/CPS request. Commissioning Authority/CPS will review these and notify contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Work, Commissioning Authority/CPS shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

3.9 BAS OPERATOR TRAINING AND O&M MANUALS

A. Training Sessions: Training sessions will be in increments of 4 hours with a maximum of one session with in a 48 hour period. Owner’s designated personal will coordinate the training sessions. Training cannot be scheduled until the “CPS BAS Verification Form” is completed and approved.

B. Attendees: The training shall be provided to the Owner's designated personnel.

C. Intent: The intent of the training sessions is to clearly and completely instruct the Owner’s personnel on all of the functions of the system, with a particular focus on operation of, and troubleshooting capabilities of, the control system.

1. The BAS contractor shall provide a training plan or syllabus for each four-hour session and the entire plan must be submitted and accepted by the commissioning agent prior to the beginning of training. In addition to the syllabus the contractor shall assemble a training manual for use during the training. This manual shall contain all the information used during the training session. The manual shall contain the following:

    a. TRAINING PLAN: The training plan shall be structured as follows:

        1) Format shall be an outline broken up into four-hour sessions. There is no training plan for the Opposite Season training.
        2) The material to be covered shall then be further sub-divided into descriptions of the material to be covered every 15 minutes.
        3) The descriptions shall include not only the material to be covered but also its location in the Training Manual including section and page number.

    b. TRAINING MANUAL: Refer to Division 23 Section, "Building Automation System (BAS)."

2. Training Performance: During any training session, should the BAS fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated. If during any training session, the trainer debugs more than three (3) items or for longer than 20 minutes total, the training session shall be terminated, and the contractor shall not be credited for training that day. The session shall be rescheduled for another date. The re-scheduled training session shall be carried out for the full four hours at no additional cost to the Owner.
3. Documentation of training: After each four-hour session the engineer shall initial and date the items on the test plan that were covered that day. A copy of the documentation shall be maintained in the engineers Training Manual and the contractor shall keep a copy.

Follow the requirements of Division 1 for documenting the training. Training will not be complete until the associated documentation from is submitted to the Owner's Representative.

Attachment 1: CPS BAS Verification Form
Submittal Checklist: Verification of readiness for BAS Demonstration Testing

In accordance with BAS Specification 23 09 20 the contractor is required to complete and confirm completion of the following prior to scheduling demonstration testing. The contractor has completed all required testing of the BAS and has verified that the BAS performs as required in the contract documents. This includes:

Yes	No	Description	Mechanical	TeleCom	Electrical
		Air and water balancing has been completed and discrepancies resolved prior to conducting Demonstration Testing.			
		The contractor will incorporated values from the approved TAB report into the BAS including duct static pressure set points for VAV air handling units, minimum outside air damper settings for air handling units and optimum differential pressure set points for variable speed pumping systems.			
		Record calibration parameters for flow control devices such as VAV boxes and flow measuring stations.			
		Verify all safety devices trip and cause required system response.			
		Verification of operator work station functions including trending and archiving of all points, web server on line, point override capability and alarms are in place, graphics have been provided to AOR/CxA for reviewed and all comments resolved, and all point and graphic binding has been verified. Webserver IP address, login and password for CxA have been provided and are operating properly. This includes displaying all trends. All systems controlled by the BAS have been verified to operate per the BAS sequence of operation. The basis for this verification must be at least two weeks of trend data that shows the systems operating per the sequence of operation. The contractor is to identify the date range that verified the sequences. Note: Trending data must be collected when there is a significant building load. For heating, this			

		would mean the outside air temperature was below 32F for most of the trend period and for cooling, the daily highs are above 80F. The trend data used by the contractor must be available from the operator workstation and web server during demonstration testing. If the trending is not available on the OWS/webserver, it is a test failure for the affected system.)			
		Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems.			
		Training documentation and submittals shall be at the job site. This includes the most current as-built control systems documents.			
		All loops are tuned to obtain the fastest stable response without hunting, offset or overshoot refer 23 09 20 Building Automation System (BAS) for acceptable tolerances.			
		Sensors are calibrated, valve leak and damper setup and stroke checks have been performed.			

The above list of requirements is a summary from specification 23 09 20 Building Automation System (BAS) identifying the major requirements to establish readiness of the Building Automation System for Demonstration Testing. The consequences of testing failures during Demonstration Testing include additional testing and retesting of failed tests as well as the potential for charges from CPS to cover the cost of additional testing and retesting. Because of the potential for CPS to recover retesting costs the contractor asked to confirm the the BAS system has met all the requirements identified in the contract documents and is ready for Demonstration Testing. Your signature is required below:

BAS Team	**Signature, Company and Title**	Initial	Date
Mechanical			
Temperature Controls			
General Contractor			

Attachment 2:
Process for proceeding with BAS Training Requirements.

1. Contractor will submit a Training Plan to the O/R for acceptance by the OR and AOR/EOR; this plan should provide a level of detail that follows the spec. The commissioning agent will review and provide comments on the plan.

2. The training manual must also be submitted for review. Tt is recommended that the contractors submit a manual via PDF and on a thumb drive to minimize the amount of paper that they need to produce.

3. The contractor is to complete the control installation in accordance with the contract drawings and the EOR is to accept the installation (including completion of punch list items).

4. The OR notifies the Department of Operations and sends an approved copy of the training plan one week prior to the start of training. This is to be the same practice for all mechanical training conducted by the contractor (chillers, boilers, generators, etc.) and not just the BAS.

5. CPS will supply a list of the attendees and a location for the training.

6. The CPS Director of Operations will sign off on completed training.

END OF SECTION

SECTION 23 21 13 (LNK)

HYDRONIC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water piping, above grade.

C. Equipment drains and overflows

D. Pipe hangers and supports.

E. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

E. ASME B31.9 - Building Services Piping; 2014.

F. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2017.

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2015.

I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).

K. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

N. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2014).

O. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).

P. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).

Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

R. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2010.

S. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.

T. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.

U. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017.

V. AWWA C606 - Grooved and Shouldered Joints; 2015.

W. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.03 SUBMITTALS

A. Product Data:
1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalogue information.
3. Indicate valve data and ratings.
4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

B. Provide 1/4" scale layout/fabrication shop drawings for all piping systems.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Maintenance Data: Include record drawings, installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M.

C. Welding: Qualify processes and operators according to ASME BPVC-IX.
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. All welders certificates shall be on file at project site
4. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC-VIII-1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in accessible locations only.
   a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect/Engineer of Record.
   b. Grooved mechanical connections and joints comply with AWWA C606.
      1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
      2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
2. On discharge of condenser water pumps, use spring loaded check valves.
3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
4. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
   3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 EQUIPMENT DRAINS AND OVERFLOWS, AND MAKEUP WATER.

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
   1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
   2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
   4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
   8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
   10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
   11. Vertical Support: Steel riser clamp.
   12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
   15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   16. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   17. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
7. Manufacturers:
a. Grinnell Products, a Tyco Business
b. Victaulic Company
c. Anvil

D. Dielectric Connections:
1. Waterways:
a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
b. Dry insulation barrier able to withstand 600 volt breakdown test.
c. Construct of galvanized steel with threaded end connections to match connecting piping.
d. Suitable for the required operating pressures and temperatures.
2. Flanges:
a. Dielectric flanges with same pressure ratings as standard flanges.
b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
c. Dry insulation barrier able to withstand 600 volt breakdown test.
d. Construct of galvanized steel with threaded end connections to match connecting piping.
e. Suitable for the required operating pressures and temperatures.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 - HVAC Water Treatment for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water, glycol piping to ASME B31.9 requirements.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls and floors.

G. Install firestopping to preserve fire resistance rating of partitions and other elements.

H. Slope piping and arrange to drain at low points.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
2. Use flexible couplings in expansion loops.

J. Grooved Joints:
1. Install in accordance with the manufacturer's latest published installation instructions.
2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

K. Inserts:
1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

L. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.

5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Refer to Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19 - HVAC Piping Insulation.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

3.03 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used (compressed air may not be used).
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.
15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.

END OF SECTION 23 21 13

SECTION 23 21 13 (MEP)

HYDRONIC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Equipment drains and overflows

C. Pipe hangers and supports.

D. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

E. ASME B31.9 - Building Services Piping; 2014.

F. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2017.

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2015.

I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

J. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

K. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

L. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

M. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2014).

N. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).

O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

Q. AWWA C606 - Grooved and Shouldered Joints; 2015.

R. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.03 SUBMITTALS

A. Product Data:
1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalogue information.
3. Indicate valve data and ratings.
4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

B. Provide 1/4" scale layout/fabrication shop drawings for all piping systems.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Maintenance Data: Include record drawings, installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M.

C. Welding: Qualify processes and operators according to ASME BPVC-IX.
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. All welders certificates shall be on file at project site
4. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC-VIII-1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in accessible locations only.
   a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect/Engineer of Record.
   b. Grooved mechanical connections and joints comply with AWWA C606.
      1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
      2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
2. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.02 EQUIPMENT DRAINS AND OVERFLOWS.

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
16. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
17. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.04 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
7. Manufacturers:
   a. Grinnell Products, a Tyco Business
   b. Victaulic Company
   c. Anvil

C. Dielectric Connections:
1. Waterways:

a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
b. Dry insulation barrier able to withstand 600 volt breakdown test.
c. Construct of galvanized steel with threaded end connections to match connecting piping.
d. Suitable for the required operating pressures and temperatures.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 - HVAC Water Treatment for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner, parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and to avoid interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Slope piping and arrange to drain at low points.

F. Grooved Joints:
1. Install in accordance with the manufacturer's latest published installation instructions.
2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

G. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.

9. Prime coat exposed steel hangers and supports. Refer to Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19 - HVAC Piping Insulation.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

3.03 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Flush hydronic piping systems with clean water.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.
15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.

END OF SECTION 23 21 13

SECTION 23 21 14 (LNK)

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.

B. Air vents.

C. Air separators.

D. Strainers.

E. Pressure-temperature test plugs.

F. Balancing valves.

G. Relief valves.

H. Glycol or makeup water pressure fill system.

I. Shell-and-tube heat exchangers.

1.02 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2017.

1.03 SUBMITTALS

A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual locations of flow controls.

E. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Tube-removal space.
   2. Structural members to which heat exchangers will be attached.

F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 EXPANSION TANKS

A. Manufacturers:
1. Amtrol Inc
2. Armstrong International, Inc
3. ITT Bell & Gossett
4. Taco, Inc
5. Wessels

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.

2.02 AIR VENTS

A. Manufacturers:
1. Armstrong International, Inc
2. ITT Bell & Gossett
3. Taco, Inc

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.03 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:
1. Manufacturers:
a. Armstrong International, Inc
b. ITT Bell & Gossett
c. Taco, Inc
2. Steel, tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.
3. Size inlet and outlet to match system capacity.

2.04 STRAINERS

A. Manufacturers:
1. Armstrong International, Inc
2. Flexicraft Industries
3. Grinnell Products, a Tyco Business
4. The Metraflex Company; LPD Y Strainer

B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen. Include blow down valve with hose connection.

C. Size 2-1/2 inch to 4 inch:
1. Provide flanged iron body for 175 psi working pressure, Y pattern with 1/16 inch, or 3/64 inch stainless steel perforated screen. Include blow down valve with hose connection.

D. Size 5 inch and Larger:
1. Provide flanged iron body for 175 psi working pressure, Y pattern with 1/8 inch stainless steel perforated screen. Include blow down valve with hose connection.

2.05 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:
1. Ferguson Enterprises Inc
2. Peterson Equipment Company Inc
3. Sisco Manufacturing Company Inc

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

C. Application: Use extended length plugs to clear insulated piping.

2.06 BALANCING VALVES

A. Manufacturers:
1. Armstrong International, Inc
2. ITT Bell & Gossett
3. Taco, Inc
4. Griswold Controls.
5. Nexus.
6. Hays
7. Victaulic

B. Size 2 inch and Smaller:
   1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.

C. Size 2.5 inch and Larger:
   1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged connections.
   2. Valve body construction materials consist of cast iron or carbon steel.
   3. Internal components construction materials consist of brass, bronze, Teflon, or EPDM.

2.07 RELIEF VALVES

A. Manufacturers:
   1. Armstrong International, Inc
   2. ITT Bell & Gossett
   3. Conbraco Industries

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.08 GLYCOL OR MAKEUP WATER PRESSURE FILL SYSTEM

A. Manufacturers:
   1. Armstrong International, Inc
   2. ITT Bell & Gossett
   3. Taco, Inc

B. Provide a complete factory packaged automatic glycol / make-up water fill system unit per system. The unit shall consist of a base, 55 gallon tank (steel or polyethylene) with removable lid, fill vent opening, observable fluid level indicator scale (gallons), Y-strainers, isolation valves, triple combination shut off – Non slam check – calibrated balance valves, open drip proof motor, pump, expansion tank, motor contactor, pressure controls, interconnecting piping, low level safety shut down, remote alarm contacts, indicator light, fill valve (automatic for water systems, manual for glycol systems), discharge pressure gauge, discharge line pressure reducing valve, isolation valves, pressure gauge and single point power connection.

C. Glycol Solution for glycol systems:
   1. Inhibited propylene glycol and water solution mixed 30 percent glycol - 70 percent water, suitable for operating temperatures from -20 degrees F to 250 degrees F.

2.09 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:
   1. Armstrong International, Inc
   2. ITT Bell & Gossett
   3. Taco, Inc

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel.

D. Head:

1. Materials: Cast iron.
2. Flanged and bolted to shell.

E. Tube:
1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

F. Tubesheet Materials: Steel tubesheets.

G. Baffles: Steel.

H. Piping Connections:
1. Shell: Threaded inlet and outlet fluid connections, threaded drain, and vent connections.
2. Head: Threaded inlet and outlet fluid connections.

I. Support Saddles:
1. Fabricated of material similar to shell.
2. Foot mount with provision for anchoring to support.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions and CPS standard mechanical details.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

D. Provide manual air vents at system high points and as indicated.

E. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

F. Provide air separator on suction side of system circulation pump and connect to expansion tank in accordance with CPS standard mechanical details.

G. Provide valved drain and hose connection on strainer blow down connection.

H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

L. Chemically clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00 - HVAC Water Treatment.

M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

3.02 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on elevated saddle supports on concrete base. Concrete base is specified in Division 23 Section "Basic HVAC Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

B. Concrete Bases: Anchor heat exchanger support to concrete base.
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.03 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 21 14

SECTION 23 21 23 (LNK)

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Close-coupled inline centrifugal pumps.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; 2017.

B. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seals for each pump.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Inline and Base Mounted Pumps
   1. Armstrong Fluid Technology, Inc
   2. Bell & Gossett, a Xylem Inc. brand
   3. Taco

2.02 HVAC PUMPS - GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

2.03 CLOSE-COUPLED INLINE CENTRIFUGAL PUMPS

A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psi maximum working pressure.

B. Casing: Cast iron, with flanged pump connections.

C. Impeller: Cast Bronze or Stainless Steel keyed to shaft.

D. Bearings: Permanently-lubricated ball bearings.

E. Shaft: Alloy steel with copper sleeve, integral thrust collar.

F. Seal: Mechanical seal , 275 degrees F maximum continuous operating temperature.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment. Fabricate brackets or supports as required.

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight.

F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over and in accordance with CPS standard mechanical details.

G. Provide line sized shut-off valve and pump suction fitting on pump suction, and line sized soft seat check valve and balancing valve on pump discharge. Coordinate with CPS standard mechanical details.

H. Provide drains for bases and seals, piped to and discharging into floor drains.

I. Check, align, and certify alignment of base-mounted pumps prior to start-up.

J. Lubricate pumps before start-up.

K. Comply with pump and coupling manufacturers' written instructions.

3.03 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to perform startup service. Startup service includes the testing, inspections and startup test reports.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.
   7. Open discharge valve slowly.

B. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01.
   1. Train Board's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. The training will occur after the startup report has been provided to the Board and the trainer will provide two (2) Installation and Operations manuals for the use of the Board personnel during training.

2. Review data in maintenance manuals. Refer to Division 01. All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.
3. Schedule training with Board, through Architect/Engineer of Record, with at least seven days' advance notice.

END OF SECTION 23 21 23

SECTION 23 22 13 (LNK)

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Pipe hangers and supports.

C. Joining materials

D. Dielectric fittings

E. Unions, flanges, and couplings

1.02 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2016.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

F. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012, Including July 2013 Errata.

G. ASME B31.1 - Power Piping; 2016.

H. ASME B31.9 - Building Services Piping; 2014.

I. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

L. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

M. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

N. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

R. AWS D10.12M/D10.12 - Guid for Welding Mild Steel Pipe; 2000.

S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.03 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, fabrication piping layout, assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual layout and locations of valves.

E. Maintenance Data: Include record drawings, installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M.

C. Pipe Welding: Qualify processes and operators according to the following:
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 and ASME B31.1 code for installation of piping system.

B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of welders.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
1. Fittings: ASME B16.3 malleable iron Class 125, 150 or 300 as indicated in Part 3, or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.03 LOW PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
1. Fittings: ASME B16.3 malleable iron Class 125, 150 or 300 as indicated in Part 3, or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

F. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

G. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.05 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME BPVC for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.06 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
1. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.07 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 Inches and Under:
1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.

B. Flanges for Pipe Over 2 Inches:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40 , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12 : Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above and below grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above and below grade, NPS 2-1/2 and larger, shall be the following:
1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.02 ANCILLARY PIPING APPLICATIONS

A. Makeup-water piping installed above grade shall be the following:
   1. Drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

D. Vacuum-Breaker Piping: Outlet, same as service where installed.

E. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.03 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 - HVAC Water Treatment.

3.04 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Section 23 05 23 - General-Duty Valves for HVAC Piping.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as required."

U. Identify piping as specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
   1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
   2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.
   3. Install pressure gage on low-pressure steam outlet according to Section 23 05 19 - Meters and Gages for HVAC Piping.

W. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

X. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23 - Interior Painting.

3.05 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

D. Install a drip leg at coil outlet.

3.07 CONTRACTOR STARTUP AND REPORTING

A. Prepare steam and condensate piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used (Air may not be used).
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure or 100 psig, whichever is greater. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

3.08 SCHEDULES

A. Hanger Spacing for Steel Steam Piping.
   1. 1/2 inch: Maximum span, 8 feet; minimum rod size, 1/4 inch.
   2. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.
   3. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   4. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   5. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
   6. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
   7. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
   8. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 6 inches: Maximum span, 21 feet; minimum rod size, 1/2 inch.
   10. 8 inches: Maximum span, 24 feet; minimum rod size, 5/8 inch.
   11. 10 inches: Maximum span, 26 feet; minimum rod size, 3/4 inch.
   12. 12 inches: Maximum span, 30 feet; minimum rod size, 7/8 inch.
   13. 14 inches: Maximum span, 32 feet; minimum rod size, 1 inch.
   14. 16 inches: Maximum span, 35 feet; minimum rod size, 1 inch.
   15. 18 inches: Maximum span, 37 feet; minimum rod size, 1-1/4 inch.
   16. 20 inches: Maximum span, 39 feet; minimum rod size, 1-1/4 inch.

B. Hanger Spacing for Steel Steam Condensate Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
   10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
   11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

END OF SECTION

SECTION 23 22 13 (MEP)

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Pipe hangers and supports.

C. Joining materials

D. Dielectric fittings

E. Unions, flanges, and couplings

1.02 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2016.

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

F. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012, Including July 2013 Errata.

G. ASME B31.1 - Power Piping; 2016.

H. ASME B31.9 - Building Services Piping; 2014.

I. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

L. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

M. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

N. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.

O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

R. AWS D10.12M/D10.12 - Guid for Welding Mild Steel Pipe; 2000.

S. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.03 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, fabrication piping layout, assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual layout and locations of valves.

E. Maintenance Data: Include record drawings, installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M.

C. Pipe Welding: Qualify processes and operators according to the following:
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 and ASME B31.1 code for installation of piping system.

B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of welders.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
1. Fittings: ASME B16.3 malleable iron Class 125, 150 or 300 as indicated in Part 3, or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.03 LOW PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
1. Fittings: ASME B16.3 malleable iron Class 125, 150 or 300 as indicated in Part 3, or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

F. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

G. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.05 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME BPVC for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.06 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
1. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.07 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 Inches and Under:
1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.

B. Flanges for Pipe Over 2 Inches:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40 , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12 : Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above and below grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above and below grade, NPS 2-1/2 and larger, shall be the following:
1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.02 ANCILLARY PIPING APPLICATIONS

A. Makeup-water piping installed above grade shall be the following:
   1. Drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

D. Vacuum-Breaker Piping: Outlet, same as service where installed.

E. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.03 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 - HVAC Water Treatment.

3.04 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Section 23 05 23 - General-Duty Valves for HVAC Piping.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as required."

U. Identify piping as specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
   1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
   2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.
   3. Install pressure gage on low-pressure steam outlet according to Section 23 05 19 - Meters and Gages for HVAC Piping.

W. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

X. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23 - Interior Painting.

3.05 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

D. Install a drip leg at coil outlet.

3.07 CONTRACTOR STARTUP AND REPORTING

A. Prepare steam and condensate piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used (Air may not be used).
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure or 100 psig, whichever is greater. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

3.08 SCHEDULES

A. Hanger Spacing for Steel Steam Piping.
   1. 1/2 inch: Maximum span, 8 feet; minimum rod size, 1/4 inch.
   2. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.
   3. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   4. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   5. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
   6. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
   7. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
   8. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 6 inches: Maximum span, 21 feet; minimum rod size, 1/2 inch.
   10. 8 inches: Maximum span, 24 feet; minimum rod size, 5/8 inch.
   11. 10 inches: Maximum span, 26 feet; minimum rod size, 3/4 inch.
   12. 12 inches: Maximum span, 30 feet; minimum rod size, 7/8 inch.
   13. 14 inches: Maximum span, 32 feet; minimum rod size, 1 inch.
   14. 16 inches: Maximum span, 35 feet; minimum rod size, 1 inch.
   15. 18 inches: Maximum span, 37 feet; minimum rod size, 1-1/4 inch.
   16. 20 inches: Maximum span, 39 feet; minimum rod size, 1-1/4 inch.

B. Hanger Spacing for Steel Steam Condensate Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
   10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
   11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
   12.

SECTION 23 22 14 (LNK)

STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Steam traps.

B. Steam air vents and vacuum breakers.

C. Steam safety valves.

D. Strainers

1.02 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

B. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

C. ASME B31.9 - Building Services Piping; 2014.

D. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data:
1. Provide for manufactured products and assemblies required for this project.
2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.

C. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M.

B. Pipe Welding: Qualify processes and operators according to the following:
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 STEAM TRAPS

A. Manufacturers:
1. Armstrong International, Inc
2. Hoffman Specialty
3. Spirax-Sarco

B. Steam Trap Performance:
1. Select to handle minimum of two times maximum condensate load of apparatus served.
2. Pressure Differentials:
   a. Low Pressure Systems (5 psi and less): 1/2 psi.

C. Inverted Bucket Traps: ASTM A126, cast iron or semi-steel body with bolted cover, brass bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces.
1. Rating: 60 psi WSP.
2. Features: Access to internal parts without disturbing piping, top test plug, bottom drain plugs.
3. Accessories:
   a. Integral inlet strainer of brass.
   b. Integral inlet check valve.
   c. Integral bimetal air vent.

D. Float and Thermostatic Traps: ASTM A126 cast iron or semi-steel body and bolted cover, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly
1. Rating: 15 psi WSP.
2. Features: Access to internal parts without disturbing piping, bottom drain plug.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

2.02 STEAM AIR VENTS AND VACUUM BREAKERS

A. Manufacturers:
1. Armstrong International, Inc
2. Bell and Gossett, a xylem brand
3. Spirax-Sarco

B. Thermostatic Air Vents:
1. Body: Cast iron, bronze or stainless steel.
2. End Connections: Threaded.
3. Float, Valve, and Seat: Stainless steel.
4. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 deg F.

C. Vacuum Breakers:
1. Body: Cast iron, bronze, or stainless steel.
2. End Connections: Threaded.
3. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
4. O-ring Seal: EPR.
5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 deg F.

2.03 SAFETY RELIEF VALVES

A. Manufacturers:
1. Armstrong International, Inc: www.armstronginternational.com.
2. ITT McDonnell & Miller, a xylem brand: www.mcdonnellmiller.com.
3. Kunkle Valve
4. Spirax-Sarco: www.spiraxsarco.com/us/#sle.

B. Bronze or Brass Safety Valves (NPS ½ through 2-1/2”):
1. Disc Material: Forged copper alloy.
2. End Connections: Threaded inlet and outlet.
3. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
4. Pressure Class: 250.
5. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
6. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

C. Cast-Iron Safety Valves (NPS 3” through 6”):
1. Disc Material: Forged copper alloy with bronze nozzle.
2. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
3. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
4. Pressure Class: 250.
5. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
6. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME BPVC.

2.04 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.

B. Install specialties in accordance with manufacturer's instructions.

C. Steam Traps:
1. Provide minimum 3/4 inch size on steam mains and branches.
2. Install with union or flanged connections at both ends.
3. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.
4. Install steam traps in accessible locations as close as possible to connected equipment.
5. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated. Coordinate with CPS standard mechanical details.

D. Install safety relief valves according to ASME B31.9.

E. Rate safety relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

F. Terminate safety relief valves to outdoors without valves. Provide drip pan elbow with drain connection to nearest floor drain.

G. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION 23 22 14

SECTION 23 23 00 (MEP)

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Pressure relief valves.

F. Filter-driers.

G. Solenoid valves.

H. Expansion valves.

I. Hot gas bypass valves

1.02 REFERENCE STANDARDS

A. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.

B. AHRI 750 - Thermostatic Refrigerant Expansion Valves; 2007.

C. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants; 2007.

D. ASHRAE (REFR) - ASHRAE Handbook - Refrigeration; 2014.

E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.

F. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators; 2017.

H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

I. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2016.

J. ASME B31.9 - Building Services Piping; 2014.

K. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

M. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).

N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

O. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

P. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. See Section 01 33 29 - LEED Sustainable Design Reporting, when required.

C. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

D. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

E. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
1. Shop Drawing Scale: 1/4 inch equals 1 foot.

F. Test Reports: Indicate results of leak test, acid test.

G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

H. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

I. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

C. Comply with all City of Chicago code requirements for installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

C. Welders Certification: In accordance with ASME BPVC-IX.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

E. Comply with ASHRAE Std 15.

F. Comply with ASME B31.5

G. Comply with all requirements of the City of Chicago Mechanical Code for relief valve requirements based on refrigerant system volume, and requirements that limit refrigerant components in the airstream.

2.02 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn, Type ACR or Type K complying with ASTM B88.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   6. Vertical Support: Steel riser clamp.
   7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
   10. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.

e. Height: Provide minimum clearance of 12 inches under pipe to top of roofing.

2.03 REFRIGERANT

A. Manufacturers:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.04 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
1. Henry Technologies; _____: www.henrytech.com/#sle.
2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.

B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.05 VALVES

A. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

B. Packed Angle Valves:
1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Ball Valves:
1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

D. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve with stainless steel springs, flared or solder ends, for maximum pressure of 500 psi.

2.06 PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.07 FILTER-DRIERS

A. Performance:
1. Flow Capacity - Liquid Line: To match circuit tonnage as scheduled in the "Air Cooled Condensing Unit Schedule" on the drawings, minimum, rated in accordance with AHRI 710.
2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
3. Design Working Pressure: 500 psi, minimum.
4. Maximum Operating Temperature: 240 deg. F.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 10 microns.; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
1. Connections: As specified for applicable pipe type.

2.08 SOLENOID VALVES

A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi and maximum operating temperature of 240 deg. F.

B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.09 EXPANSION VALVES

A. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass or steel body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well. Working pressure rating of 700 psig.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.10 ELECTRONIC EXPANSION VALVES

A. Valve:
1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

B. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.11 HOT-GAS BYPASS VALVES

A. Body, Bonnet, and Seal Cap: Ductile iron or steel.

B. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

C. Packing and Gaskets: Non-asbestos.

D. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

E. Seat: Polytetrafluoroethylene.

F. Equalizer: Internal or External.

G. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and ac coil.

H. End connections: Socket.

I. Set Pressure: As required.

J. Throttling Range: Maximum 5 psig.

K. Working Pressure Range: 500 psig.

L. Maximum Operating temperature: 240 deg F.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. All refrigerant pipe sizing shall be the responsibility of the Contractor in accordance with the equipment manufacturer’s recommendations.

B. Pipe sizing shall be in accordance with the recommendations in the ASHRAE (REFR), Chapter 2 - System Practices for Halocarbon Refrigerants.

C. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Install refrigeration specialties in accordance with manufacturer's instructions.

E. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

F. Install piping to conserve building space and avoid interference with use of space.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Install refrigerant piping in protective conduit where installed belowground.

I. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

J. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

K. Valve and Specialties Installation:
   1. Install packed-angle valves in suction and discharge lines of compressor.
   2. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
   3. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
   4. Install thermostatic expansion valves as close as possible to distributors on evaporators.
      a. Install valve so diaphragm case is warmer than bulb.
      b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
      c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
   5. Install safety relief valves where required by ASME BPVC. Pipe safety-relief-valve discharge line to outside according to ASHRAE Std 15.
   6. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

M. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers properly sized for the unloading of the compressor as required to entrain oil in vertical runs. Slope horizontal piping 0.40 percent in direction of flow.

N. Provide clearance for installation of insulation and access to valves and fittings.

O. Provide access to concealed valves and fittings.

P. Flood piping system with nitrogen when brazing.

Q. Insulate piping and equipment; refer to Section and Section 23 07 16.

R. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

S. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

T. Provide replaceable cartridge filter-driers, with isolation valves.

U. Fully charge completed system with refrigerant after testing.

V. Provide electrical connection to solenoid valves. Refer to Section 26 05 83 - Wiring Connections.

W. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.04 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.05 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Verify that compressor oil level is correct.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.06 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.

3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION 23 23 00

SECTION 23 25 00 (LNK)

HVAC WATER TREATMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).

B. By-pass (pot) feeder.

C. Water meter.

D. Solenoid valves.

E. Timers.

F. Test equipment.

G. Side-stream filtration equipment.

H. Centrifugal separators

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements. Submit shop drawings showing scaled plans, elevations, sections, and large-scale details. Include pretreatment and chemical treatment equipment, including tanks, sequence of operations and piping connections to HVAC systems, and clear space required for maintenance.
   1. Wiring Diagrams: For power and control wiring. Clearly differentiate between factory-installed and field-installed wiring.

D. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

E. Qualifications: For treatment provider and project technicians.

F. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

G. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

H. Certificate: Submit certificate of compliance from Authority Having Jurisdiction indicating approval of chemicals and their proposed disposal.

I. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

J. Water Treatment Program: Written explanation of procedures and operations to be performed, on an annual basis, by application equipment to ensure water quality criteria specified in Article "Performance Requirements" is achieved and maintained. Submit three copies in 3-ring binders.

1.03 QUALITY ASSURANCE

A. Water Treatment Service Provider Qualifications: Engage a firm with not less than 5 years experience in the analysis and maintenance of the quality of water utilized in HVAC equipment and systems comparable to those indicated or required for the Project, and that clearly demonstrates a capability to accurately analyze water qualities, install water-treatment equipment, and apply water treatment processes as specified.
1. Project Technicians: Certified Water Technologists (CWT) in good standing, certified by the AWT, or have similar training and experience qualifications.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.04 PERFORMANCE REQUIREMENTS

A. Water Quality:
1. General: Water used within HVAC systems shall minimize corrosion, scale buildup, and biological growth, to ensure optimum efficiency of HVAC equipment and that a hazard to either operating personnel or the environment has not been created.
2. HVAC water treatment shall be based upon quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
3. Water used within closed hydronic systems (both water and glycol), including hot-water heating, chilled water, geothermal, and dual-temperature water systems shall have the following qualities:
   a. Acidity (pH): 8.5 to 10.2.
   b. "P" Alkalinity: Record value and include in test report.
   c. Boron: Adjust value as needed to buffer pH to range indicated. Record final value in test report.
   d. Soluble Copper: 0.20 ppm, maximum.
   e. Conductivity: 3500 µS/cm, maximum.
   f. Free Caustic Alkalinity: 20 ppm, maximum.
   g. Microbiological Limits:
      1) Total Aerobic Plate Count: 1000 organisms/ml, maximum.
      2) Total Anaerobic Plate Count: 100 organisms/ml, maximum.
      3) Nitrate Reducers: 100organisms/ml, maximum.
      4) Sulfate Reducers: 0 organisms/ml.
      5) Iron Bacteria: 0 organisms/ml.

1.05 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service (all labor) program to maintain required water conditions and quality for heating hot-water piping and related equipment. Services and chemicals shall be provided for a period of one year from date of Preliminary Acceptance, and shall include the following:
1. Initial water analysis (conducted at Site) and HVAC water-treatment recommendations. Written report of the findings to be left with the Board and a copy of such report shall be forwarded to both the commissioning agent and consulting engineer.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required glycol/chemical treatment prior to operation.
3. Periodic field service and consultation. Include all work specified. Check for proper operation of all pumps, controllers, meters, and sensors. Calibrate sensors as required. Check chemical tank levels and inventory, and arrange chemical deliveries well in advance of needs.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
7. Train Board's operating personnel with the operation and adjustment of each piece of equipment / system, care and handling of treatment chemicals, and water test control procedures including basic water chemistry and the importance of water treatment.

1.06 WARRANTY

A. Written warranty, executed by manufacturer agreeing to repair or replace components or equipment that fail in materials or workmanship within warranty period indicated.
1. Warranty Period: One year from date of Preliminary Acceptance or eighteen months from date of shipment from factory, whichever is longer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Nalco, an Ecolab Company

B. Earthwise Environmental.

C. H-O-H Chemicals, Inc.

D. US Water

E. Global Water Technology, Inc.

2.02 MATERIALS

A. System Cleaner:
1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

B. Closed System Treatment (Water):
1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

C. Glycol (Closed Systems):
1. Propylene Glycol: HVAC grade, containing corrosion inhibitors and environmental stabilizer additives for mixing with softened water. Softened water shall be used to dilute the glycol to 30 percent by volume in the system.

a. Industrial/automotive/marine/raw glycol shall NOT be used in any HVAC application.

2.03 BY-PASS (POT) FEEDER

A. Manufacturers:
1. Griswold Controls
2. J. L. Wingert Company
3. Neptune, a brand of the Dover Company

B. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gallons.
2. Minimum Working Pressure: 125 psig.

2.04 WATER METER

A. Water Meter:
1. Type: AWWA C700, oscillating-piston, magnetic-drive, tantalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded or flanged.
7. Controls: Flow-control switches with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow. Hardwired to both the chemical controller and the building automation system (BAS).

B. Water Meter:
1. Type: AWWA C701, turbine-type, tantalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded or flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow. Hardwired to both the chemical controller and the building automation system (BAS).

2.05 SOLENOID VALVES

A. Forged brass body globe pattern, normally open or closed as required, explosion-proof and watertight solenoid enclosure, and continuous duty coil.

2.06 TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, conductivity, inhibitor, chloride, alkalinity, and hardness; include sulfite and testable polymer tests for high-pressure boilers, oxidizing biocide test for open cooling systems, glycol test kit for closed loop heating/cooling/dual temperature systems, and other test equipment as required by the water treatment supplier.

B. Portable Glycol Test Kit Assembly: Kit shall include sample container, chart, carrying case, instructions, all components required to determine the type of glycol, percent of glycol to water by volume, and condition of glycol (contamination) in the field.

C. Corrosion Test-Coupon Assembly: Constructed of 1-inch diameter corrosion resistant material, complete with piping, valves, 0-20 gpm flow meter and control valve, and mild steel and copper coupons. Alternatively, the assembly may be constructed from 1-inch black iron pipe, to provide additional surfaces for corrosion evaluation. The assembly shall be installed in the vertical plane, properly supported, with water flow from the bottom to the top of the assembly.
1. Two-station rack for closed-loop systems.
2. Four-station rack for open systems.

2.07 SIDE-STREAM FILTRATION SYSTEM

A. Manufacturers:
1. PEP Filters, Inc.
2. Cuno.
3. Watts.

B. Description: Floor-mounting housing with multiple filter cartridges (minimum 4) for removing particles from water.
1. Housing: Stainless steel; designed to separate inlet from outlet and to direct inlet through multiple cartridge-type water filters; with base, feet, or skirt.
   a. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
   b. Stainless Steel Housing Pipe Connections NPS 2-1/2 and Larger: Stainless Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
   c. Tool free replacement of filters (V-Band Clamp, etc.).
   d. Top vent with valve.
   e. Bottom drain with valve.
   f. Pressure and temperature taps across unit.
2. Multi-Filter Cartridges: Wound polypropylene media with a tin core, 0-20 micron rating, and a maximum temperature rating of 200 deg F; sized to properly fit the filter vessel. The minimum flow rate shall be the greatest of 5% of system pump flow rate/filtration of the entire system volume every 4 hours or 25 GPM. Pressure drop through clean filters at flow rate above shall not exceed 2 psig. Filter cartridges shall be furnished in a quantity sufficient for six (6) complete changes of the filter vessel. Filter cartridges shall be changed when the pressure drop across the filter vessel exceeds 6 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

A. Concentration:
1. As recommended by manufacturer.
2. Fill steam boilers only with cleaner and water.

B. Hot Water Heating Systems:
   1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
   2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
   3. Circulate for 6 hours at design temperatures, then drain.
   4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer of Record.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

D. Multi-Cartridge Side Stream Filter: Install in all closed hydronic systems, and equipped with the following:
   1. Install multi-cartridge side stream filter in a bypass circuit around circulating pumps.
   2. Install a full-port ball isolation valves on inlet, outlet, vent and drain below feeder inlet.
   3. Install a swing check on inlet after the isolation valve.
   4. Install on 4-inch high equipment pad.

E. Provide 30% by volume inhibited glycol mix in all closed hydronic systems.
   1. Glycol to be propylene for new systems or where propylene is currently used.
   2. Glycol to be ethylene for existing systems where ethylene is currently installed.

F. Install pressure fill units on all closed hydronic systems and include the following:
   1. Install water meter in makeup water supply. Coordinate totalization signal with building automation system.
   2. Coordinate alarm signal tie in to building automation system.
   3. Provide pressure regulator set at the difference in height (in psig) between the discharge of the pressure regulator to the highest point in the system plus 5 psig.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water/glycol (as indicated), and are fully operational before introducing chemicals for water-treatment system.
3. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
4. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
5. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
6. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
7. Repair leaks and defects with new materials and retest piping until no leaks exist.
8. Adjust water flow through corrosion coupon assemblies to equal a rate of 3 gpm = 3 ft./sec. through a 3/4-inch pipe, or lower flow as required by the Board.

C. Remove and replace malfunctioning units and retest as specified.

D. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.06 CLOSEOUT ACTIVITIES

A. Training: Train Board's personnel on operation and maintenance of chemical treatment system.
1. Have operation and maintenance data prepared and available for review during training.
2. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION 23 25 00

SECTION 23 31 00 (LNK)

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Manufactured ductwork and fittings

1.02 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. AWS D9.1/D9.1M - Sheet Metal Welding Code; 2018.

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

I. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.

J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012, 2nd Edition.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems. Drawn at a scale of not less than 1/4" = 1'-0".
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.

3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:
1. Spacing of hangers and supports.

E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

G. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.04 DELIVERY, STORAGE AND HANDLING

A. All materials shall be stored in a designated area and protected from inclement weather.

B. All materials shall be secured so as not to be a hazard during the construction process.

C. Store ductwork with tight-fitting seals on open ends to ensure ductwork is free of all dirt, debris and moisture during the installation process.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.

C. PVC Coating for Steel Ducts: 4 mils polyvinyl chloride plastic on both sides.

D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
1. Hangers Installed in Corrosive Atmospheres: All-thread rods used in pool areas, pool equipment rooms, and pool supporting spaces shall be aluminum if the ducts are aluminum and stainless steel if the ducts are stainless steel.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
a. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
b. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials.

I. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

J. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

K. Insulated Flexible Ducts: Flexible ducts wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.

L. Sealant Materials
1. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes combinations of open-weave fabric strips and mastics.
2. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
3. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
4. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.03 MANUFACTURED DUCTWORK AND FITTINGS

A. Duct Joints:
1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

B. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA (DCS) with metal thicknesses specified for longitudinal-seam straight ducts.

C. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

D. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA (DCS) unless otherwise indicated.
2. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
3. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

PART 3 - EXECUTION

3.01 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
1. Supply Ducts (constant volume units): +2".
2. Supply Ducts (before Air Terminal Units): +4”.
3. Supply Ducts (after Air Terminal Units): +2”.

4. Return Ducts (Negative Pressure): -2".
5. Return Ducts (return fan discharge and AHU intake / exhaust damper): -4".
6. Exhaust Ducts (Negative Pressure): -2".

B. All ducts shall be galvanized steel except as follows:
1. Natatorium equipment room ducts:
a. Aluminum or PVC coated galvanized steel (inside and out)
b. Welded/flanged seams and joints.

3.02 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. PVC Coated Metal Ductwork: Tape with PVC tape. Repair damage to PVC coating with manufacturers recommended materials.

E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

H. Identify and label all fire dampers and reheat coil locations on the ceiling or on a set of drawings.

3.03 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Unless otherwise noted, do not clean existing ductwork.

3.04 SEAM AND JOINT SEALING

A. Seal all duct seams and joints to the most severe requirement between the latest Chicago Building Code and SMACNA (DCS) for duct pressure class indicated.

B. Seal ducts before external insulation is applied.

3.05 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. For concrete structure installations: Install concrete inserts before placing concrete.

E. For concrete structure installations: Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.06 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA (DCS) for branch, outlet and inlet, and terminal unit connections.

3.07 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA (LEAK) and prepare test reports:
   1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
   4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 23 31 00

SECTION 23 31 00 (MEP)

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Manufactured ductwork and fittings

C. Natatorium ductwork

1.02 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. AWS D9.1/D9.1M - Sheet Metal Welding Code; 2018.

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

I. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.

J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012, 2nd Edition.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems. Drawn at a scale of not less than 1/4" = 1'-0".

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:
1. Spacing of hangers and supports.

E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

G. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.04 DELIVERY, STORAGE AND HANDLING

A. All materials shall be stored in a designated area and protected from inclement weather.

B. All materials shall be secured so as not to be a hazard during the construction process.

C. Store ductwork with tight-fitting seals on open ends to ensure ductwork is free of all dirt, debris and moisture during the installation process.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.

C. PVC Coating for Steel Ducts: 4 mils polyvinyl chloride plastic on both sides.

D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
   1. Hangers Installed in Corrosive Atmospheres: All-thread rods used in pool areas, pool equipment rooms, and pool supporting spaces shall be aluminum if the ducts are aluminum and stainless steel if the ducts are stainless steel.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   1. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
      a. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
      b. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
   3. Supports for Aluminum Ducts: Aluminum support materials.

I. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

J. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

K. Insulated Flexible Ducts: Flexible ducts wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.

L. Sealant Materials
   1. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes combinations of open-weave fabric strips and mastics.
   2. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

3. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
4. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.03 MANUFACTURED DUCTWORK AND FITTINGS

A. Duct Joints:
1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

B. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA (DCS) with metal thicknesses specified for longitudinal-seam straight ducts.

C. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

D. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA (DCS) unless otherwise indicated.
2. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
3. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

E. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Other Fittings: Riveted and bonded joints.

4. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.04 NATATORIUM DUCTWORK

A. Aluminum or PVC coated galvanized steel (inside and out)

2.05 LOCKER ROOM/SHOWER ROOM EXHAUST DUCTWORK

A. Aluminum or PVC coated galvanized steel, with seams and laps arranged on top of duct.

PART 3 - EXECUTION

3.01 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
1. Supply Ducts (constant volume units): +2".
2. Supply Ducts (before Air Terminal Units): +4".
3. Supply Ducts (after Air Terminal Units): +2".
4. Return Ducts (Negative Pressure): -2".
5. Return Ducts (return fan discharge and AHU intake / exhaust damper): -4".
6. Exhaust Ducts (Negative Pressure): -2".

B. All ducts shall be galvanized steel except as follows:
1. Locker room / shower room / green house ducts:
   a. Aluminum or PVC coated galvanized steel, with seams and laps arranged on top of duct.
2. Natatorium ducts:
   a. Aluminum or PVC coated galvanized steel (inside and out)
   b. Welded/flanged seams and joints.

3.02 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. PVC Coated Metal Ductwork: Tape with PVC tape. Repair damage to PVC coating with manufacturers recommended materials.

E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

H. Identify and label all fire dampers and reheat coil locations on the ceiling or on a set of drawings.

3.03 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Unless otherwise noted, do not clean existing ductwork.

3.04 SEAM AND JOINT SEALING

A. Seal all duct seams and joints to the most severe requirement between the latest Chicago Building Code and SMACNA (DCS) for duct pressure class indicated.

B. Seal ducts before external insulation is applied.

3.05 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. For concrete structure installations: Install concrete inserts before placing concrete.

E. For concrete structure installations: Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.06 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA (DCS) for branch, outlet and inlet, and terminal unit connections.

3.07 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA (LEAK) and prepare test reports:
   1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.

4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 23 31 00

SECTION 23 33 00 (LNK)
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air turning devices/extractors.

B. Duct access doors.

C. Fire dampers.

D. Flexible duct connectors.

E. Flexible ductwork

F. Volume control dampers.

1.02 REFERENCE STANDARDS

A. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2017.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.

E. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2013, with Editorial Revision.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

K. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

L. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

E. Project Record Drawings: Record actual locations of access doors and test holes.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A and NFPA 90B

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

B. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

C. All materials shall be stored in a designated area and protected from the environment.

D. All materials shall be secured so as not to be a hazard during the construction process.

E. All materials must be free of all dirt, debris and moisture during the installation process.

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. Comply with SMACNA (DCS) for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A653/A653M and having G90coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B209 alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: ASTM B221, alloy 6063, temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

G. All accessories installed in harsh environments (Natatorium, shower, fume hood exhaust, etc.) shall be provided with corrosion protection appropriate to the application.

2.02 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane)
2. Krueger-HVAC, Division of Air System Components
3. Ruskin Company, a brand of Johnson Controls
4. Titus HVAC, a brand of Johnson Controls

B. Fabricate to comply with SMACNA (DCS) for vanes and vane runners. Vane runners shall automatically align vanes.

C. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

D. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.03 DUCT ACCESS DOORS

A. Manufacturers:
1. Nailor Industries, Inc
2. Ruskin Company, a brand of Johnson Controls
3. CESCO Products
4. Ductmate Industries
5. Greenheck
6. Vent Products Co.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Continuous hinge and two sash locks.
3. Up to 24 by 48 inches: Continuous hinge and two compression latches with outside and inside handles.
4. Access doors shall be double wall construction.

2.04 FIRE DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc
2. Ruskin Company, a brand of Johnson Controls
3. Greenheck
4. Vent Products Co.
5. Price

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage, 0.0299 inch frame and 16 gage, 0.0598 inch flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
2. Ductmate Industries
3. Ventfabrics, Inc.
4. Ward Industries

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Indoor Flexible Duct Connections: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
a. Net Fabric Width: Approximately 2 inches wide.

D. Outdoor Flexible Duct Connections: shall be constructed of hypalon material for UV and water resistance.

2.06 FLEXIBLE DUCTS

A. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F

B. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.07 MANUAL VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc: www.nailor.com/#sle.
2. Ruskin Company, a brand of Johnson Controls
3. Vent Products Co.
4. Price
5. Greenheck
6. TAMCO

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

D. Single Blade Dampers:
1. Fabricate for duct sizes up to 6 by 30 inch.
2. Blade: 24 gage, 0.0239 inch, minimum.

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Steel Frames (For use in steel ductwork): Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades (For use with steel frames): 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames (For use in stainless steel or aluminum ductwork): Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades (For use with aluminum frames): 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades (For use with aluminum frames): 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve.
8. Tie Bars and Brackets: Aluminum (aluminum or stainless steel ductwork applications), Galvanized steel (galvanized steel ductwork applications).

F. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames (For use in steel ductwork) : galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades (For use with steel frames): 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames (For use in stainless steel or aluminum ductwork) : 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades (For use with aluminum frames): 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades (For use with aluminum frames): 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve thrust or ball.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum (aluminum or stainless steel ductwork applications), Galvanized steel (galvanized steel ductwork applications).

G. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 - HVAC Ducts and Casings for duct construction and pressure class.

B. Install duct access doors to allow for inspecting, adjusting, and maintaining duct accessories, control devices - sensors and terminal units as follows:
1. On both sides of duct coils. On terminal units coordinate upstream coil access door with equipment supplier.
2. Downstream from volume dampers, turning vanes, and duct mounted equipment.
3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
4. On sides of ducts where adequate clearance is available.
5. Where indicated on plans.
6. Upstream and downstream of ducted fans.

C. Provide turning vanes in all short radius / square elbows (>45 degrees) and tees.

D. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

E. Demonstrate re-setting of fire dampers to Board's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Use splitter dampers only where indicated.

J. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

K. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

3.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION 23 33 00

SECTION 23 33 00 (MEP)
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air turning devices/extractors.

B. Duct access doors.

C. Fire dampers.

D. Flexible duct connectors.

E. Flexible ductwork

F. Volume control dampers.

1.02 REFERENCE STANDARDS

A. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2017.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.

E. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2013, with Editorial Revision.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

K. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

L. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

E. Project Record Drawings: Record actual locations of access doors and test holes.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A and NFPA 90B

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

B. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

C. All materials shall be stored in a designated area and protected from the environment.

D. All materials shall be secured so as not to be a hazard during the construction process.

E. All materials must be free of all dirt, debris and moisture during the installation process.

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. Comply with SMACNA (DCS) for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A653/A653M and having G90coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B209 alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: ASTM B221, alloy 6063, temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

G. All accessories installed in harsh environments (Natatorium, shower, fume hood exhaust, etc.) shall be provided with corrosion protection appropriate to the application.

2.02 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane)
2. Krueger-HVAC, Division of Air System Components
3. Ruskin Company, a brand of Johnson Controls
4. Titus HVAC, a brand of Johnson Controls

B. Fabricate to comply with SMACNA (DCS) for vanes and vane runners. Vane runners shall automatically align vanes.

C. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

D. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.03 DUCT ACCESS DOORS

A. Manufacturers:
1. Nailor Industries, Inc
2. Ruskin Company, a brand of Johnson Controls
3. CESCO Products
4. Ductmate Industries
5. Greenheck
6. Vent Products Co.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Continuous hinge and two sash locks.
3. Up to 24 by 48 inches: Continuous hinge and two compression latches with outside and inside handles.
4. Access doors shall be double wall construction.

2.04 FIRE DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc
2. Ruskin Company, a brand of Johnson Controls
3. Greenheck
4. Vent Products Co.
5. Price

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling Dampers: Galvanized steel, 22 gage, 0.0299 inch frame and 16 gage, 0.0598 inch flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22 gage, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
2. Ductmate Industries
3. Ventfabrics, Inc.
4. Ward Industries

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Indoor Flexible Duct Connections: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
a. Net Fabric Width: Approximately 2 inches wide.

D. Outdoor Flexible Duct Connections: shall be constructed of hypalon material for UV and water resistance.

2.06 FLEXIBLE DUCTS

A. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F

B. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.07 MANUAL VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc; _____: www.nailor.com/#sle.
2. Ruskin Company, a brand of Johnson Controls
3. Vent Products Co.
4. Price
5. Greenheck
6. TAMCO

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

D. Single Blade Dampers:
1. Fabricate for duct sizes up to 6 by 30 inch.
2. Blade: 24 gage, 0.0239 inch, minimum.

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Steel Frames (For use in steel ductwork): Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades (For use with steel frames): 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames (For use in stainless steel or aluminum ductwork): Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades (For use with aluminum frames): 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades (For use with aluminum frames): 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve.
8. Tie Bars and Brackets: Aluminum (aluminum or stainless steel ductwork applications), Galvanized steel (galvanized steel ductwork applications).

F. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames (For use in steel ductwork) : galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades (For use with steel frames): 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames (For use in stainless steel or aluminum ductwork) : 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades (For use with aluminum frames): 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades (For use with aluminum frames): 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve thrust or ball.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum (aluminum or stainless steel ductwork applications), Galvanized steel (galvanized steel ductwork applications).

G. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 - HVAC Ducts and Casings for duct construction and pressure class.

B. Install duct access doors to allow for inspecting, adjusting, and maintaining duct accessories, control devices - sensors and terminal units as follows:
1. On both sides of duct coils. On terminal units coordinate upstream coil access door with equipment supplier.
2. Downstream from volume dampers, turning vanes, and duct mounted equipment.
3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
4. On sides of ducts where adequate clearance is available.
5. Where indicated on plans.
6. Upstream and downstream of ducted fans.

C. Provide turning vanes in all short radius / square elbows (>45 degrees) and tees.

D. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

E. Demonstrate re-setting of fire dampers to Board's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
1. Refer to Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Use splitter dampers only where indicated.

J. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

K. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

3.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION 23 33 00

SECTION 23 34 23 (LNK)
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

1.02 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
B. AMCA 99 - Standards Handbook 2016.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
J. UL 705 - Power Ventilators Current Edition, Including All Revisions.
K. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Provide wiring Diagrams: Power, signal, and control wiring.
D. Manufacturer's Instructions: Indicate installation instructions.
E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.05 FIELD CONDITIONS

A. Permanent ventilators may not be used for ventilation during construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.07 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Greenheck Fan Corporation: www.greenheck.com

B. Loren Cook Company: www.lorencook.com

C. PennBarry, Division of Air System Components: www.pennbarry.com

D. Twin City Fan & Blower: www.tcf.com

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. In general, direct drive fans with ECM motors/speed controller are preferred over belt drive fans.

C. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

D. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

E. Fabrication: Comply with AMCA 99.

F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

G. Motors and Electrical Accessories: Comply with the requirements of NEMA standards.

2.03 ROOF EXHAUSTERS

A. Fan Unit: Direct driven, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

C. Down blast discharge direction.

D. Direct drive motor assembly with ECM motor and variable speed controller.

E. Roof Curb: 16 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

F. Disconnect Switch: NEMA 3R, Factory wired, non-fusible, in housing for thermal overload protected motor.

G. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and CPS standard mechanical details.

B. Install units with clearances for service and maintenance.

C. Install power ventilators level and plumb.

D. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

E. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

F. Install dampers on inlet to roof exhausters in accordance with CPS standard mechanical details.

3.02 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

3.03 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

D. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.05 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain the fans.

1. Train Board's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining fans. The training will occur after the startup report has been provided to the Board and the trainer will provide two (2) Installation and Operations manuals for the use of the Board’s personnel during training.
2. Review data in maintenance manuals. Refer to Division 01. All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.
3. Schedule training with Board, through Architect/Engineer of Record, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or designated Board personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 01 and 23.

END OF SECTION

SECTION 23 34 23 (MEP)
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inline centrifugal fans.

1.02 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
B. AMCA 99 - Standards Handbook 2016.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 705 - Power Ventilators Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Provide wiring Diagrams: Power, signal, and control wiring.
D. Manufacturer's Instructions: Indicate installation instructions.
E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.05 FIELD CONDITIONS

A. Permanent ventilators may not be used for ventilation during construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.07 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.
B. Operating Limits: Classify according to AMCA 99.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Greenheck Fan Corporation: www.greenheck.com
B. Loren Cook Company: www.lorencook.com
C. PennBarry, Division of Air System Components: www.pennbarry.com
D. Twin City Fan & Blower: www.tcf.com

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.
B. In general, direct drive fans with ECM motors/speed controller are preferred over belt drive fans.
C. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
D. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
E. Fabrication: Comply with AMCA 99.
F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
G. Motors and Electrical Accessories: Comply with the requirements of NEMA standards.

2.03 INLINE CENTRIFUGAL FANS AND BLOWERS

A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor.
B. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
C. Direct drive motor assembly with ECM motor and variable speed controller.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and CPS standard mechanical details.
B. Install units with clearances for service and maintenance.
C. Install power ventilators level and plumb.
D. Hung Cabinet Fans:
    1. Install fans with resilient mountings and flexible electrical leads.
    2. Install flexible connections specified in Section 23 33 00 - Air Duct Accessories between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

3.02 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing procedures.
C. Lubricate bearings.

3.03 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
    1. Verify that shipping, blocking, and bracing are removed.
    2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
    3. Verify that cleaning and adjusting are complete.
    4. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
    5. Adjust damper linkages for proper damper operation.
    6. Verify lubrication for bearings and other moving parts.

7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

D. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.05 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain the fans.
1. Train Board's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining fans. The training will occur after the startup report has been provided to the Board and the trainer will provide two (2) Installation and Operations manuals for the use of the Board’s personnel during training.
2. Review data in maintenance manuals. Refer to Division 01. All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.
3. Schedule training with Board, through Architect/Engineer of Record, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or designated Board personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 01 and 23.

END OF SECTION

SECTION 23 36 00 (LNK)

AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fan-powered air terminal units.

1.02 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.

C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; 2016.

D. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2016.

E. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2013).

F. ASTM A603 - Standard Specification for Zinc-Coated Steel Structural Wire Rope; 1998 (Reapproved 2014).

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

H. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2015.

I. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

K. NFPA 70 - National Electrical Code; 2017.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

M. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.

N. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

O. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

F. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

G. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.

I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Board's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Codes and Standards
   1. Air Diffusion Council (ADC) Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
   2. AHRI Compliance: Provide air terminals which have been tested and rated in accordance with AHRI 880 (I-P) and bear ARI certification seal.
   3. NFPA Compliance: Install air terminals according to NFPA 90A.
   4. Comply with NFPA 70 for electrical components and installation.
   5. Comply with City of Chicago Building Code.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.

B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

1.06 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1. This coordination will include clear indication on the drawings of the required access clearances for the control panel, and equipment access panels to allow maintenance, minimum 2 feet or as required by code. Conduit, pipe or duct may not be routed in the area required for any access to the unit.

PART 2 - PRODUCTS

2.01 FAN-POWERED SERIES AIR TERMINAL UNITS

A. Manufacturers:
1. Price Industries, Inc: www.priceindustries.com/#sle.
2. Nailor Industries
3. Titus
4. Krueger

B. General:
1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.

C. Unit Casing:
1. Minimum 22 gage, 0.034 inch galvanized steel or 0.032 inch aluminum.
2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
3. Unit Discharge: Rectangular, suitable for flanged duct connection.
4. Plenum Inlet: Filter rack with disposable filters.
   a. 1 inch thick disposable fiberglass filters.
5. Acceptable Liners:
   a. 3/4 inch thick polyurethane foam adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum flame spread index of 25 and a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.

D. Primary Air Damper Assembly:
1. Heavy-gage, galvanized steel or extruded aluminum construction with solid shaft rotating in self lubricating bearings.
2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff at 3" wg inlet static pressure.
4. Fan(s): Forward curved, centrifugal type, direct drive.
5. Fan Motor:
   a. ECM (Electrically Commutated Motor):
      1) Brushless DC controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator.
      2) Permanent magnet type motor with near-zero rotor losses designed for synchronous rotation.
   b. Fan motor shaft directly connected to fan and and isolated from unit casing to prevent transmission of vibration.

E. Hot Water Heating Coil(where scheduled):
1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
2. Heavy-gage aluminum fins, mechanically bonded to tubes.
3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.

4. Coil leak tested to minimum 305 psig.
5. Base performance data on tests run in accordance with AHRI 410.

F. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

G. Controls:
1. DDC (Direct-Digital Controls):
a. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
b. Coordinate controls and sequence with BAS Specifications.
2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
a. Signal accuracy: Plus/minus five percent throughout terminal operating range.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance, 2 foot minimum or as required by code for all access doors or panels.

D. See drawings for the size(s) and duct location(s) of the air terminal units.

E. Provide ceiling access doors or locate units above easily removable ceiling components.

F. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM).

G. Embed anchors in concrete in accordance with ASTM E488/E488M.

H. Do not support from ductwork.

I. Connect to ductwork in accordance with Section 23 31 00 - HVAC Ducts and Casings.

J. Install heating coils in accordance with Section 23 82 00 - Convection Heating and Cooling Units.

K. Verify that electric power is available and of the correct characteristics.

3.03 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Unless otherwise indicated on drawings/details, install union, P&T tap, y-strainer with hose end blow down valve and ball valve on supply-water connection and union, P&T tap, manual air vent, control valve, calibrated balancing valve and ball valve on return-water connection. If supply side is the high point of installation, install manual air vent on supply side. Hydronic specialties are specified in Section 23 21 13 - Hydronic Piping.

D. Connect ducts to air terminal units according to Section 23 31 00 - HVAC Ducts and Casings.

E. Flexible duct connections to air terminal unit inlet shall be a maximum of 2 ft. long.

F. Ground units with electric heating coils according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

G. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

I. Provide access doors on the upstream side of all heating coils.

3.04 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow.

3.05 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test (when hydronic coils are provided): After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.06 CLEANING

A. Vacuum clean coils and inside of units.

B. Install new filters.

END OF SECTION 23 36 00

SECTION 23 37 00 (LNK)

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Diffusers.

1.02 REFERENCE STANDARDS

A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.

B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).

C. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.

E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2013.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to material, size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, pressure drop, throw velocity, and noise level.

C. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

1.04 QUALITY ASSURANCE

A. AHRI Compliance: Test and rate diffusers, registers, and grilles in accordance with AHRI 880 (I-P).

B. ASHRAE Compliance: Test and rate diffusers, registers, and grilles in accordance with ASHRAE Std 70.

C. ADC Compliance: Test and rate diffusers, registers, and grilles in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

D. ADC Seal: Provide diffusers, registers, and grilles bearing ADC Certified Rating Seal.

E. NFPA Compliance: Install diffusers, registers, and grilles in accordance with NFPA 90A.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.06 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2 - PRODUCTS

2.01 GENERAL APPLICATION INFORMATION

A. In general, diffusers, registers, and grilles shall be constructed of steel with color as selected by AOR/EOR.

2.02 MANUFACTURERS

A. Diffusers, Registers, and Grilles
1. Price Industries: www.price-hvac.com.
2. Titus: www.titus-hvac.com.
3. Tuttle and Bailey: www.tuttleandbailey.com/sle.
4. Nailor

2.03 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square, stamped, plaque face diffuser to discharge air in 360 degree, one way, two way, three way, and four way pattern with sectorizing baffles where indicated.

B. Connections: Round.

C. Frame: Provide surface mount, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Steel or Aluminum as indicated, with baked enamel finish.

E. Color: As selected by Architect/Engineer of Record from manufacturer's standard range.

2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Same as Rectangular Ceiling Diffusers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

3.02 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.03 CONTRACTOR STARTUP AND REPORTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 00

SECTION 23 37 00 (MEP)

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.02 REFERENCE STANDARDS

A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.

B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).

C. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.

E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2013.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to material, size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, pressure drop, throw velocity, and noise level.

C. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

1.04 QUALITY ASSURANCE

A. AHRI Compliance: Test and rate diffusers, registers, and grilles in accordance with AHRI 880 (I-P).

B. ASHRAE Compliance: Test and rate diffusers, registers, and grilles in accordance with ASHRAE Std 70.

C. ADC Compliance: Test and rate diffusers, registers, and grilles in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

D. ADC Seal: Provide diffusers, registers, and grilles bearing ADC Certified Rating Seal.

E. NFPA Compliance: Install diffusers, registers, and grilles in accordance with NFPA 90A.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.06 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

PART 2 - PRODUCTS

2.01 GENERAL APPLICATION INFORMATION

A. In general, diffusers, registers, and grilles shall be constructed of steel with color as selected by AOR/EOR.

2.02 MANUFACTURERS

A. Diffusers, Registers, and Grilles
1. Price Industries: www.price-hvac.com.
2. Titus: www.titus-hvac.com.
3. Tuttle and Bailey: www.tuttleandbailey.com/sle.
4. Nailor

2.03 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square, stamped, plaque face diffuser to discharge air in 360 degree, one way, two way, three way, and four way pattern with sectorizing baffles where indicated.

B. Connections: Round.

C. Frame: Provide surface mount, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Steel or Aluminum as indicated, with baked enamel finish.

E. Color: As selected by Architect/Engineer of Record from manufacturer's standard range.

2.04 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.

B. Frame: 1-1/4 inch margin with countersunk screw mounting.

C. Fabrication: Aluminum frames and blades, with factory baked enamel finish.

D. Color: To be selected by Architect/Engineer of Record from manufacturer's standard range.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

3.02 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.03 CONTRACTOR STARTUP AND REPORTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 00

SECTION 23 62 00 (MEP)

PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged, refrigerant compressor and condenser units.

1.3 SUBMITTALS

A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.
6. Evaporators.

D. Field quality-control reports.

E. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of compressor and condenser units and are based on the specific system indicated. See Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of preliminary acceptance, whichever is longer.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of preliminary acceptance.

2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of preliminary acceptance.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS (21 TO 422 kW)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Commercial HVAC Systems.

2. Daikin

3. Trane; a business of American Standard Companies.

4. YORK; a Johnson Controls company.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: On-off compressor cycling and Hot-gas bypass on lead compressor.

D. Refrigerant: R-410A.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

F. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

1. Permanently lubricated, ball-bearing totally enclosed motors.

2. Separate motor for each fan.

3. Dynamically and statically balanced fan assemblies.

G. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.

2. Automatic-reset, low-pressure cutout switches.

3. Low-oil-pressure cutout switch.

4. Compressor-winding thermostat cutout switch.

5. Three-leg, compressor-overload protection.

6. Control transformer.

7. Magnetic contactors for compressor and condenser fan motors.

8. Timer to prevent excessive compressor cycling.

H. Accessories:

1. Hot-gas bypass kit.

I. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
3. Condenser coil hail guard.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.3 SOURCE QUALITY CONTROL

A. Energy Efficiency: Equal to or greater than prescribed by International Energy Conservation Code 2018

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install roof-mounting units on equipment supports specified in Division 07.

C. Vibration Isolation: Mount compressor and condenser units on restrained spring isolators with a minimum deflection of 3/4".

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Comply with requirements for piping in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

E. Verify proper operation of condenser capacity control device.

F. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

G. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION

SECTION 23 74 16.11 (LNK)

PACKAGED ROOFTOP UNIT (15 TONS AND LESS)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Packaged, gas heat/DX cooled, rooftop air handling units

1.02 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.

B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment; 2015.

C. AHRI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment; 2011.

D. ANSI Z21.47 - American National Standard for Gas-Fired Central Furnaces; 2016.

E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.

F. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017.

G. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; 2016.

H. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019, Including All Amendments and Errata.

I. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2016.

J. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; Latest.

K. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2016.

L. NFPA 54 - National Fuel Gas Code; 2018.

M. NFPA 70 - National Electrical Code; 2017.

N. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.

O. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.

1.03 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at AHRI standard conditions and at conditions scheduled (provide EER).

2. Performance at AHRI standard unloading conditions and at conditions scheduled (provide EER).
3. Refrigerant type and capacity of unit.
4. Characteristics of safety relief valves.
5. Minimum entering condenser-air temperature
6. Sound data.
7. Weight
8. Dimensions
9. Unit construction.
10. Components
11. Options
12. Required clearances
13. Characteristics
14. Furnished specialties
15. Accessories.
16. ASHRAE Std 90.1 I-P for energy compliance statement.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

D. Manufacturer's Instructions: Include assembly instructions, support details, connection requirements, and start-up instructions.

E. Operation and Maintenance Data: Provide maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Board's name and registered with manufacturer.

G. Field quality control test reports.

1.04 QUALITY ASSURANCE

A. AHRI Compliance:
1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:
1. Comply with ASHRAE Std 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE Std 62.1 for condensate drain pans.
4. Comply with ASHRAE Std 90.1 I-P for minimum efficiency of heating and cooling.

C. City of Chicago Compliance: Comply with City of Chicago Building Code

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

B. Follow manufacturer’s instructions for unloading, rigging and storage of equipment.

C. Maintain manufacturer’s recommended temperature and humidity limits during storage and installation. Protect equipment from dirt, dust and other jobsite contaminants and conditions detrimental to the equipment.

1.06 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of preliminary acceptance, whichever is longer.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of preliminary acceptance.
   2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten years from date of preliminary acceptance.
   3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than one year from date of preliminary acceptance.
   4. Warranty Period for Control Boards: Manufacturer's standard, but not less than one year from date of preliminary acceptance.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Carrier:

B. Trane, a brand of Ingersoll Rand

C. Daikin

D. York International Corporation/Johnson Controls Inc

2.02 AIR CONDITIONING UNITS

A. Description: Factory assembled and tested, packaged, self-contained, roof-mounted, air cooled air conditioning units, with electric refrigeration system, gas fired heating, outside air louvers, built-in temperature controls; fully charged with refrigerant and filled with oil.

B. Energy Efficiency:
1. Air conditioners shall have a EER better than ASHRAE Std 90.1 I-P under AHRI test procedures. When air conditioners with higher efficiencies then the Standard are scheduled on the drawings, the more efficient value shall be the minimum project requirement.

2.03 CASING

A. General: Casings shall be formed and reinforced, foil faced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed and access doors with neoprene gasket.

B. Exterior casing material shall be galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Cabinet shall be tested 1000 hour in salt spray test in compliance with ASTM B117.

C. Casing Insulation shall comply with NFPA 90A or NFPA 90B and ASTM C1071, Type I. Minimum thickness shall be 1/2 inch, with an aluminum foil or neoprene coating on all surfaces in contact with the air stream.

D. Condensate drain pans shall be formed sections of stainless steel, with a minimum ¾" NPT drain connection.

E. Provide with steel hail guard.

2.04 FANS

A. Evaporator fan shall be backward inclined, direct drive plenum fans with variable speed drive. Bearings shall be sealed and permanently lubricated.

B. Condenser fans shall be propeller, mounted on shaft of permanently lubricated motor.

C. Fan Motor: Comply with requirements in Section 23 05 13 - Common Motor Requirements for HVAC Equipment

D. Provide power exhaust fan.

2.05 COILS

A. Evaporator and condenser refrigerant coils shall incorporate aluminum-plate fins mechanically bonded to seamless copper tubes. Coils shall be factory pressure tested per AHRI standards and leak tested at 150 psig.

2.06 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection. For units more than 7.5 tons, provide two compressors. Motor shall be suction gas cooled.

B. Refrigeration Specialties:
1. Refrigerant Charge: R-407 or 410A. Units shall be fully charged when delivered to the site.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset compressor motor thermal overload.
6. Service ports installed in compressor suction and liquid lines.

2.07 AIR FILTRATION

A. Minimum arrestance according to ASHRAE Std 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2. Filters shall be glass fiber, two-inch thick (MERV 13).

2.08 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54. ASHRAE Std 90.1 I-P compliant. Modulating capacity control.

B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.
1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark.

C. Heat-Exchanger: Stainless steel.

D. Combustion system shall be induced-draft with redundant main gas valves.

E. Safeties: Provide high-temperature limit switches, flame rollout switch, flame proving controls and induced draft pressure sensor.

2.09 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated with bird screen and hood.

2.10 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.11 CONTROLS

A. Control sequence is specified in Division 23 Sections.

B. Direct digital controls with BACnet IP communication, and Fault Detections and Diagnosis.

2.12 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.13 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards. Roof curb height shall be 14 inches minimum above roof surface.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Roof Curb: Install on roof structure, level and secure, according to AHRI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.

C. Install condensate drain, pipe shall be minimum 1 1/2" copper piping, with trap and concrete splash block.

D. Install piping adjacent to RTUs to allow service and maintenance.
1. Gas Piping: Comply with applicable requirements in Section 33 51 13 - Natural Gas Piping. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 23 33 00 - Air Duct Accessories.
4. Install return-air duct continuously through roof structure.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

B. Tests and Inspections:
1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.04 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of preliminary acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.05 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
16. Inspect and record performance of interlocks and protective devices; verify sequences.
17. Operate unit for an initial period as recommended or required by manufacturer.
18. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.

e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

19. Calibrate thermostats.
20. Adjust and inspect high-temperature limits.
21. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
22. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
23. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
24. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.
25. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
26. Verify operation of remote BAS interface.
27. After startup and performance testing and prior to preliminary acceptance, replace existing filters with new filters.
28. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain RTUs.

3.06 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01.

END OF SECTION 23 74 16.11

SECTION 23 82 00 (LNK)
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cabinet unit heaters.
B. Air coils.

1.02 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addendum (2011).
B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter 1992 Edition.
C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Errata (2020).
D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
F. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2020.
G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2005 (Revised 2009).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Conduct a pre-installation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
    1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Pre-installation Meeting.
    2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
    3. Require attendance by all affected installers including but not limited to
        a. Contractor's Superintendent
        b. Installer
        c. Manufacturer/Fabricator Representative
        d. Other affected Subcontractors
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide typical catalog of information including arrangements, fan curves, sound levels, etc.
C. Shop Drawings:
    1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
    2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
    3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors,

pilaster covers, and comparison of specified cooling or heat required to actual cooling or heat output provided.

4. Indicate mechanical and electrical service locations and requirements.

D. Selection Samples: For each finish product specified, color chart representing manufacturer's full range of available colors.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Board's name and registered with manufacturer.

G. Maintenance Materials: Furnish the following for Board's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements for additional provisions.
2. Extra Filters: One set of each type and size.

1.05 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE AND HANDLING

A. Units shall be stored and handled in accordance with manufacturer’s instructions.

B. Protect units from damage and construction debris before installation. Cover open pipe ends during shipping and storage at the construction site.

C. Coils:

1. Comply with ASHRAE Std 62.1, Section 7 (practices to be followed during construction and startup). Protect equipment from rain and other sources of moisture by appropriate in-transit and on-site procedures.
2. Follow manufacturer’s recommendations for handling, unloading and storage.
3. Seal openings to protect against damage during shipping, handling and storage.
4. Provide shrink-wrap around entire exterior of coil. The membrane shall cover the entire coil to fully protect it during shipping and storage.
5. Storage: Store per manufacturer’s written recommendations. Store coils indoors in a warm, clean, dry place where the units will be protected from weather, construction traffic, dirt, dust, water and moisture.

1.07 COORDINATION

A. For cabinet unit heaters and fan coils that penetrate or are supported by the ceiling, coordinate layout and installation of units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.08 WARRANTY

A. See Section 01 78 23.1 - Closeout Submittals for additional warranty requirements.

B. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of Preliminary Acceptance, whichever is longer.

PART 2 PRODUCTS

2.01 HYDRONIC CABINET UNIT HEATERS

A. Manufacturers:

1. Dunham Bush: www.dbamericas.com
2. Engineered Air: www.engineeredair.com
3. International Environmental Corp: ww.iec-okc.com
4. Vulcan Radiator: www.vulcanrad.com
5. ZehnderRittling: www.sehnder-rittling.com

B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) as suitable for the purpose indicated. Comply with UL 2021.

C. Coils:
   1. Evenly spaced aluminum fins mechanically bonded to copper tubes. Minimum 2 row coils.
   2. Heating Hot Water: Suitable for working temperatures up to a maximum not less than 200 degrees F.

D. Cabinet: Steel with factory prime coating, ready for field painting.
   1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.

E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven. Scheduled capacity is based on low fan speed.

F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

G. Control: Local disconnect switch with remote mounted 7-day programmable thermostat.
   1. Lockable cover with tamper proof screws
   2. Low voltage relays and control transformers.

H. Filters: Minimum arrestance according to ASHRAE Std 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2.
   1. Pleated: 90 percent arrestance and 7 MERV.

2.02 AIR COILS

A. Manufacturers:
   1. Refrigerant Coils:
      a. AAON: www.aaon.com
      b. Aerofin Corporation: www.aerofin.com
      c. Carrier Corporation: www.commercial.carrier.com
      d. Coilmaster Corp: www.coilmastercorp.com
      e. Direct Coil: www.directcoil.com
      f. Daikin Applied: www.daikinapplied.com
      g. Heatcraft: www.heatcraftrpd.com
      h. Precision Coils: www.precision-coils.com
      i. Trane, a brand of Ingersoll Rand: www.trane.com
      j. USA Coil & Air: www.usacoil.com
      k. York, a Johnson Controls Company: www.york.com

B. Refrigerant Coils:
   1. Coils rated and tested in accordance with AHRI 410.
   2. Tubes: Material to consist of seamless copper, mechanically expanded to fins; appropriate tube joining methods based on tube material.
   3. Fins: Material to consist of aluminum or copper, continuous plate type with full fin collars. Maximum of 12 fins per inch (FPI).
   4. Casing: ASTM A666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in or flanged mounting.
   5. Maximum face velocity shall not exceed 450FPM.
   6. Suction Header: Construct of nonferrous material with tube connection appropriate to header material provided. ASTM B88, Type L copper tube with brazed joints.
   7. Liquid distributor: Brass or copper venture type with seamless copper distribution tubes; maximum 12 or 18 circuits per distributor. ASTM B88, Type L copper tube with brazed joints.
   8. Configuration: Down feed with bottom suction to prevent oil trapping.
   9. Acceptable Factory Testing Methods:

a. Proof test at 1.5 times the maximum operating pressure and leak test at the maximum operating temperature.
b. Perform hydrostatic testing for coils with removable headers in accordance with approved shop drawings and normally accepted means and methods.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for installation.
B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's recommendations.
B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
C. Do not damage equipment or finishes.
D. Cabinet Unit Heaters:
1. Coordinate to ensure correct recess size for recessed units.
2. Install new filters in each unit within two weeks of Substantial Completion.
3. Install piping adjacent to unit to allow service and maintenance.
4. Provide temperature controls.
5. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
6. Connect wiring according to Section 26 05 83 - Wiring Connections.
E. Units with Hydronic Coils:
1. Provide factory piping package for hydronic units. Install piping package if shipped loose.
2. Where drawings/details do not indicate piping arrangement, provide:
a. Hydronic units (per coil): Supply side - isolation valve, y-strainer with blow down valve and hose cap, manual air vent, union, p&t tap and union coil connection. Return side - isolation valve, p&t, calibrated balance valve, p&t and manual air vent.
3. Connect piping to unit.
4. Coordinate valve trim with CPS Mechanical Details.
F. Air Coils:
1. Install in ducts and casings in accordance with SMACNA (DCS).
a. Support coil sections independent of piping on steel channel or double angle frames and secure to casing.
b. Provide frames for maximum of three coil sections.
c. Arrange supports to avoid piercing drain pans.
d. Provide airtight seals between coil and casing or duct.
e. Provide smooth duct transitions between coils and ducts.
f. Provide access doors upstream and downstream of coils for maintenance.
2. Coil Safeguards:
a. Protect coils to prevent damage to flanges and fins.
b. Comb out damaged fins.
3. Install all coils level except cleanable coils with 1:50 pitch.
4. Make connections to hydronic coils with unions and flanges.
5. Hydronic (Drainable) Coils:
a. Connect water supply to leaving air side of coil (counterflow arrangement).

b. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping. Refer to CPS standard mechanical details for additional requirements.
c. Locate supply water connection on leaving air side at bottom of supply header and return water connection at top.
d. Provide manual air vents with stop valves at high points.
    1) Install drain connections at low points of installation.

6. Cooling Coils:
    a. Cooling Condensate Drain Pan and Drain Connection:
        1) Fabricate from stainless steel 20 gage, 0.0359 inch sheet steel, extend 3 inches from face of entering air side, 6 inches from the face of the leaving air side, and 4 inches from the face of moisture eliminators.
        2) Design slope in accordance with ASHRAE Std 62.1 and install to prevent standing water.
        3) Pipe drains individually to floor drain with water seal trap.
        4) See project details for additional requirements.
    b. Install condensate drain pan under each main cooling coil and intermediate condensate drain pan at each level of stacked cooling coils to collect all condensate from coil assembly, pipe header, pipe return bends, upstream run-off, and downstream carry-over.
    c. Insulate bottom of intermediate drain pans for coils mounted in 100 percent outdoor air units with 3/8 inch thick flexible closed cell elastomeric insulation, with the upstream edge protected by stainless steel angle.
        1) Provide rigidly supported, leak-tight copper drain piping from each intermediate pan to pan below.
7. Refrigerant Coils:
    a. Provide sight glass in liquid line within 12 inches of coil.

3.03 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.
B. Vacuum clean coils and inside of units.
C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
D. Install new filters.

END OF SECTION

SECTION 23 82 00 (MEP)
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air coils.

1.02 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addendum (2011).
B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter 1992 Edition.
C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Errata (2020).
D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
F. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
G. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2020.
H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2005 (Revised 2009).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
    1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Preinstallation Meeting.
    2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
    3. Require attendance by all affected installers including but not limited to
        a. Contractor's Superintendent
        b. Installer
        c. Manufacturer/Fabricator Representative
        d. Other affected Subcontractors
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide typical catalog of information including arrangements, fan curves, sound levels, etc.
C. Shop Drawings:
    1. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
    2. Indicate mechanical and electrical service locations and requirements.
D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Board's name and registered with manufacturer.
F. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE
A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
B. Comply with minimum COP/efficiency levels according to ASHRAE Std 90.1 I-P.

1.06 DELIVERY, STORAGE AND HANDLING
A. Units shall be stored and handled in accordance with manufacturer's instructions.
B. Protect units from damage and construction debris before installation. Cover open pipe ends during shipping and storage at the construction site.
C. Coils:
1. Comply with ASHRAE Std 62.1, Section 7 (practices to be followed during construction and startup). Protect equipment from rain and other sources of moisture by appropriate in-transit and on-site procedures.
2. Follow manufacturer's recommendations for handling, unloading and storage.
3. Seal openings to protect against damage during shipping, handling and storage.
4. Provide shrink-wrap around entire exterior of coil. The membrane shall cover the entire coil to fully protect it during shipping and storage.
5. Storage: Store per manufacturer's written recommendations. Store coils indoors in a warm, clean, dry place where the units will be protected from weather, construction traffic, dirt, dust, water and moisture.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of Preliminary Acceptance, whichever is longer.

PART 2 PRODUCTS

2.01 AIR COILS
A. Manufacturers:
1. Refrigerant Coils:
a. AAON: www.aaon.com
b. Aerofin Corporation: www.aerofin.com
c. Carrier Corporation: www.commercial.carrier.com
d. Coilmaster Corp: www.coilmastercorp.com
e. Direct Coil: www.directcoil.com
f. Daikin Applied: www.daikinapplied.com
g. Heatcraft: www.heatcraftrpd.com
h. Precision Coils: www.precision-coils.com
i. Trane, a brand of Ingersoll Rand: www.trane.com
j. USA Coil & Air: www.usacoil.com
k. York, a Johnson Controls Company: www.york.com
2. Electric Coils:
a. Brasch Manufacturing Company: www.braschmfg.com
b. Chromalox: wwwchromalox.com
c. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com
B. Refrigerant Coils:
1. Coils rated and tested in accordance with AHRI 410.

2. Tubes: Material to consist of seamless copper, mechanically expanded to fins; appropriate tube joining methods based on tube material.
3. Fins: Material to consist of aluminum or copper, continuous plate type with full fin collars. Maximum of 12 fins per inch (FPI).
4. Casing: ASTM A666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in or flanged mounting.
5. Maximum face velocity shall not exceed 450FPM.
6. Suction Header: Construct of nonferrous material with tube connection appropriate to header material provided. ASTM B88, Type L copper tube with brazed joints.
7. Liquid distributor: Brass or copper venture type with seamless copper distribution tubes; maximum 12 or 18 circuits per distributor. ASTM B88, Type L copper tube with brazed joints.
8. Configuration: Down feed with bottom suction to prevent oil trapping.
9. Acceptable Factory Testing Methods:
    a. Proof test at 1.5 times the maximum operating pressure and leak test at the maximum operating temperature.
    b. Perform hydrostatic testing for coils with removable headers in accordance with approved shop drawings and normally accepted means and methods.

C. Electric Coils:
1. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) as suitable for the purpose indicated.
2. Standard Built-In Components:
    a. Contactors.
    b. Airflow switch.
    c. Interlocked disconnect switch.
    d. Fused transformers.
    e. Circuit fuses.
    f. Load and control terminal blocks.
3. Assembly: Terminal control box with hinged or screwed access cover, heating element, casing, and controls.
4. Open Coil: Nickel chromium heating element, stainless steel or nickel plated terminals supported in ceramic bracket bushings.
5. Frame: Heavy gage galvanized steel for slip-in mounting.
6. SCR control.
7. Over-Temperature Protection: Provide thermal cutouts for primary and secondary over-temperature protection.
8. Additional Controls:
    a. Toggle switches; one per step.
    b. Step controller.
    c. Time-delay relay.
    d. Pilot lights; one per step.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for installation.
B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's recommendations.
B. Do not damage equipment or finishes.
C. Air Coils:

1. Install in ducts and casings in accordance with SMACNA (DCS).
    a. Support coil sections independent of piping on steel channel or double angle frames and secure to casing.
    b. Provide frames for maximum of three coil sections.
    c. Arrange supports to avoid piercing drain pans.
    d. Provide airtight seals between coil and casing or duct.
    e. Provide smooth duct transitions between coils and ducts.
    f. Provide access doors upstream and downstream of coils for maintenance.
2. Coil Safeguards:
    a. Protect coils to prevent damage to flanges and fins.
    b. Comb out damaged fins.
3. Install all coils level except cleanable coils with 1:50 pitch.
4. Cooling Coils:
    a. Cooling Condensate Drain Pan and Drain Connection:
        1) Fabricate from stainless steel 20 gage, 0.0359 inch sheet steel, extend 3 inches from face of entering air side, 6 inches from the face of the leaving air side, and 4 inches from the face of moisture eliminators.
        2) Design slope in accordance with ASHRAE Std 62.1 and install to prevent standing water.
        3) Pipe drains individually to floor drain with water seal trap.
        4) See project details for additional requirements.
    b. Install condensate drain pan under each main cooling coil and intermediate condensate drain pan at each level of stacked cooling coils to collect all condensate from coil assembly, pipe header, pipe return bends, upstream run-off, and downstream carry-over.
    c. Insulate bottom of intermediate drain pans for coils mounted in 100 percent outdoor air units with 3/8 inch thick flexible closed cell elastomeric insulation, with the upstream edge protected by stainless steel angle.
        1) Provide rigidly supported, leak-tight copper drain piping from each intermediate pan to pan below.
5. Refrigerant Coils:
    a. Provide sight glass in liquid line within 12 inches of coil.
6. Electric Coils:
    a. Provide minimum airflow switch.
    b. Provide high limit switch.
    c. Provide disconnect.
    d. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
    e. Connect wiring according to Section 26 05 83 - Wiring Connections.
    f. Perform the following field tests and inspections and prepare test reports:
        1) Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
        2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.03 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.
B. Vacuum clean coils and inside of units.
C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

D. Install new filters.

END OF SECTION

SECTION 23 84 17 (MEP)

NATATORIUM DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, factory-assembled and tested, refrigerant-type, mechanical dehumidification units designed for a natatorium environment (outdoor condenser with outdoor RTU).

1.2 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include or indicated the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Certified furnace-performance ratings with system operating conditions indicated.
5. Certified energy recovery performance ratings with system operating conditions indicated.
6. Compressor performance characteristics and refrigerant charge.
7. Condenser performance characteristics.
8. Motor ratings, electrical characteristics, and motor and fan accessories.
9. Material gages and finishes.
10. Filters with performance characteristics.
11. Dampers, including housings, linkages, and operators.
12. Accessories.
13. Required access clearances.
14. Wiring Diagrams: Power, signal, and control wiring. Clearly distinguish between factory-installed and field-installed wiring.
15. Controls & Sequence of Operation.
16. Field or Factory certified air leakage test (maximum 1% airflow from -4”WC to +4”WC).
17. Non-spring isolator roof curb (Renovation Projects unless scheduled with vibration curb).

B. Shop Drawings: Include plans, elevations, sections, enlarged details, and attachments to other work.

1. Where not clearly indicated on Product Data, provide details of equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Reports:

1. Startup report.
2. Field Quality-Control Test Reports: Submit reports documenting the activities performed. These reports shall be submitted within two weeks following the completion of startup procedures.
3. Training Reports: Submit reports on training documenting dates and attendance. Submit after training is completed.

D. Operation and Maintenance Manuals. Provide two-weeks prior to start-up.

E. Warranty: Sample of warranties specified.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Award the work to a single firm that specializes in the production of dehumidification units, with not less than five years experience in the production of units comparable in size and performance to those required for the Project, and whose work has resulted in construction with a history of successful in-service performance. The manufacturer shall have sufficient production capacity, have organized quality control and testing procedures, to produce the dehumidification units required for the Project without causing a delay in the Work.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, "National Electric Code," and the Chicago Building Code by UL or another testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. ASHRAE Compliance:

1. Comply with ASHRAE 62.1.
2. Comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
3. Comply with ASHRAE 90.1.

D. Source Limitations: Obtain equipment through one source from a single manufacturer.

E. NFPA Compliance: Units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

F. ARI Certification: Coils shall comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

G. Piping shall be in accordance with the Chicago Building Code.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Package and protect equipment during transit, storage, and handling in accordance with manufacturer's recommendations to ensure units are free of damage when installed. Tightly seal external openings, in accordance with manufacturer's recommendations.

B. Provide protective crating and covering, and deliver with manufacturer's original labels intact.

1. A detailed list of loose-shipped items shall be included, with detailed instructions for installation.
2. Each unit shall have a label indicating its tag number, segment sequence number, and direction of airflow, and safety warnings.

C. Store equipment in a dry location, off of ground, under cover, in accordance with manufacturer's recommendations. Provide for air circulation beneath covers to prevent condensation.

1. Store electronic equipment in a dry, warm, ventilated, weathertight location. Do not store electronic equipment in wet or damp areas.
2. Protect controls devices, motor control devices, and other electronic equipment to ensure they will be free of damage at time of installation.

D. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

E. Lift and support units with the manufacturer's designated lifting or supporting points, in accordance with manufacturer's written instructions.

F. Comply with ASHRAE 62for mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design.

G. Comply with ASHRAE 62 for practices to be followed during construction and startup.

1.5 COORDINATION

A. Outdoor Installations - Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Coordinate size and location of structural-steel support members.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Dehumidication Units: One year from date of Substantial Completion / Preliminary Acceptance, or eighteen months from shipment, whichever is longer.
2. Warranty Period for Compressors: Five years from date of Substantial Completion / Preliminary Acceptance.
3. Warranty for Fuel Fired Heat Exchangers: Ten years from date of Substantial Completion / Preliminary Acceptance.
4. Warranty Period for Coils: Five years from date of Substantial Completion / Preliminary Acceptance.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two sets of each type of filter.
2. Fan Belts: One set for each belt-drive fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dectron International.
2. Desert Aire.
3. PoolPak Technologies Corporation.

2.2 UNIT CONFIGURATION

A. Provide unit configuration as indicated on the Drawings.

2.3 DEHUMIDIFICATION UNITS

A. Roof Top Dehumidification Unit (As Scheduled): Unit shall be supplied with an integral air-cooled condenser/dry cooler (As scheduled). The unit shall include compressor(s), evaporator (dehumidifying coil), heat (gas), condenser refrigerant hot gas reheat coil, condenser/dry cooler, supply air blower(s), return/exhaust air blower(s), blower motor(s), motor starters and controls. All controls shall be BACnet IP fully programmable and fully self-diagnostic microprocessor with set point control, alarming and enable/disable integrated into the building automation system. Unit shall be factory piped, wired and factory charged with refrigerant. Provide additional refrigerant receiver as required. It shall be mounted on the same curb (when shown on the Drawings) as the dehumidification unit and shall utilize a single point power connection.

2.4 BASE RAIL

A. Provide a structural base rail under the full perimeter of the unit, formed from corrosion resistant painted hot dipped galvanized steel. Rail shall provide sufficient clearance to achieve proper external trapping of drain pans. Lifting lug system shall not require additional support for rigging, and shall include lifting lugs at each side of each shipping split and at unit corners.

2.5 ACCESS DOORS

A. Provide insulated access doors at all sections (both sides of unit for units larger than six feet wide).

B. Provide high compression single handle multiple closure type hatches/handles for quick access and positive air seal. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or “paw” latches are not acceptable

C. Access doors for outdoor roof top units shall be equipped with gutters extending 3 inches on either side of the door opening or shall be designed to prevent water from accumulating/entering around door seals.

D. Provide access door(s) that meet requirements for the unit casing.

E. Access doors shall open against pressure.

F. Provide a bulb-type gasket around the entire door or doorframe perimeter. Gasketing material and means of attachment shall be suitable for a pool air environment (all applications) and an outdoor environment (rooftop applications).

G. Provide continuous corrosion resistant hinges that permit 180 degrees of door swing.

2.6 CASINGS

A. Casing (Floor, Roof, Walls): Double-wall construction hot dipped zinc coated sheet metal solid inside (minimum 0.027-inch thick walls/ceiling, 0.064-inch thick floor) and outside (minimum 0.064-inch thick) with corrosion-protective coating and interior and exterior baked-enamel or powder-coated finish (providing a minimum 1000 hr + salt spray resistance), stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs. Increase gauge thicknesses/structural rigidity as required to maintain a maximum of 1% unit airflow leakage from -4” to +4” WC.

1. Insulation: glass-fiber-insulation, fill insulation or foam insulation with no metal structure through the insulation. Minimum thermal resistance (Indoor units R-5, Outdoor units R-8).
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Casing Drain Pans: Sloped powder coated aluminum; insulated and complying with ASHRAE 62.1. Provide intermediate drain pan for coils over 45 inches tall or multiple coils. Provide a condensate drain connection on both sides of the unit fitted to allow field piping to nearest drain.

C. Provide one-piece units where possible. Split units only where necessary for shipping or installation.

D. Each unit shall have a built-in electrical control panel in a separate compartment in order not to disturb the air flow.

E. Rooftop Cabinet (Outdoor Units):

1. The unit shall be equipped with a rainhood and birdscreen for the outdoor air intake and exhaust. The rainhood shall not reduce the face area of the damper. The rainhood and birdscreen construction and paint shall be the same as the unit casing. The rainhood shall be shipped loose from the unit for field installation.
2. Rain guards shall be installed over all access doors or doors shall be designed to prevent rain/moisture entry under all operating conditions.
3. Roof panel has 1-1/2-inch standing seams with two 90-degree bends to form an inverted ‘snap U’ channel. Each 90-degree bend shall be fully gasketed to eliminate thermal bridging.

2.7 FANS

A. Fans: Forward curved or backward inclined, centrifugal/plenum, composite material; direct driven with EC-motor. Fans shall be dynamically/statically balanced and tested. Fans shall bear the AMCA certified ratings Air Performance label.

2.8 FILTERS

A. Return Air, Outside Air and Exhaust at Heat Recovery: 2-inch MERV 13 pleated. Sizing shall not exceed 500 fpm.

2.9 REFRIGERATION SYSTEM

A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, but not less than scheduled.

1. Refrigerant Coils (Evaporator and Condenser Air Reheat): Copper tubes with seamless copper tubes expanded into aluminum fins (max 10 fins per inch); factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized steel frame. Coils, fins, end plates and frames shall have a polyester, hypoxy or heresite coating. Headers, pipes, connections and fittings shall have corrosion protection (vinyl, heresite, polyester or hypoxy). Coils shall have a minimum 200 psig for R-134A and 450 psig for R-410A-working-pressure rating and be factory tested to 400 psig for R-134A and to 600 psig for R-410A while underwater. Evaporator coils shall be provided with thermostatic expansion valves, adjustable superheat controls, and external equalizers. Expansion devices to be

located out of airstream. Coil capacities and pressure drops shall be rated in accordance with ARI Standard 410.

2. An adjustable damper shall be installed above the evaporator coil or compressor staging shall be used for apparatus dew point control.

B. Compressors: Hermetic scroll (R-410A) / Semi-hermetic reciprocating (R-134A) compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

1. Number of Refrigerant Circuits: Minimum of two for compressor capacities more than 7-1/2 tons.
2. Refrigerant: R-134a, or R-410A (As Scheduled).
3. Capacity Control:

   a. Hot-gas bypass valve and piping on one compressor.

4. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
5. High-Pressure Cutout: Manual reset.
6. Compressor Motor Overload Protection: Manual reset.
7. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.

C. Refrigeration Circuit:

1. Shall have a replaceable core type liquid line filter drier, liquid and moisture indicator visible from outside the unit without removal of the access panel, and thermostatic expansion valve.
2. Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schraeder type valves.
3. Refrigeration service valves and thermal expansion valves shall be located outside of the airstream in accordance with the Chicago Building Code.
4. Suction line shall be fully insulated with not less than 1/2 inch closed cell insulation.
5. Provide high-pressure relief valve on condenser in accordance with the Chicago Building Code.

2.10 AIR-COOLED CONDENSER

A. Casing: Steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Refrigerant Coil: ARI 210/240, copper tube with mechanically bonded aluminum fins; with liquid subcooler.

C. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.

D. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.

E. Unit shall be equipped with air conditioning feature such that all compressor heat can be rejected to a remote (or integral as part of a roof top unit) outdoor air-cooled condenser if pool heating or reheat is not required. The outdoor condenser shall be equipped with transformer and 24VAC control including contactor for fan motor.

F. Unit shall be provided with a dry contact rated for 24VAC/5A to operate the remote outdoor condenser control.

G. Refrigeration circuit shall include refrigerant valves (3-way or solenoid type), receiver with pressure relief valve (valve vented outside cabinet if refrigerant charge over 100 lbs) set at 400 psig sized to hold the outdoor condenser charge, pressure control valve and pressure differential valve, and two shutoff valves to isolate the outdoor condenser.

H. Direct expansion systems containing over 100 lbs. of refrigerant shall be equipped with a hand operated emergency valve installed in accordance with the Chicago Building Code.

I. Unit shall include an oil separator package if system charge is over 200 lbs. or line length is over 75 feet.

J. Hot gas lines shall be fully insulated with not less than 1/2-inch closed cell insulation. Units without insulated hot gas lines in the air stream shall not be acceptable.

K. Condenser coil shall be designed for variable heat transfer into the air with seamless deoxidized heavy wall smooth copper tubing mechanically expanded in self-spaced full collared aluminum plate fins for permanent bond to assure high heat transfer with maximum ten corrugated aluminum fins per inch. Coil shall have galvanized casing, minimum 0.064-inch thick, and end plates with plated hardware. Connections and bends are brazed with high temperature brazing alloy. Coils are factory leak tested at 400 psig in a water bath and purged using -40 deg F dew point air. Air-cooled condenser coils are provided with sweat-type connections and are sealed and pressurized at 20-psig dry air. Tube sheets are provided with oversized holes, and coils are supported in sliding tracks for friction-free assembly and maximum reliability.

2.11 GAS FURNACE (OUTDOOR UNITS ONLY)

A. General: The heater shall be a natural gas indirect fired type with capacity as scheduled. The heat exchanger shall be constructed of stainless steel. The burner shall be of the power firing type and shall incorporate a primary combustion air blower and spark ignition transformer. The gas train shall be complete with all controls factory mounted to comply with requirements of CSD-1 and AGA. Shut-off valve shall be located outside of the unit casing, upstream of the pressure regulator. Standard controls shall include a modulating main gas valve, flame supervision, positive burner safety switch, pilot gas cock, main gas cock, and adjustable main and pilot pressure regulators. Main gas shall be outside unit casing. The gas train shall be ready for connection to a natural gas supply with pressure between 4 inches and 14 inches WC. The complete unit shall be test fired and preliminary adjustments made prior to leaving the factory. Final adjustments shall be made in the field during unit start-up. Unit shall include multiple stages with low fire until a temperature is satisfied to keep the heat exchange from overheating.

B. Provide a safety disconnect switch in the exterior mounted control panel for the furnace. Switch shall be protected from accidental contact, such as ice sliding down the exterior, with a collar.

C. Furnace control shall be such that manual restart shall be required after one (1) attempted automatic restart.

D. Provide an exhaust flue from the heat exchanger discharge to a minimum of 72 inches above the roof level or as required to eliminate recirculation of flue gas into the outside air intake whichever is greater. The flue shall be double wall positive pressure type constructed of 304 SS with 1-inch air gap separating inner and outer walls. The flue shall be supported without cables to withstand winds defined in the Chicago Building Code. This extension shall not adversely effect the operation of the burner.

E. Controls: Each unit will use an intermittent direct spark system with pre-purge. The safeties wired to the sequence of operation shall include but not limit themselves to; redundant gas valves with pressure regulator, flame supervision controller, high limit, transformer, gas filter, pressure switch and flame roll out. Burners/control shall be modulating type (5 to 1 minimum turndown).

2.12 HEAT RECOVERY

A. Unit shall have heat recovery between the minimum exhaust and outdoor air streams. Heat recovery coils shall be sized for heat transfer between the two air streams. Heat recovery fluid circulating between coils shall be glycol. Heat recovery shall be a complete package with circulating pump, fill valves and expansion tank.

B. Coils shall be fully dipped and coated with a polyester/enamel coating for maximum corrosion protection. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance against common acids, salt and gases. Aluminum fin and copper tube joints shall be mechanically bonded to assure high heat transfer.

2.13 ECONOMIZER SECTION

A. The unit shall be equipped with Economizer section as part of the cabinet and shall consist of outdoor, exhaust and re-circulating air modulating dampers, exhaust air blower and outdoor air connection complete with filter and weatherproof hoods on rooftop models. Outdoor air opening shall be sized for a maximum of 500 FPM at full economizer operation.

B. The unit shall be equipped with a 7-day occupied/unoccupied period schedule capability to control outdoor air ventilation.

2.14 DAMPERS/ACTUATORS

A. Provide dampers and actuators in compliance with Division 23 “Building Automation System (BAS) - Operator Interface.” In addition, provide Heresite/Hypoxy coating on all dampers and provided insulated dampers for outside air and exhaust air applications. Dampers shall be fully modulating between 0 and 100 percent.

2.15 FABRICATION

A. General: Fabricate the dehumidification units to the designs and sizes shown, using the materials specified, to produce units that meet or exceed the performance requirements indicated. To the greatest extent possible, complete assembly, wiring, piping, and testing before shipment to the Project site. Controls shall be factory-adjusted and preset to the design conditions required for the Project.

1. Disassemble units only as required for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
2. Test reports documenting factory testing shall be available upon request.
3. Engineer of Record reserves the right to witness factory testing.

B. Provide factory mounted dead front disconnect. Manufacturer shall wire disconnect to motors/compressors.

C. Provide a separate and independent power terminal for convenience receptacles and lights, with switches.

D. Electrical Convenience Outlet: 115-V ac fused, duplex, straight-blade receptacles, separately fused and located inside casing of dehumidification unit or in roof-curb perimeter.

E. Service Lights: 115 volts LED marine type vaporproof lights within all sections of the air-handling unit having access doors. Include single wall switch with pilot light on outside of supply fan section controlling all unit lights. Provide all necessary conduit and wiring from lights to switch and extend wiring to a single point power connection junction box on the exterior of the unit. The junction box shall serve as the unit power connection for lighting and receptacle power.

F. All electrical accessories shall be suitable for a pool air environment and protected from the weather when located outdoors.

G. Smoke Detectors (Supply & Return Air): Photoelectric detector located in return-air and supply air plenum, to de-energize unit.

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
3. Plug-in Arrangement: Detector and associated electronic components mounted in module with tamper-resistant connection to fixed base with twist-locking plug. Terminals in fixed base accept building wiring.
4. Integral Visual-Indicating Light: Digital-display type indicating detector operation.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
7. Detector Sensitivity: Between 2.5 and 3.5 percent/foot of smoke obscuration when tested according to UL 268A.

2.16 CONTROL PANEL

A. Integral service compartment containing fan-motor thermal and overload cutouts, fan/pump/compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.

B. Control panel shall be painted with corrosion inhibitor matching casing requirements.

C. The panel shall be negative relative to the airstream to prevent pool air from entering during fan(s) operation.

D. All electrical components shall be mounted on a painted sub-panel. Direct mounting of components to the partition wall shall not be acceptable.

E. Blower motor(s) and compressor(s) shall be controlled by contactors.

F. Voltage monitor shall be provided to shut down electrical system to prevent damage in the event of temporary voltage fluctuation, phase loss, or phase-sequence reversal. Voltage monitor shall be auto reset.

G. Unit shall be provided with single point power connection when available.

H. Dry contacts shall be provided for auxiliary pool heater, alarm and blower interlock.

I. Color coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in a wire duct.

J. Compressor(s) shall have a time delay start to prevent short cycling.

K. All wiring shall be installed in accordance with UL safety electrical standards, and shall be in accordance with NFPA 70, "National Electrical Code," and the Chicago Building Code. All components used shall be UL Listed.

L. Rooftop Unit Applications Cabinet: A separate power block terminal shall be provided for 115V, single phase power for service and lights. A grounded 115 V AC 15Amp, convenience outlet shall be provided in the compressor compartment.

2.17 CONTROLS

A. General: Provide a packaged, self-contained, solid state microprocessor controller to monitor and control the dehumidification unit and the split or integral condenser/dry cooler. The controller shall be unit mounted with a local LCD display and a keypad. Provide a BACnet IP interface to integrate the controller with the Building Automation System (BAS) for remote enable/disable, and monitoring of operational parameters and set point adjustments as described below. Provide all hardware, software and graphics as required to for a complete and fully functioning system to accomplish the sequence of operation, control space temperature/humidity conditions, and interface to the BAS.

B. All control components, sensors and devices shall be installed and prewired at the factory for each shipping split with required terminations for final connections in the field.

C. The following sensors and devices shall be factory mounted in the unit at a minimum. Provide additional sensors/devices as required to accomplish the sequence:

1. Return air temperature.
2. Return air relative humidity.
3. Dehumidifying coil discharge air temperature.
4. Hot gas heat recovery coil discharge air temperature.
5. Compressor hot gas temperature.
6. Freezestat.
7. Unit supply air temperature.
8. Unit supply air relative humidity.
9. Outside air temperature.
10. Outside air relative humidity.
11. Modulating gas valve / gas train (as scheduled) with electronic actuator (when source of unit heating is provided by natural gas).

D. All sensors shall be factory calibrated and tested. Field calibration capability shall be provided through the controller.

E. The following sensors and devices shall be shipped loose with the controller for field installation at a minimum. Provide additional sensors/devices as required to accomplish the sequence:

1. Space temperature.
2. Space relative humidity.

F. The natatorium dehumidification unit controller shall communicate with the BAS via BACnet IP communication protocol. It shall be capable of the following functions at a minimum. Provide additional functions as required to accomplish the sequence:

1. Remote start/stop of the unit.
2. Unit status.

3. Occupancy schedule (occupied or unoccupied mode).
4. Space temperature, relative humidity reading.
5. Remote Set point adjustment.
6. Alarm for automatic restart type failure.
7. Alarm for manual restart type failure.

G. The controller shall be programmed at the factory developed to user specifications, factory tested, and loaded into the controller.

H. The user shall be able to set/perform the following functions at a minimum. Provide additional functions as required to accomplish the sequence:

1. Compressor auto/off mode.
2. Blower auto/off mode (supply fan and exhaust fan).
3. Manual reset.
4. Humidity and temperature set point adjustment.
5. Programmable 7-day timer schedule for occupied mode with a minimum of 3 ON/OFF periods for each day of the week.
6. Disable or force occupied mode.
7. Activate purge mode and adjust purge mode
8. Service mode with password protection for the following:

    a. Heating/cooling dead band and differential.
    b. Sensor calibration.
    c. Minimum damper setting.
    d. Bypass damper setting.
    e. Compressor run time.

I. The following shall be capable of being displayed at the controller at a minimum. Provide additional displays as required to accomplish the sequence:

1. System on.
2. System dehumidifying mode.
3. System air-conditioning mode.
4. System outdoor-air (economizer) mode.
5. Auxiliary space heat is operating.
6. Valve position / firing rate.
7. Unit requires service.
8. Space temperature.
9. Space relative humidity.
10. Outdoor-air temperature.
11. Evaporator air temperature.
12. Supply air temperature.
13. Supply air relative humidity.
14. Service codes from built-in diagnostics.
15. Purge mode on.

J. The following alarm messages shall be displayed at the natatorium dehumidification unit controller at a minimum. Provide additional alarms as required to accomplish the sequence:

1. Communication failure.
2. Humidity sensor fault(s) (all relative humidity sensors).
3. Sensor fault(s) (all temperature sensors).
4. VFD faults (supply and exhaust fans).
5. Compressor faults.
6. Freezestat alarm.

K. Indicate the following sensor and device failures at the controller at a minimum. Provide additional failure indications as required to accomplish the sequence:

1. Airflow: Dirty air filter, blocked airflow, and fan failure.
2. Refrigerant high and low pressure.
3. High and low evaporator temperature.
4. Communication fault.
5. System off.
6. Antishort cycle delay.
7. Power failure.

L. The following set points shall be accessible at the controller at a minimum. Provide additional set points at the controller as required to accomplish the sequence:

1. Return air temperature.
2. Return air relative humidity.
3. Outdoor ventilation / air conditioning changeover temperature.
4. Occupancy schedule (occupied or unoccupied).

M. Principle of Operation: The unit shall be designed to maintain optimum space temperature and relative humidity level. The unit shall not allow wide swings in space air conditions.

N. Supply fan and purge exhaust fans are constant volume type. The ECMs for these fans are intended for fine tuning of the final fan speed settings in the field based on actual system pressure losses and economizer and non-economizer operation. Minimum exhaust fan speed shall be controlled to maintain space pressure setpoint.

O. The unit shall operate according to the following sequence of operation:

1. There will be three modes of operation for the natatorium dehumidification unit:

    a. Unoccupied Mode.
    b. Occupied Mode – Non-Economizer Cycle.
    c. Occupied Mode – Economizer/Purge Cycle.

2. Unoccupied Mode: The supply fan shall operate continuously. The unit mounted exhaust fans shall be disabled. Outside air dampers shall be closed. The natatorium dehumidification unit controller shall monitor and stage mechanical refrigeration and heating to maintain space temperature, space relative humidity and pool temperature set points.
3. Occupied Mode – Non-Economizer Cycle:

    a. The supply fan shall operate continuously.
    b. The minimum outside air damper shall be open to the preset position to introduce minimum required ventilation air. Purge outside air dampers shall remain closed.
    c. Unit mounted minimum exhaust fan shall be enabled. The fan ecm drive shall adjust the speed to maintain the space pressure setpoint. Purge exhaust fans shall be off.
    d. Dehumidification: Unit compressors shall be staged for dehumidification operation when space relative humidity level is above the set point. Hot gas from the compressors shall be directed to the hot gas heat recovery coil.
    e. Space Heating: When space heating is required, the controller shall modulate the furnace gas valve to maintain space temperature set point.
    f. Air Conditioning: When the space temperature is above set point, the controller shall enable mechanical refrigeration system and stage the compressors as

required to maintain space temperature set point. Heat will be rejected to outdoor through the integral/split air-cooled condenser.

g. Once the outdoor air temperature falls below the heat recovery setpoint (65 °F by default; field-adjustable) the glycol pump shall circulate a glycol mixture between the exhaust air and the outdoor air heat recovery coils, recovering heat from the space condition exhaust air and using it to preheat the incoming outside air.

4. Occupied Mode – Economizer/Purge Cycle: When outdoor conditions permit, the space cooling requirements shall be accomplished by 100 percent ventilation mode. The supply fan shall operate continuously. The unit mounted purge exhaust fan shall be activated and the minimum exhaust fan ecm shall adjust the speed to maintain the space pressure setpoint.

   a. The unit shall allow this mode to be manually enabled to allow purging of the natatorium.

P. Control Sensors and Devices:

1. Corrosion Resistance: All sensors exposed to pool environment shall be corrosion resistant and suited for harsh exposure to chlorine containing environment.
2. Temperature Sensor Assemblies:

   a. Temperature sensing shall be with RTDs with matched transmitters. Thermistors, nickel and silver elements, thermocouples or pneumatic transmitters shall not be allowed.
   b. The assembly shall consist of a 1000 ohm platinum RTD and a solid-state, 2-wire, 4-20mA transmitter. The transmitter shall be compatible with the temperature element and the natatorium dehumidification unit control panel. The assembly shall be factory calibrated over the entire operating span.
   c. End-to-end accuracies shall be as follows:

Application	Accuracy	Range
Hot water	± 1.0 deg F	70 deg F – 250 deg F
Duct	± 0.50 deg F	40 deg F – 120 deg F
Outside Air	± 1.0 deg F	-30 deg F – 120 deg F
Space	± 0.50 deg F	50 deg F – 95 deg F

   d. Manufacturer: Minco or comparable, subject to review and approval of Engineer of Record.
   e. Liquid Insertion:

      1) The assembly shall be contained in housing suitable for pipe mounting.
      2) Provide sensor/transmitter as specified above.
      3) Provide thermal wells for temperature sensors. Stainless steel tapered shank fitting with protective well for installation in threaded pipe fitting to hold sensor and transmitter.

   f. Air Stream, Averaging:

      1) All coil leaving temperature sensors shall be averaging type.
      2) The assembly shall consist of an averaging type sensor housed in a flexible sheath with housing suitable for duct mounting.
      3) Probe length: 1 ft. per 4 sq. ft. of duct area.
      4) Averaging temperature sensors shall be used for mixed air temperature measurements and as shown on the Drawings.
      5) Provide sensor/transmitter as specified above.

g. Air Stream, Non-Averaging

1) The assembly shall consist of an 18-inch probe with housing suitable for duct mounting.
2) Probe length: 18-inch or half the duct diameter, whichever is smaller. Mount where directed at a location in which no stratification exists.
3) Provide sensor/transmitter as specified above.

h. Outside Air

1) The assembly shall be mounted in housing suitable for outdoor installation. The sensing element shall be installed in a weatherproof aspirating enclosure.
2) The assembly shall be installed in a location such that the effects of heat radiated from the building or from sunlight are minimized.
3) Provide sensor/transmitter as specified above.
4) Outside air temperature sensors shown in outdoor air intake ducts shall meet the specifications for Temperature Sensor Assembly - Air Stream, Non-Averaging, except that the accuracy and range shall be as specified for Outside Air.

i. Space

1) The assembly shall consist of a decorative ventilated enclosure acceptable to Owner.
2) Provide sensor/transmitter as specified above.

3. Relative Humidity Sensor Assemblies

a. Relative humidity sensing shall be temperature compensated, monolithic bulk polymer integrated circuit humidity sensing.
b. The assembly shall consist of humidity sensor with a solid state, two wire 4-20 mA transmitter matched to the sensing element. The assembly shall be factory calibrated.
c. The output shall be linearly proportional to 0-100 percent relative humidity.
d. The transmitter shall have non-interactive zero and span adjustments, adjustable from the outside cover.
e. Assembly shall have the ability to be field calibrated without disturbing operations using a single point electronic field calibrator.
f. Where periodic cleaning of the sensing element is required or recommended by the manufacturer, mount in a manner which will allow easy removal and replacement.
g. End-to-end accuracy shall be as follows:

Range	Accuracy
0% - 20% RH	± 3% RH
20% - 90% RH	± 2% RH
90% - 100% RH	± 3% RH

h. Long-term stability of the assembly shall be less than ± 1 percent RH per year.
i. Manufacturer: Vaisala, General Eastern, or comparable, subject to review and approval of Engineer of Record.
j. Space: Mounted in a decorative ventilated enclosure suitable for wall mounting and acceptable to the Owner. Enclosure styling shall be similar to space temperature sensors.
k. Duct Mounted: Provide duct-type stainless steel sensing probes and fully gasketed housing suitable for duct mounting.

l. Outside Air:

1) The assembly shall be mounted adjacent to the outside air temperature sensor in a housing suitable for outdoor installation. The sensing element shall be installed in a weatherproof aspirating enclosure.
2) The assembly shall be matched to the respective sensing element. The assembly shall be factory calibrated to an accuracy of ± 2 percent RH over the entire operating span.

4. Combination Temperature and Relative Humidity Sensor Assemblies:

a. Combination temperature and relative humidity sensor assemblies may be used for the following applications provided the above specifications for each portion of the assembly are met.

1) Outside Air.
2) Return Air.

5. Freezestat:

a. Shall have a 20 foot flexible vapor charged element. When temperature sensed by any 12-inch segment of the element falls below set point (typically 40 deg F), the thermostat shall operate DPDT contacts as required.
b. Contact rating: 5 amps at 110 volts resistive.
c. Manual reset.
d. Mount in serpentine fashion across coil inlet top to bottom.
e. Provide a minimum of one such thermostat for each coil section in multiple coil section air handling unit.
f. Provide additional switches as required to provide full protection of the air stream.
g. Manufacturer: Johnson Controls A-70 or comparable, subject to review and approval of Engineer of Record.

6. Control Wiring and Cables:

a. All wiring shall be installed in accordance with UL standards and shall be in accordance with NFPA 70, "National Electrical Code," and the Chicago Building Code.
b. All components used shall be UL Listed.
c. All wires shall installed be in liquid tight rubber flexible conduits.
d. Color coding and wire numbering shall be provided for ease of troubleshooting.

2.18 ROOF CURBS (OUTDOOR UNITS)

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, internal insulation, and factory-installed wood nailer; complying with NRCA standards.

B. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I or II.
2. Thickness: 2 inches.
3. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

5. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
6. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.

C. Curb Height: 14 inches, minimum, above the surface of the finished roof assembly.

2.19 SOURCE QUALITY CONTROL

A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.

B. Sound-Power-Level Ratings: Provide sound power ratings for compressors and fans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roofs where dehumidification units will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Piping – General: Expansion valves and devices shall be located outside the conditioned air stream. Pressure relief valves shall be provided on the high-pressure side of the system, upstream of any intervening valves.

B. Piping – Refrigerant: All refrigerant pipes, including joints and connections, shall be type "K" copper. All refrigerant piping shall be brazed.

C. Curb Support: Install roof curb on roof structure, level and secure, in accordance with Division 07 Section, "Roof Accessories." Install and secure dehumidification units on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

3.3 CONNECTIONS

A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.

B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.

C. Connect condensate drain pans using minimum NPS 1-1/4 copper tubing. Extend to nearest equipment, roof or floor drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.

D. Refrigerant Piping: Size and provide all refrigerant piping/components as required by the actual system layout. Final sizing shall be by the equipment manufacturer. Comply with refrigeration

piping requirements in Division 15. Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

E. Refrigerant Piping: Direct expansion systems containing more than 100 pounds of refrigerant shall be provided with a hand operated emergency valve in accordance with the Chicago Building Code. Piping to the device shall be connected to the low-pressure side of the refrigeration system and piped to the hand valve located in a secure box with a fireman's key and labeling. The box shall be located in a readily accessible location for the Fire Departments use. The downstream side of the valve for Group 1 refrigerants shall be piped to an outdoor location at least 12 feet above the ground, at least 20 feet from any fire escape and at least 2 feet from any building opening, intake or exhaust location. For Group 2 refrigerants, the discharge shall be above the roof of the highest story of the building and shall be at least 40 feet from any adjoining building which extends above the roof and at least 40 feet from any access point to the roof, intake or exhaust opening.

F. Gas Piping: Comply with gas piping requirements in Division 15. Connect with shutoff valve, regulator and union or flange.

G. Duct installation requirements are specified in other Division 23 Sections. The following are specific connection requirements:

1. Install ducts to termination in roof-mounted frames. Where indicated, terminate supply/return/exhaust-air duct through roof structure and insulate the space between roof and bottom of dehumidification unit.

H. Connect piping/ductwork as indicated above, as shown on the Drawings, and as required by the unit manufacturer. Where conflicts occur, the most stringent or highest initial cost shall apply.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Dehumidification unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Perform the following final checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Check lubrication of bearings, pulleys, belts, and other moving parts.
6. Set outside, exhaust- and return-air mixing dampers to minimum outside-air setting.
7. Install clean filters.
8. Set pool heater flow rate.
9. Verify that manual and automatic volume control and smoke dampers in connected duct systems are in fully open position.

C. Startup procedures for dehumidification units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
2. Measure and record motor's electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Comply with testing, adjusting and balancing requirements in Division 23 Section, "Testing, Adjusting, and Balancing for HVAC."

E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results. Reports shall be provided to Owner and commissioning agent a minimum of one week prior to training.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust initial temperature and humidity set points.

3.7 CLEANING

A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.

B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

3.8 DEMONSTRATION AND COMMISSIOINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining units. The training will occur after the startup report has been provided to the Owner and the trainer will provide two (2) Installation and Operations manuals for the use of the Owner’s personnel during training. Training will be a minimum of 8 hours and shall occur on two separate days. Training shall not occur on the same day as startup.
2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.

3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or Owner's designated personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 01 and 23.

END OF SECTION

SECTION 26 05 05 (LNK)

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

B. Telecommunication demolition.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer of Record before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
2. PCB- and DEHP-containing lighting ballasts.
3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 26 05 05

SECTION 26 05 05 (MEP)

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

B. Telecommunication demolition.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer of Record before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
2. PCB- and DEHP-containing lighting ballasts.
3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 26 05 05

SECTION 26 05 19 (LNK)
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Wiring connectors.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

G. NFPA 70 - National Electrical Code; 2017.

H. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

I. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

J. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

K. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 - PRODUCTS

2.01 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:
1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
2. Tinned Copper Conductors: Comply with ASTM B33.

H. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. Equipment Ground, All Systems: Green.

2.02 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
   a. Size 12 AWG and Smaller: Solid.
   b. Size 10 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.03 SERVICE ENTRANCE CABLE

A. Conductor Stranding: Stranded.

B. Insulation Voltage Rating: 600 V.

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

D. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

E. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

F. Install conductors with a minimum of 12 inches of slack at each outlet.

G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

I. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

K. Insulate ends of spare conductors using vinyl insulating electrical tape.

L. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.

M. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 26 05 19

SECTION 26 05 19 (MEP)
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Wiring connectors.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

G. NFPA 70 - National Electrical Code; 2017.

H. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

I. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

J. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

K. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 - PRODUCTS

2.01 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:
1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
2. Tinned Copper Conductors: Comply with ASTM B33.

H. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. Equipment Ground, All Systems: Green.

2.02 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
   a. Size 12 AWG and Smaller: Solid.
   b. Size 10 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.03 SERVICE ENTRANCE CABLE

A. Conductor Stranding: Stranded.

B. Insulation Voltage Rating: 600 V.

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

D. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

E. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

F. Install conductors with a minimum of 12 inches of slack at each outlet.

G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

I. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

K. Insulate ends of spare conductors using vinyl insulating electrical tape.

L. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.

M. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 26 05 19

SECTION 26 05 26 (LNK)

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.
   1. Equipment grounding.
   2. Wiring device grounding.
   3. Panelboard grounding.
   4. Isolated grounding.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground loop.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

C. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

D. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment; 2005.

E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

H. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.

I. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

J. TIA-942 - Telecommunications Infrastructure Standard for Data Centers; 2017.

K. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

L. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of component for grounding and bonding system(s).

C. Shop Drawings:
1. Plans showing dimension as-built locations of grounding features, including the following:
a. Ground rods.
b. Grounding arrangements and connections for separately derived systems.
c. Grounding for sensitive electronic equipment.
2. Grounding rod and ground loop locations.
3. Grounding arrangements and connections for separately derived systems.
4. Grounding for sensitive electronic equipment.

D. Field quality control test reports with indication of overall resistance to ground.

E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

F. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
a. Periodic testing and inspection shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.05 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: An organization recognized by OSHA regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and as defined in the City of Chicago Electrical Code, Article 100.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Conform with UL 467 for grounding and bonding materials and equipment

D. Conform with City of Chicago Electrical Code.

E. Installer Qualifications: Electrical contractor approved by the Board for installation and termination of the main bonding conductor to the building service entrance ground.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

G. Follow IEEE 1100 - Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book).

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by the City of Chicago Electrical Code and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect/Engineer of Record. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not to exceed the values set forth to ground as indicated in part 3.03 of this specification, when tested according to IEEE 81 using the "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with the City of Chicago Electrical Code.
4. Ground Ring:
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
5. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in the City of Chicago Electrical Code. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in the City of Chicago Electrical Code.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with the City of Chicago Electrical Code.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with the City of Chicago Electrical Code.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with the City of Chicago Electrical Code.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with the City of Chicago Electrical Code. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.
   c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with the City of Chicago Electrical Code.
12. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

K. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated equipment grounding conductors.
2. Connect isolated equipment grounding conductors only to separate isolated equipment ground busses.
3. Connect the isolated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do

not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with the City of Chicago Electrical Code.
2. Communications grounding system shall adhere to the recommendations of the TIA-942 and TIA-607-C standards, and shall be installed in accordance with best industry practices.
3. Utilize equipment manufacturer bonding terminals where provided.
4. Thread-forming screws and paint piercing grounding washers will be used to ensure metal-to-metal contact.
5. In MDF/IDF telecommunication rooms mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGESD-1 (or OTS approved equal), directly to each side of the vertical mounting rail of the center most rack using thread-forming screws to form a bond to the rack. Mount at approximately 48 inches from the floor. Place the Electric Static Discharge (ESD) protection identification stickers directly above the ESD ports.
6. Provide an equipment grounding conductor from the Telecommunications Grounding Busbar (TGB) to each MDF/IDF rack grounding bar and ladder tray.
7. Each Concentrator Enclosure Telecommunications Grounding Busbar (TGB) will:
   a. Be terminated to the equipment ground terminal within the isolated ground receptacle outlet box.
   b. Have a ground conductor to the enclosure door.
8. Two-hole lugs shall be used to resist loosening. All lugs shall be irreversible compression type.
9. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
   a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
   b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
   c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
10. Grounding/Earthing System (in reference to Telecommunication Systems)
   a. Antioxidant shall be used when making bonding connections in the field.
   b. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded (earthed) to the Telecommunications Main Grounding Busbar (TMGB) located at the electrical service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) shall follow TIA-607-C and referenced in the table appendix for sizing the Telecommunications Bonding Backbone (TBB).
   c. The Telecommunications Main Grounding Busbar (TMGB) shall be bonded to the electrical service grounding according to the BICSI TDMM rev. 10 and TIA-607-C. Verify all requirements in Chicago Electrical Code (including all updates and addendum) as they may supersede the BICSI requirements. Where telecommunications spaces have only one rack, the jumper cables must be connected directly to the Telecommunications Grounding Busbar (TGB).
   d. Route the TBB to each TGB in straight pathways. The TBB shall be a continuous conductor. The TBB shall be bonded to the equipment ground bar in the IG Computer Panel to the TGB in the MDF and IDF's.
   e. In the event of more than one TBB, the contractor will bond them together at the TBD on the top floor with a Grounding Equalizer (GE). Reference the TIA-607-C standards for sizing TBB's for the GE.
   f. Building steel and metallic water piping must be bonded to the grounding system for safety, however neither may be utilized as the TBB.

g. Equipment racks shall be bonded to the grounding system in accordance with TIA-942.
h. To maintain continuity throughout each equipment rack where bonding to the grounding system paint or insulators must be ground away to expose bare, unpainted, and uncoated metal to insure metal to metal contact.
i. Paint piercing grounding washers and hardware shall be used where rack sections join together. Paint piercing hardware will be used on both sides when and where the hardware passes through the rack.
j. Any metallic components that part of the data equipment (equipment, racks, ladder racks, enclosures, cable runway, etc.) must be bonded to the grounding systems.

11. Each of the Communications surge protection devices shall be grounded in accordance with manufacturers recommendations as presented in product installation instructions to the TGB.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26 - Grounding and Bonding for Electrical Systems.
1. Use insulated copper conductors unless otherwise indicated.
a. Exceptions:
1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Equipment Grounding Conductors: Insulated with green color insulation.
3. Grounding-Electrode Conductors: Stranded cable.
4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
5. Insulated Conductors: Wire or cable insulated for 600V unless otherwise required by applicable code or authorities having jurisdiction.
6. Bare Copper Conductors:
a. Solid Conductors: ASTM B3.
b. Stranded Conductors: ASTM 8.
c. Tinned Conductors: ASTM B33.
d. Bonding Cable: 28kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
f. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
g. Bonding Straps: Soft copper, 0.05 inch think and 2 inches wide, except as indicated.
h. Cable assemblies shall be UL listed and CSA certified.
i. Cables shall be a distinctive green (equipment ground) or green/yellow tracer (isolated ground) in color, and all jackets shall be UL, VW-1 flame rated.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.

4. Mechanical Connectors: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   a. Heavy Duty Pipe Clamps: Pipe clamps shall be high copper alloy or cast bronze with silicon bronze threaded fasteners; saddle type designed for the size of conductor indicated or required by Contract Documents.
   b. Beam Clamps: Beam clamps shall be compression type; heavy duty bronze construction; provide a minimum of 8 square inches of bonding surface; and designed for copper rope-lay cable.
   c. Grounding Bushing: Groundings bushings shall be malleable iron, threaded, with insulated liner and solderless lug.
5. Pressure Connectors: High-conductivity plated units.
6. Terminating Lugs: Exothermic weld or crimp compression type.
7. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy LLC: www.burndy.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. NSI Industries; www.nsiindustries.com.
8. Manufacturers - Exothermic Welded Connections:
   a. Burndy LLC: www.burndy.com.
   b. Cadweld, a brand of Erico International Corporation: www.erico.com.
   c. Cadweld, a brand of Erico International Corporation; www.erico.com.

D. Ground Bars:
1. Description: Rectangular bars of annealed copper, 1/4 by 2 inches in cross-section, unless otherwise indicated; with insulators.
2. Length: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
   a. Harger Lightning & Grounding: www.harger.com.
   b. Burndy LLC; www.burndy.com
   c. NSI Industries; www.nsiindustries.com
   d. Thomas and Betts Corporation; www.tnb.com

F. Ground Ring:
1. Material: Copper
2. Size: As indicated.
3. Manufacturers: Refer to "Grounding and Bonding Requirements".

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, provide ground plates.
   1. Outdoor and Indoor Installations: Unless otherwise indicated, install with top of rod 2 inches below finished grade.
      a. Verify all conditions prior to initiation of work.
      b. Verify final backfill and compaction are complete before driving rod electrodes.
      c. Do not expose steel or damage coating, if any, on interconnection of ground rods with grounding electrode conductors
      d. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to service grounding electrode conductor.

E. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Bond straps directory to structure without penetrating adjacent parts.
   4. Install bonding to equipment mounted on vibration isolators so any vibration from equipment is not transmitted to any other equipment, devices, fixtures, and/or structure.
   5. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
   8. Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building.
      a. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange.
      b. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting.
      c. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   9. Use braided-type bonding jumpers at water meter piping to electrically bypass water meters. Connect to pipe with a bolted connector.
   10. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Identify grounding and bonding system components in accordance with Section[]26 05 53 - Identification for Electrical Systems.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connector for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Restore surface features, including vegetation, at areas disturbed by work of this Section including but not limited to:
1. Re-establish original grades, except as otherwise indicated.
2. Where sod has been removed, replace it as soon as possible after backfilling has been completed.
3. Restore areas disturbed by trenching of dirt, cable laying, and other activities to their original condition.
   a. Include trenching, storing of dirt, cable laying, and other areas to their original condition.
   b. Include top soiling, fertilizing, liming, sodding, sprigging, and mulching.
4. Restore disturbed paving as indicated or to original condition prior to the initiation of work of this Section.

C. Perform the following tests and inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   c. Perform tests by fall-of-potential method according to IEEE 81.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements or exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
4. Substations and Pad-Mounted Equipment: 5 ohms.

E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

F. If resistance to exceeds specified values, notify Architect/Engineer of Record immediately with inclusion of recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 26 (MEP)

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.
   1. Equipment grounding.
   2. Wiring device grounding.
   3. Panelboard grounding.
   4. Isolated grounding.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

F. Ground loop.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

C. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

D. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment; 2005.

E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

H. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.

I. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

J. TIA-942 - Telecommunications Infrastructure Standard for Data Centers; 2017.

K. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

L. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of component for grounding and bonding system(s).

C. Shop Drawings:
1. Plans showing dimension as-built locations of grounding features, including the following:
a. Ground rods.
b. Grounding arrangements and connections for separately derived systems.
c. Grounding for sensitive electronic equipment.
2. Grounding rod and ground loop locations.
3. Grounding arrangements and connections for separately derived systems.
4. Grounding for sensitive electronic equipment.

D. Field quality control test reports with indication of overall resistance to ground.

E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

F. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
a. Periodic testing and inspection shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.05 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: An organization recognized by OSHA regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and as defined in the City of Chicago Electrical Code, Article 100.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Conform with UL 467 for grounding and bonding materials and equipment

D. Conform with City of Chicago Electrical Code.

E. Installer Qualifications: Electrical contractor approved by the Board for installation and termination of the main bonding conductor to the building service entrance ground.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

G. Follow IEEE 1100 - Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book).

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by the City of Chicago Electrical Code and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect/Engineer of Record. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not to exceed the values set forth to ground as indicated in part 3.03 of this specification, when tested according to IEEE 81 using the "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with the City of Chicago Electrical Code.
4. Ground Ring:
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
5. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in the City of Chicago Electrical Code. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in the City of Chicago Electrical Code.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with the City of Chicago Electrical Code.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with the City of Chicago Electrical Code.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with the City of Chicago Electrical Code.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with the City of Chicago Electrical Code. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.
   c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with the City of Chicago Electrical Code.
12. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

K. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated equipment grounding conductors.
2. Connect isolated equipment grounding conductors only to separate isolated equipment ground busses.
3. Connect the isolated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do

not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with the City of Chicago Electrical Code.
2. Communications grounding system shall adhere to the recommendations of the TIA-942 and TIA-607-C standards, and shall be installed in accordance with best industry practices.
3. Utilize equipment manufacturer bonding terminals where provided.
4. Thread-forming screws and paint piercing grounding washers will be used to ensure metal-to-metal contact.
5. In MDF/IDF telecommunication rooms mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGESD-1 (or OTS approved equal), directly to each side of the vertical mounting rail of the center most rack using thread-forming screws to form a bond to the rack. Mount at approximately 48 inches from the floor. Place the Electric Static Discharge (ESD) protection identification stickers directly above the ESD ports.
6. Provide an equipment grounding conductor from the Telecommunications Grounding Busbar (TGB) to each MDF/IDF rack grounding bar and ladder tray.
7. Each Concentrator Enclosure Telecommunications Grounding Busbar (TGB) will:
   a. Be terminated to the equipment ground terminal within the isolated ground receptacle outlet box.
   b. Have a ground conductor to the enclosure door.
8. Two-hole lugs shall be used to resist loosening. All lugs shall be irreversible compression type.
9. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
   a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
   b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
   c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
10. Grounding/Earthing System (in reference to Telecommunication Systems)
   a. Antioxidant shall be used when making bonding connections in the field.
   b. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded (earthed) to the Telecommunications Main Grounding Busbar (TMGB) located at the electrical service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) shall follow TIA-607-C and referenced in the table appendix for sizing the Telecommunications Bonding Backbone (TBB).
   c. The Telecommunications Main Grounding Busbar (TMGB) shall be bonded to the electrical service grounding according to the BICSI TDMM rev. 10 and TIA-607-C. Verify all requirements in Chicago Electrical Code (including all updates and addendum) as they may supersede the BICSI requirements. Where telecommunications spaces have only one rack, the jumper cables must be connected directly to the Telecommunications Grounding Busbar (TGB).
   d. Route the TBB to each TGB in straight pathways. The TBB shall be a continuous conductor. The TBB shall be bonded to the equipment ground bar in the IG Computer Panel to the TGB in the MDF and IDF's.
   e. In the event of more than one TBB, the contractor will bond them together at the TBD on the top floor with a Grounding Equalizer (GE). Reference the TIA-607-C standards for sizing TBB's for the GE.
   f. Building steel and metallic water piping must be bonded to the grounding system for safety, however neither may be utilized as the TBB.

g. Equipment racks shall be bonded to the grounding system in accordance with TIA-942.
h. To maintain continuity throughout each equipment rack where bonding to the grounding system paint or insulators must be ground away to expose bare, unpainted, and uncoated metal to insure metal to metal contact.
i. Paint piercing grounding washers and hardware shall be used where rack sections join together. Paint piercing hardware will be used on both sides when and where the hardware passes through the rack.
j. Any metallic components that part of the data equipment (equipment, racks, ladder racks, enclosures, cable runway, etc.) must be bonded to the grounding systems.

11. Each of the Communications surge protection devices shall be grounded in accordance with manufacturers recommendations as presented in product installation instructions to the TGB.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26 - Grounding and Bonding for Electrical Systems.
1. Use insulated copper conductors unless otherwise indicated.
a. Exceptions:
1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Equipment Grounding Conductors: Insulated with green color insulation.
3. Grounding-Electrode Conductors: Stranded cable.
4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
5. Insulated Conductors: Wire or cable insulated for 600V unless otherwise required by applicable code or authorities having jurisdiction.
6. Bare Copper Conductors:
a. Solid Conductors: ASTM B3.
b. Stranded Conductors: ASTM 8.
c. Tinned Conductors: ASTM B33.
d. Bonding Cable: 28kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
f. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
g. Bonding Straps: Soft copper, 0.05 inch think and 2 inches wide, except as indicated.
h. Cable assemblies shall be UL listed and CSA certified.
i. Cables shall be a distinctive green (equipment ground) or green/yellow tracer (isolated ground) in color, and all jackets shall be UL, VW-1 flame rated.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.

4. Mechanical Connectors: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   a. Heavy Duty Pipe Clamps: Pipe clamps shall be high copper alloy or cast bronze with silicon bronze threaded fasteners; saddle type designed for the size of conductor indicated or required by Contract Documents.
   b. Beam Clamps: Beam clamps shall be compression type; heavy duty bronze construction; provide a minimum of 8 square inches of bonding surface; and designed for copper rope-lay cable.
   c. Grounding Bushing: Groundings bushings shall be malleable iron, threaded, with insulated liner and solderless lug.
5. Pressure Connectors: High-conductivity plated units.
6. Terminating Lugs: Exothermic weld or crimp compression type.
7. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy LLC: www.burndy.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. NSI Industries; www.nsiindustries.com.
8. Manufacturers - Exothermic Welded Connections:
   a. Burndy LLC: www.burndy.com.
   b. Cadweld, a brand of Erico International Corporation: www.erico.com.
   c. Cadweld, a brand of Erico International Corporation; www.erico.com.

D. Ground Bars:
1. Description: Rectangular bars of annealed copper, 1/4 by 2 inches in cross-section, unless otherwise indicated; with insulators.
2. Length: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
   a. Harger Lightning & Grounding: www.harger.com.
   b. Burndy LLC; www.burndy.com
   c. NSI Industries; www.nsiindustries.com
   d. Thomas and Betts Corporation; www.tnb.com

F. Ground Ring:
1. Material: Copper
2. Size: As indicated.
3. Manufacturers: Refer to "Grounding and Bonding Requirements".

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, provide ground plates.
   1. Outdoor and Indoor Installations: Unless otherwise indicated, install with top of rod 2 inches below finished grade.
      a. Verify all conditions prior to initiation of work.
      b. Verify final backfill and compaction are complete before driving rod electrodes.
      c. Do not expose steel or damage coating, if any, on interconnection of ground rods with grounding electrode conductors
      d. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to service grounding electrode conductor.

E. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Bond straps directory to structure without penetrating adjacent parts.
   4. Install bonding to equipment mounted on vibration isolators so any vibration from equipment is not transmitted to any other equipment, devices, fixtures, and/or structure.
   5. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
   8. Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building.
      a. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange.
      b. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting.
      c. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   9. Use braided-type bonding jumpers at water meter piping to electrically bypass water meters. Connect to pipe with a bolted connector.
   10. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Identify grounding and bonding system components in accordance with Section[]26 05 53 - Identification for Electrical Systems.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connector for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Restore surface features, including vegetation, at areas disturbed by work of this Section including but not limited to:
1. Re-establish original grades, except as otherwise indicated.
2. Where sod has been removed, replace it as soon as possible after backfilling has been completed.
3. Restore areas disturbed by trenching of dirt, cable laying, and other activities to their original condition.
   a. Include trenching, storing of dirt, cable laying, and other areas to their original condition.
   b. Include top soiling, fertilizing, liming, sodding, sprigging, and mulching.
4. Restore disturbed paving as indicated or to original condition prior to the initiation of work of this Section.

C. Perform the following tests and inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   c. Perform tests by fall-of-potential method according to IEEE 81.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements or exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
4. Substations and Pad-Mounted Equipment: 5 ohms.

E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

F. If resistance to exceeds specified values, notify Architect/Engineer of Record immediately with inclusion of recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 (LNK)

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical systems and work.

B. Construction requirements for concrete bases.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

E. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).

F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

I. MFMA-4 - Metal Framing Standards Publication; 2004.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

K. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

L. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

M. NFPA 70 - National Electrical Code; 2017.

N. SSPC-PA 1 - Shop, Field, and Maintenance Painting of Steel; 2004.

O. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Install floor-mounted electrical equipment on a minimum of 4 inch concrete housekeeping pad, with a minimum of 4 inches of equipment inset on all sides. Concrete shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete.
6. Provide steel supports, anchor bolts, inserts, etc., for all equipment specified under this section of the specifications.
7. Provide formed steel support channels extending from and solidly anchored to the floor and ceiling slabs and mount the designated equipment thereto.
8. Coordinate installation of roof curbs, equipment supports, and roof penetrations specified under Section 07 72 00 - Roof Accessories.
9. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
10. Provide concrete pads for:
    a. Switchboards.
    b. Transformers.
11. Provide steel support channels for:
    a. Communication and special systems cabinets.
    b. Disconnect switches.
    c. Individual motor starters.
    d. Panelboards.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00 - Cast-in-Place Concrete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Installer's Qualification Statement: Include evidence of compliance with specified requirements.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Comply with the City of Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualification for Field-Welding: Procedures and personnel according to AWS D1.1/D1.1M

D. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this Section with a minimum three years' experience.

E. Listing and Labeling: Provide products specified in this section that are listed and labeled.

F. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

G. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and in original packaging.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:

E. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Steel: Use beam clamps, machine bolts, or welded threaded studs.
4. Plastic and lead anchors are not permitted.
5. Powder-actuated fasteners are permitted only as follows:
   a. Use only threaded studs; do not use pins.
      1) Threaded-heat-treated steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used..
6. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   a. Comply with MFMA-4 or MSS SP-58.
   b. Channel Material: Use Steel or malleable-iron, slotted support system units similar to MSS Type 18..
   c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
7. Manufacturers - Mechanical Anchors:
   a. Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      1) Hilti, Inc.: www.us.hilti.com.
      2) ITW Red Head, a division of Illinois Tool Works, Inc.: www.itwredhead.com.
      3) Cooper B-Line, a division of Eaton Corporation; www.cooperindustries.com.
      4) Empire Tool and Manufacturing Company; www.empireindustries.com
      5) MKT Fastening, LLC; www.mktfastening.com
8. Manufacturers - Powder-Actuated Fastening Systems:
   a. Hilti, Inc.: www.us.hilti.com.
   b. ITW Ramset, a division of Illinois Tool Works, Inc.: www.ramset.com.
   c. Simpson Strong-Tie Company Inc.: www.strongtie.com.
   d. MKT Fastening, LLC; www.mktfastening.com.

F. Clamps (attachment to steel structural elements):
1. MSS SP-58, suitable for attached structural element.

G. Through Bolts:
1. Structural type, hex head, and high strength.
2. Comply with ASTM A325.

H. Toggle Bolts:
1. All-steel springhead type.

I. Hanger Rods:
1. Threaded steel.

2.02 VIBRATION ISOLATORS

A. General: Provide vibration isolators with either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
1. Provide isolators that operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves from the manufacturer that are linear, over a deflection range 50% above the design deflection.

B. Manufacturers:
1. California Dynamics Company; www.caldyn.com

2. Mason Industries: www.mason-ind.com

C. Vibration Isolator Types:
1. General Properties:
a. The ratio of lateral to vertical stiffness shall be not less than 0.9 or greater than 1.5.
b. The theoretical vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than (+/-) 10%.
c. Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems with 1-dB to 50 dB at all frequencies above the 150 Hz.
d. All neoprene mountings shall have a shore hardness of 40 -65 after minimum aging of 30 days, or corresponding open-aging.
2. Isolator Description:
a. Type MS shall be spring type, without housings or snubbers, equipped with leveling bolts and with two layers of ribbed or waffled neoprene pads, separated by a 1/16” galvanized steel plate under the base plate. Neoprene sleeves and washer shall be installed at all anchor bolts.
b. Type HS shall be suspension hangers having a steel frame and spring element, in series with a neoprene pad, cut or washer. The isolator shall be designed so that hanger rod may be misaligned 15 degrees in any direction relative to the vertical, without contacting hanger box frame.
c. Type MN shall be neoprene isolator support type unit having a minimum static deflection of ¼”.
d. Type HN shall be a suspension hanger type employing a neoprene isolator unit having a minimum static deflection of ¼”.

D. Equipment Frames
1. Mounting frames and brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. The mounting frames shall consist of welded, wide flange or channel structural steel, with welder brackets to accept the isolators. The section depth of any frame member shall be not less than 1/10th of the length of the longest frame member, and not less than 1/10th of the greatest span between support points. All frame members shall have the same depth.

2.03 MANUFACTURERD SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps as described in NECA 1 and NECA 101.

B. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs shall have number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish. Provide OZ/Gedney type “S” cable support or equal.

D. U-Channel Systems: 12-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 2 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

2.04 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 - Metal Fabrications for steel shapes and plates.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
   a. 3 inch and smaller: 2 gauge.
   b. 4 inch to 6 inch: 16 gauge.
   c. Over 6 inch: 14 gauge.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1 and .NECA 101

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect/Engineer of Record, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect/Engineer of Record, do not provide support from roof deck.

F. RMC, IMC, and EMT may be supported by openings through structure members, as permitted in the Chicago Electrical Code.

G. Minimum static design load used for strength of support assemblies shall be weight of supported components plus 200 pounds.

H. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

I. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations 1 inch off of wall or surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
5. To Wood: Fasten with lag screws or through bolts.
6. To New Concrete: Bolt to concrete inserts.
   a. Do not penetrate water proofing.
7. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
8. To Existing Concrete: Expansion anchor fasteners.
   a. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
9. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Spring-tension clamps.
   a. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
10. To Light Steel: Sheet metal screws.
11. Fasteners: Select so the load applied to each fastener does not of its proof test load.
12. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.
13. Provide weight-distributing facilities, where required, so as not to exceed the load-bearing capabilities of floors or walls that bear the weight of, or support, electrical systems.
14. Exposed part of hangers and supports shall be painted with one coat of rust-inhibiting primer.
15. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
16. Miscellaneous Supports: Support miscellaneous electrical components as required to provide the same structural safety factors as specified for raceway supports. Install metal channel or angle iron racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

J. Conduit Support and Attachment: Also comply with Section 26 05 33.13 - Conduit for Electrical Systems.

K. Box Support and Attachment: Also comply with Section 26 05 33.16 - Boxes for Electrical Systems.

L. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00 - Interior Lighting.

M. Overhead boxes shall be supported independently of associated raceways.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

P. Installation of Fabricated metal Supports:
1. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
2. Comply with installation requirements in Section 05 50 00 - Metal Fabrications for site-fabricated metal supports.
3. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
4. Field Welding: Comply with AWS D1.1/D1.1M.

3.03 SCHEDULE, TABLE 1: SPACING FOR RACEWAY SUPPORTS:

*** Maximum spacing for IMC above apply to straight runs only. Otherwise the maximums for EMT appl**

RACEWAY SIZE (INCHS)	NO. OF CONDUCTORS IN RUN		MAXIMUM SPACING OF SUPPORTS (FEET) FOR RGS AND IMC	MAXIMUM SPACING OF SUPPORTS (FEET) FOR EMT
HORIZONTAL RUNS				
1/2, 3/4	1 or 2	Flat ceiling or wall	5	5
1/2, 3/4	1 OR 2	Where limited to support by building construction.	7	7
1/2, 3/4	3 or more	Any location	7	7
1/2-1	3 or more	Any location	7	7
1 and larger	1 or 2	Flat ceiling or wall	6	6
1 and larger	1 or 2	Where limited to support by building construction.	10	10
1 and larger	3 or more	Any location	10	10
Any	-	Concealed	10	10
VERTICAL RUNS				
1/2, 3/4	-	Exposed	7	7
1, 1 1/4	-	Exposed	8	8
1 1/2 and larger	-	Exposed	10	10
Up to 2	-	Shaftway	14	10
2 1/2	-	Shaftway	16	10
3 and larger	-	Shaftway	20	10
Any	-	Concealed	10	10

*** Maximum spacing for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.**

A. Abbreviations:
   1. EMT:
   2. IMC:
   3. RGS:

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

3.05 CLEANING AND PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 23 - Interior Painting for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

END OF SECTION 26 05 29

SECTION 26 05 29 (MEP)

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical systems and work.

B. Construction requirements for concrete bases.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

E. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2009 (Reapproved 2015).

F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

I. MFMA-4 - Metal Framing Standards Publication; 2004.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

K. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

L. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

M. NFPA 70 - National Electrical Code; 2017.

N. SSPC-PA 1 - Shop, Field, and Maintenance Painting of Steel; 2004.

O. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Install floor-mounted electrical equipment on a minimum of 4 inch concrete housekeeping pad, with a minimum of 4 inches of equipment inset on all sides. Concrete shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete.
6. Provide steel supports, anchor bolts, inserts, etc., for all equipment specified under this section of the specifications.
7. Provide formed steel support channels extending from and solidly anchored to the floor and ceiling slabs and mount the designated equipment thereto.
8. Coordinate installation of roof curbs, equipment supports, and roof penetrations specified under Section 07 72 00 - Roof Accessories.
9. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
10. Provide concrete pads for:
    a. Switchboards.
    b. Transformers.
11. Provide steel support channels for:
    a. Communication and special systems cabinets.
    b. Disconnect switches.
    c. Individual motor starters.
    d. Panelboards.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00 - Cast-in-Place Concrete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Installer's Qualification Statement: Include evidence of compliance with specified requirements.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Comply with the City of Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualification for Field-Welding: Procedures and personnel according to AWS D1.1/D1.1M

D. Manufacturer's Qualifications: Company specializing in manufacturing products specified in this Section with a minimum three years' experience.

E. Listing and Labeling: Provide products specified in this section that are listed and labeled.

F. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

G. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and in original packaging.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:

E. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Steel: Use beam clamps, machine bolts, or welded threaded studs.
4. Plastic and lead anchors are not permitted.
5. Powder-actuated fasteners are permitted only as follows:
   a. Use only threaded studs; do not use pins.
      1) Threaded-heat-treated steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used..
6. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   a. Comply with MFMA-4 or MSS SP-58.
   b. Channel Material: Use Steel or malleable-iron, slotted support system units similar to MSS Type 18..
   c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
7. Manufacturers - Mechanical Anchors:
   a. Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      1) Hilti, Inc.: www.us.hilti.com.
      2) ITW Red Head, a division of Illinois Tool Works, Inc.: www.itwredhead.com.
      3) Cooper B-Line, a division of Eaton Corporation; www.cooperindustries.com.
      4) Empire Tool and Manufacturing Company; www.empireindustries.com
      5) MKT Fastening, LLC; www.mktfastening.com
8. Manufacturers - Powder-Actuated Fastening Systems:
   a. Hilti, Inc.: www.us.hilti.com.
   b. ITW Ramset, a division of Illinois Tool Works, Inc.: www.ramset.com.
   c. Simpson Strong-Tie Company Inc.: www.strongtie.com.
   d. MKT Fastening, LLC; www.mktfastening.com.

F. Clamps (attachment to steel structural elements):
1. MSS SP-58, suitable for attached structural element.

G. Through Bolts:
1. Structural type, hex head, and high strength.
2. Comply with ASTM A325.

H. Toggle Bolts:
1. All-steel springhead type.

I. Hanger Rods:
1. Threaded steel.

2.02 VIBRATION ISOLATORS

A. General: Provide vibration isolators with either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
1. Provide isolators that operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves from the manufacturer that are linear, over a deflection range 50% above the design deflection.

B. Manufacturers:
1. California Dynamics Company; www.caldyn.com

2. Mason Industries: www.mason-ind.com

C. Vibration Isolator Types:
1. General Properties:
a. The ratio of lateral to vertical stiffness shall be not less than 0.9 or greater than 1.5.
b. The theoretical vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than (+/-) 10%.
c. Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems with 1-dB to 50 dB at all frequencies above the 150 Hz.
d. All neoprene mountings shall have a shore hardness of 40 -65 after minimum aging of 30 days, or corresponding open-aging.
2. Isolator Description:
a. Type MS shall be spring type, without housings or snubbers, equipped with leveling bolts and with two layers of ribbed or waffled neoprene pads, separated by a 1/16” galvanized steel plate under the base plate. Neoprene sleeves and washer shall be installed at all anchor bolts.
b. Type HS shall be suspension hangers having a steel frame and spring element, in series with a neoprene pad, cut or washer. The isolator shall be designed so that hanger rod may be misaligned 15 degrees in any direction relative to the vertical, without contacting hanger box frame.
c. Type MN shall be neoprene isolator support type unit having a minimum static deflection of ¼”.
d. Type HN shall be a suspension hanger type employing a neoprene isolator unit having a minimum static deflection of ¼”.

D. Equipment Frames
1. Mounting frames and brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. The mounting frames shall consist of welded, wide flange or channel structural steel, with welder brackets to accept the isolators. The section depth of any frame member shall be not less than 1/10th of the length of the longest frame member, and not less than 1/10th of the greatest span between support points. All frame members shall have the same depth.

2.03 MANUFACTURERD SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps as described in NECA 1 and NECA 101.

B. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs shall have number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish. Provide OZ/Gedney type “S” cable support or equal.

D. U-Channel Systems: 12-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 2 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

2.04 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 - Metal Fabrications for steel shapes and plates.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
   a. 3 inch and smaller: 2 gauge.
   b. 4 inch to 6 inch: 16 gauge.
   c. Over 6 inch: 14 gauge.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1 and .NECA 101

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect/Engineer of Record, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect/Engineer of Record, do not provide support from roof deck.

F. RMC, IMC, and EMT may be supported by openings through structure members, as permitted in the Chicago Electrical Code.

G. Minimum static design load used for strength of support assemblies shall be weight of supported components plus 200 pounds.

H. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

I. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations 1 inch off of wall or surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
   5. To Wood: Fasten with lag screws or through bolts.
   6. To New Concrete: Bolt to concrete inserts.
      a. Do not penetrate water proofing.
   7. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   8. To Existing Concrete: Expansion anchor fasteners.
      a. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   9. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Spring-tension clamps.
      a. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
   10. To Light Steel: Sheet metal screws.
   11. Fasteners: Select so the load applied to each fastener does not of its proof test load.
   12. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.
   13. Provide weight-distributing facilities, where required, so as not to exceed the load-bearing capabilities of floors or walls that bear the weight of, or support, electrical systems.
   14. Exposed part of hangers and supports shall be painted with one coat of rust-inhibiting primer.
   15. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
   16. Miscellaneous Supports: Support miscellaneous electrical components as required to provide the same structural safety factors as specified for raceway supports. Install metal channel or angle iron racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

J. Conduit Support and Attachment: Also comply with Section 26 05 33.13 - Conduit for Electrical Systems.

K. Box Support and Attachment: Also comply with Section 26 05 33.16 - Boxes for Electrical Systems.

L. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00 - Interior Lighting.

M. Overhead boxes shall be supported independently of associated raceways.

N. Secure fasteners according to manufacturer's recommended torque settings.

O. Remove temporary supports.

P. Installation of Fabricated metal Supports:
1. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
2. Comply with installation requirements in Section 05 50 00 - Metal Fabrications for site-fabricated metal supports.
3. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
4. Field Welding: Comply with AWS D1.1/D1.1M.

3.03 SCHEDULE, TABLE 1: SPACING FOR RACEWAY SUPPORTS:

*** Maximum spacing for IMC above apply to straight runs only. Otherwise the maximums for EMT appl**

RACEWAY SIZE (INCHS)	NO. OF CONDUCTORS IN RUN		MAXIMUM SPACING OF SUPPORTS (FEET) FOR RGS AND IMC	MAXIMUM SPACING OF SUPPORTS (FEET) FOR EMT
HORIZONTAL RUNS				
1/2, 3/4	1 or 2	Flat ceiling or wall	5	5
1/2, 3/4	1 OR 2	Where limited to support by building construction.	7	7
1/2, 3/4	3 or more	Any location	7	7
1/2-1	3 or more	Any location	7	7
1 and larger	1 or 2	Flat ceiling or wall	6	6
1 and larger	1 or 2	Where limited to support by building construction.	10	10
1 and larger	3 or more	Any location	10	10
Any	-	Concealed	10	10
VERTICAL RUNS				
1/2, 3/4	-	Exposed	7	7
1, 1 1/4	-	Exposed	8	8
1 1/2 and larger	-	Exposed	10	10
Up to 2	-	Shaftway	14	10
2 1/2	-	Shaftway	16	10
3 and larger	-	Shaftway	20	10
Any	-	Concealed	10	10

*** Maximum spacing for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.**

A. Abbreviations:
   1. EMT:
   2. IMC:
   3. RGS:

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

3.05 CLEANING AND PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 23 - Interior Painting for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

END OF SECTION 26 05 29

SECTION 26 05 33.13 (LNK)

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Electrical metallic tubing (EMT).

G. Conduit fittings.

H. Accessories.

1.02 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

D. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.

H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2016.

L. NFPA 70 - National Electrical Code; 2017.

M. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

N. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

O. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

P. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

T. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

U. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
1. Indicate each type and size of conduit to be utilized within project.
2. Indicate each type and size of conduit fitting to be utilized within project.

C. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch trade size and larger.

1.05 QUALITY ASSURANCE

A. Comply with NECA's "Standard of Installation".

B. Comply with the Chicago Electrical Code.

C. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Effectively protect all materials, accessories, and components from any damage or injury from the time of fabrication until final Board acceptance.

C. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by the City of Chicago Electrical Code and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit where permitted by the City of Chicago Electrical Code..
3. Service Entrance: Use galvanized steel rigid metal conduit.
4. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit.
5. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
6. Where rigid polyvinyl (PVC) conduit larger than 2 inch trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
7. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection.
8. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.

D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit.

2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Exposed, Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
   a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
   b. Loading dock..
   c. Mechanical rooms.

K. Exposed, Exterior: Use intermediate metal conduit (IMC).

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use intermediate metal conduit (IMC).

M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.

O. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.

2.02 CONDUIT REQUIREMENTS

A. Fittings for Grounding and Bonding: Also comply with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Minimum Conduit Size, Unless Otherwise Indicated:
1. 3/4-inch trade size..

E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

F. Where conduit size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Wheatland Tube Company: www.wheatland.com/#sle.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Wheatland Tube Company: www.wheatland.com/#sle.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. Allied Tube & Conduit; www.alliedeg.com..
2. Wheatland Tube Company; www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. Allied Tube & Conduit; www.alliedeg.com..
2. Wheatland Tube Company; www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com.
2. Wheatland Tube Company: www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Description: The City of Chicago Electrical Code, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

D. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
3. Connectors and Couplings: Use compression (gland) type with insulated throat.
   a. Do not use indenter type connectors and couplings.
   b. Do not use set-screw type connectors and couplings.
4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
1. Electri-Flex Company: www.electriflex.com/#sle.
2. Hubbell Company, RACO products; www.hubbell-rtb.com.
3. CertainTeed Pipe and Plastics; www.certainteed.com

B. Description: The City of Chicago Electrical Code, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.09 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

I. Conduit Routing:
1. Unless dimensioned, any conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Protect stub-ups from damage where conduits rise through floor slabs. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
9. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
   a. For Telecommunications conduit, fewer bends are allowed.
10. Arrange conduit to provide no more than 150 feet between pull points.
    a. For Telecommunications conduit, install pull boxes every 100 feet.
11. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plan and straight legs of offsets parallel, unless otherwise indicated.
    a. Use raceway fittings compatible with raceways and suitable for use and location.
    b. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
12. Route conduits above water and drain piping where possible.
13. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
14. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
15. Maintain minimum clearance of 6 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
16. Group parallel conduits in the same area together on a common rack.

J. Conduit Support:
1. Secure and support conduits in accordance with the City of Chicago Electrical Code and Section 26 05 29 - Hangers and Supports for Electrical Systems, using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit 1 1/2 inch and smaller from beam clamp or threaded rod and for fastening raceways to trapeze supports.

7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   a. Sized so capacity can be increased by 25 percent in future without exceeding specified design load limits.
   b. Secure raceways and cables to supports with single-bolt conduit clamps.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.

K. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

L. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.
10. Install sealing fittings in suitable, approved, and accessible locations.
    a. Install in flush steel box with blank cover plate.
       1) Finish similar to adjacent plates or surfaces.
    b. Install at the following locations:
       1) Where conduits pass from warm to cold locations.
       2) Where required by the City of Chicago Electrical Code.

M. Underground Installation:
1. Provide trenching and backfilling in accordance with Division 31 - Earthwork.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.

b. Under Slab on Grade: 12 inches to bottom of slab.

3. Provide underground warning tape in accordance with Section 26 05 53 - Identification for Electrical Systems along entire conduit length.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
2. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
3. Install conduits within middle one third of slab thickness.
4. Secure conduits to prevent floating or movement during pouring of concrete.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 - Cast-in-Place Concrete with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

P. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with the City of Chicago Electrical Code.

Q. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

R. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

S. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave minimum slack of 12 inches at each end.

T. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

U. Voice and Data System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 100 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Provide insulating bushings at all terminations. Comply with EIA/TIA-569-D.
1. Conduit to be color coded for Voice and Data systems in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.13 (MEP)

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Intermediate metal conduit (IMC).

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Electrical metallic tubing (EMT).

G. Conduit fittings.

H. Accessories.

1.02 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

D. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.

H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2016.

L. NFPA 70 - National Electrical Code; 2017.

M. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

N. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

O. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

P. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

T. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

U. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
1. Indicate each type and size of conduit to be utilized within project.
2. Indicate each type and size of conduit fitting to be utilized within project.

C. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch trade size and larger.

1.05 QUALITY ASSURANCE

A. Comply with NECA's "Standard of Installation".

B. Comply with the Chicago Electrical Code.

C. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

B. Effectively protect all materials, accessories, and components from any damage or injury from the time of fabrication until final Board acceptance.

C. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by the City of Chicago Electrical Code and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit where permitted by the City of Chicago Electrical Code..
3. Service Entrance: Use galvanized steel rigid metal conduit.
4. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit.
5. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
6. Where rigid polyvinyl (PVC) conduit larger than 2 inch trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
7. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection.
8. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.

D. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit.

2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Exposed, Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
   a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
   b. Loading dock..
   c. Mechanical rooms.

K. Exposed, Exterior: Use intermediate metal conduit (IMC).

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use intermediate metal conduit (IMC).

M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
1. Maximum Length: 6 feet.

O. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.

2.02 CONDUIT REQUIREMENTS

A. Fittings for Grounding and Bonding: Also comply with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Minimum Conduit Size, Unless Otherwise Indicated:
1. 3/4-inch trade size..

E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

F. Where conduit size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Wheatland Tube Company: www.wheatland.com/#sle.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com/#sle.
2. Wheatland Tube Company: www.wheatland.com/#sle.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. Allied Tube & Conduit; www.alliedeg.com..
2. Wheatland Tube Company; www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. Allied Tube & Conduit; www.alliedeg.com..
2. Wheatland Tube Company; www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: The City of Chicago Electrical Code, type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com.
2. Wheatland Tube Company: www.wheatland.com.
3. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com.
4. Tenaris (formerly Maverick Tube Corporation); www.tenaris.com

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Description: The City of Chicago Electrical Code, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

D. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
3. Connectors and Couplings: Use compression (gland) type with insulated throat.
   a. Do not use indenter type connectors and couplings.
   b. Do not use set-screw type connectors and couplings.
4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

2.08 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
1. Electri-Flex Company: www.electriflex.com/#sle.
2. Hubbell Company, RACO products; www.hubbell-rtb.com.
3. CertainTeed Pipe and Plastics; www.certainteed.com

B. Description: The City of Chicago Electrical Code, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.09 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

I. Conduit Routing:
1. Unless dimensioned, any conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Protect stub-ups from damage where conduits rise through floor slabs. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
9. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
   a. For Telecommunications conduit, fewer bends are allowed.
10. Arrange conduit to provide no more than 150 feet between pull points.
    a. For Telecommunications conduit, install pull boxes every 100 feet.
11. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plan and straight legs of offsets parallel, unless otherwise indicated.
    a. Use raceway fittings compatible with raceways and suitable for use and location.
    b. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
12. Route conduits above water and drain piping where possible.
13. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
14. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
15. Maintain minimum clearance of 6 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
16. Group parallel conduits in the same area together on a common rack.

J. Conduit Support:
1. Secure and support conduits in accordance with the City of Chicago Electrical Code and Section 26 05 29 - Hangers and Supports for Electrical Systems, using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit 1 1/2 inch and smaller from beam clamp or threaded rod and for fastening raceways to trapeze supports.

7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   a. Sized so capacity can be increased by 25 percent in future without exceeding specified design load limits.
   b. Secure raceways and cables to supports with single-bolt conduit clamps.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.

K. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

L. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.
10. Install sealing fittings in suitable, approved, and accessible locations.
    a. Install in flush steel box with blank cover plate.
       1) Finish similar to adjacent plates or surfaces.
    b. Install at the following locations:
       1) Where conduits pass from warm to cold locations.
       2) Where required by the City of Chicago Electrical Code.

M. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 16 - Excavation and Section 31 23 23 - Fill.
2. Minimum Cover, Unless Otherwise Indicated or Required:

a. Underground, Exterior: 24 inches.
b. Under Slab on Grade: 12 inches to bottom of slab.

3. Provide underground warning tape in accordance with Section 26 05 53 - Identification for Electrical Systems along entire conduit length.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
2. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
3. Install conduits within middle one third of slab thickness.
4. Secure conduits to prevent floating or movement during pouring of concrete.

O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 - Cast-in-Place Concrete with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

P. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with the City of Chicago Electrical Code.

Q. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

R. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits penetrate coolers or freezers.

S. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave minimum slack of 12 inches at each end.

T. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

U. Voice and Data System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 100 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Provide insulating bushings at all terminations. Comply with EIA/TIA-569-D.
1. Conduit to be color coded for Voice and Data systems in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16 (LNK)

BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NFPA 70 - National Electrical Code; 2017.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 508A - Industrial Control Panels; 2013.

L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by the Chicago Electrical Code.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to the City of Chicago Electrical Code.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to the City of Chicago Electrical Code.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations for junction boxes, pull boxes, cabinets and enclosures, and floor boxes.

1.05 QUALITY ASSURANCE

A. Comply with City of Chicago Electrical Code.

B. Comply with NECA's "Standard of Installation".

C. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by the City of Chicago Electrical Code.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. here box size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use nonmetallic boxes where exposed rigid PVC conduit is used.
6. Use suitable concrete type boxes where flush-mounted in concrete.
7. Use suitable masonry type boxes where flush-mounted in masonry walls.
8. Use raised covers suitable for the type of wall construction and device configuration where required.
9. Use shallow boxes where required by the type of wall construction.
10. Do not use "through-wall" boxes designed for access from both sides of wall.
11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
16. Wall Plates: Comply with Section 26 27 26 - Wiring Devices.
17. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
    b. Hubbell Incorporated; : www.hubbell-rtb.com.
    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com.
    d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
    e. Appleton Electric, a brand of Emerson Corporation; www.emersonindustrial.com
    f. Walker Systems, a part of Wiremold, a brand of Legrand; www.legrand.us .
    g. Hoffman, a brand of Pentair Technical Products; www.hoffmanonline.com

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide hinged-cover enclosures unless otherwise indicated.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Removable interior panel and removable front.
    b. Hinged door in front cover with flush latch and concealed hinge.
    c. Keyed latch to match panelboards.

d. Metal barriers to separate wiring of different systems and voltages.
e. Accessory feet where required for freestanding equipment.

5. Finish for Painted Steel Enclosures: Finished inside and out with manufacturer's standard enamel. unless otherwise indicated.
6. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
   b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
   c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com.
   d. Hubbell Incorporated; RACO Products; www.hubbell-rtb.com.
   e. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com
   f. Appleton Electric, a brand of Emerson Corporation; www.emersonindustrial.com
   g. Walker Systems, a part of Wiremold, a brand of Legrand; www.legrand.us

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
1. Manufacturers:
   a. Appleton, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
   c. Hubbell Incorporated; Killark Products: www.hubbell-killark.com.

E. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26 - Wiring Devices; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Use cast iron floor boxes within slab on grade.
3. Use sheet-steel or cast iron floor boxes within slab above grade.
4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings, comply with Section 26 27 26 - Wiring Devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive boxes.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

1. In masonry walls, saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

G. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 - Access Doors and Panels as required where approved by the Architect/Engineer of Record.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26 - Wiring Devices.
   b. Communications Systems Outlets: Comply with Division 27 - Communications.
4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Unless otherwise indicated, where multiple outlet boxes are installed at the same location and at the same mounting height, install devices in multi-gang barriered box appropriate for the devices types.
   a. Multi-ganged devices shall have a common, multi-device faceplate.
8. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
9. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
10. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
    a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
    b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect/Engineer of Record:
    a. Concealed above accessible suspended ceilings.
    b. Within joists in areas with no ceiling.
    c. Electrical rooms.
    d. Mechanical equipment rooms.
12. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
13. Installation of Combination Device Wall Enclosures:
    a. In each instance where two or more device boxes are generally located in the same vicinity and at the same mounting height, mount those devices in a common multi-gang barriered box appropriate for the device types.
    b. Combination receptacle and communications devices (i.e. television, data and receptacle shall be installed in minimum 2 gang boxes with barriers to segregate the systems.
    c. Combination devices (i.e. data/voice outlet and normal and IG receptacle) installed in minimum 3 gang box under common wall plate. Provide barriers to segregate systems.

H. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 - Hangers and Supports for Electrical Systems using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Install hinged-cover enclosures and cabinets plumb. Support each corner.

I. Install boxes plumb and level.

J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

K. Install boxes as required to preserve insulation integrity.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide minimum 2-gang box with barriers for combination receptacle and data locations for specialty equipment (i.e. televisions, monitors).

Q. Combination devices (i.e. data/voice outlet and normal and isolated ground receptacle) installed in minimum 3-gang box with barriers.

R. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

S. Identify boxes in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 33.16

SECTION 26 05 33.16 (MEP)

BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NFPA 70 - National Electrical Code; 2017.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 508A - Industrial Control Panels; 2013.

L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by the Chicago Electrical Code.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to the City of Chicago Electrical Code.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to the City of Chicago Electrical Code.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations for junction boxes, pull boxes, cabinets and enclosures, and floor boxes.

1.05 QUALITY ASSURANCE

A. Comply with City of Chicago Electrical Code.

B. Comply with NECA's "Standard of Installation".

C. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by the City of Chicago Electrical Code.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. here box size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
5. Use nonmetallic boxes where exposed rigid PVC conduit is used.
6. Use suitable concrete type boxes where flush-mounted in concrete.
7. Use suitable masonry type boxes where flush-mounted in masonry walls.
8. Use raised covers suitable for the type of wall construction and device configuration where required.
9. Use shallow boxes where required by the type of wall construction.
10. Do not use "through-wall" boxes designed for access from both sides of wall.
11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
16. Wall Plates: Comply with Section 26 27 26 - Wiring Devices.
17. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
    b. Hubbell Incorporated; : www.hubbell-rtb.com.
    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com.
    d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
    e. Appleton Electric, a brand of Emerson Corporation; www.emersonindustrial.com
    f. Walker Systems, a part of Wiremold, a brand of Legrand; www.legrand.us .
    g. Hoffman, a brand of Pentair Technical Products; www.hoffmanonline.com

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide hinged-cover enclosures unless otherwise indicated.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Removable interior panel and removable front.
    b. Hinged door in front cover with flush latch and concealed hinge.
    c. Keyed latch to match panelboards.

d. Metal barriers to separate wiring of different systems and voltages.
e. Accessory feet where required for freestanding equipment.

5. Finish for Painted Steel Enclosures: Finished inside and out with manufacturer's standard enamel. unless otherwise indicated.
6. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
   b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
   c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com.
   d. Hubbell Incorporated; RACO Products; www.hubbell-rtb.com.
   e. O-Z/Gedney, a brand of Emerson Industrial Automation; www.emersonindustrial.com
   f. Appleton Electric, a brand of Emerson Corporation; www.emersonindustrial.com
   g. Walker Systems, a part of Wiremold, a brand of Legrand; www.legrand.us

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
1. Manufacturers:
   a. Appleton, a brand of Emerson Industrial Automation: www.emersonindustrial.com.
   b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
   c. Hubbell Incorporated; Killark Products: www.hubbell-killark.com.

E. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26 - Wiring Devices; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
2. Use cast iron floor boxes within slab on grade.
3. Use sheet-steel or cast iron floor boxes within slab above grade.
4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings, comply with Section 26 27 26 - Wiring Devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive boxes.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

1. In masonry walls, saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

G. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 - Access Doors and Panels as required where approved by the Architect/Engineer of Record.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26 - Wiring Devices.
   b. Communications Systems Outlets: Comply with Section 27 10 00 - Structured Cabling.
4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Unless otherwise indicated, where multiple outlet boxes are installed at the same location and at the same mounting height, install devices in multi-gang barriered box appropriate for the devices types.
   a. Multi-ganged devices shall have a common, multi-device faceplate.
8. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
9. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
10. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
    a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
    b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect/Engineer of Record:
    a. Concealed above accessible suspended ceilings.
    b. Within joists in areas with no ceiling.
    c. Electrical rooms.
    d. Mechanical equipment rooms.
12. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
13. Installation of Combination Device Wall Enclosures:
    a. In each instance where two or more device boxes are generally located in the same vicinity and at the same mounting height, mount those devices in a common multi-gang barriered box appropriate for the device types.
    b. Combination receptacle and communications devices (i.e. television, data and receptacle shall be installed in minimum 2 gang boxes with barriers to segregate the systems.
    c. Combination devices (i.e. data/voice outlet and normal and IG receptacle) installed in minimum 3 gang box under common wall plate. Provide barriers to segregate systems.

H. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 - Hangers and Supports for Electrical Systems using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Install hinged-cover enclosures and cabinets plumb. Support each corner.

I. Install boxes plumb and level.

J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

K. Install boxes as required to preserve insulation integrity.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide minimum 2-gang box with barriers for combination receptacle and data locations for specialty equipment (i.e. televisions, monitors).

Q. Combination devices (i.e. data/voice outlet and normal and isolated ground receptacle) installed in minimum 3-gang box with barriers.

R. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

S. Identify boxes in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 33.16

SECTION 26 05 33.23 (LNK)

SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NFPA 70 - National Electrical Code; 2017.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

F. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

G. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems and conduit provided under Section 26 05 33.13 - Conduit for Electrical Systems as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Wall Duct: Coordinate the work with other trades to provide walls suitable for installation of flush-mounted wall duct where indicated.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:
1. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by the City of Chicago Electrical Code and product listing.

2.02 SURFACE RACEWAY SYSTEMS

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com.
2. Wiremold, a brand of Legrand North America, Inc.: www.legrand.us.

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
1. Galvanized steel with snap-on cover.
2. Manufacturer's standard enamel finish in color selected by the Architect/Engineer of Record.

C. Multi-outlet Assemblies: Listed and labeled as complying with UL 111.

2.03 WIREWAYS

A. Manufacturers:
1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
2. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.

D. Finish for Painted Steel Wireways: Manufacturer's standard enamel finish unless otherwise indicated.

E. Where wireway size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with the City of Chicago Electrical Code to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install raceways plumb and level.

D. Arrange wireways and associated raceway connections to comply with the City of Chicago Electrical Code, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

E. Secure and support raceways in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems at intervals complying with the City of Chicago Electrical Code.

F. Close unused raceway openings.

G. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

H. Identify raceways in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect raceways for damage and defects.

C. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION 26 05 33.23

SECTION 26 05 33.23 (MEP)

SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NFPA 70 - National Electrical Code; 2017.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

F. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

G. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems and conduit provided under Section 26 05 33.13 - Conduit for Electrical Systems as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Wall Duct: Coordinate the work with other trades to provide walls suitable for installation of flush-mounted wall duct where indicated.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:
1. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by the City of Chicago Electrical Code and product listing.

2.02 SURFACE RACEWAY SYSTEMS

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com.
2. Wiremold, a brand of Legrand North America, Inc.: www.legrand.us.

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
1. Galvanized steel with snap-on cover.
2. Manufacturer's standard enamel finish in color selected by the Architect/Engineer of Record.

C. Multi-outlet Assemblies: Listed and labeled as complying with UL 111.

2.03 WIREWAYS

A. Manufacturers:
1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
2. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
   1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.

D. Finish for Painted Steel Wireways: Manufacturer's standard enamel finish unless otherwise indicated.

E. Where wireway size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with the City of Chicago Electrical Code to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install raceways plumb and level.

D. Arrange wireways and associated raceway connections to comply with the City of Chicago Electrical Code, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

E. Secure and support raceways in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems at intervals complying with the City of Chicago Electrical Code.

F. Close unused raceway openings.

G. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

H. Identify raceways in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect raceways for damage and defects.

C. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION

A. Protect installed raceways from subsequent construction operations.

END OF SECTION 26 05 33.23

SECTION 26 05 53 (LNK)
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Identification signs.
D. Wire and cable markers.
E. Voltage markers.
F. Underground warning tape.
G. Floor marking tape.
H. Warning signs and labels.

1.02 REFERENCE STANDARDS

A. 29 CFR 1910.145 - Accident Prevention Signs and Tags current edition.
B. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.
C. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
D. NFPA 70E - Standard for Electrical Safety in the Workplace 2018.
E. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
C. Samples:
   1. For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features..
D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE

A. Comply with ASME A13.1.
B. Comply with ANSI/IEEE 802.7.
C. Comply with 29 CFR 1910.145.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

1.07 COORDINATION

A. Coordinate all names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Designations and labeling shall be consistent throughout the project.
B. Coordinate installation with coverings and painting of surfaces.
C. Coordinate installation with location of access panels and doors.

D. Install identifying devices before installation of acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use identification nameplate to identify main overcurrent protective device.
      5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   b. Panelboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
      5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   c. Transformers:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify load(s) served. Include location when not within sight of equipment.
   d. Enclosed switches, circuit breakers, and motor controllers:
      1) Identify voltage and phase.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.
   e. Transfer Switches:
      1) Identify voltage and phase.
      2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.
      4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
   f. Electricity Meters:
      1) Identify load(s) metered.
   g. UPS:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify load(s) served. Include location when not within sight of equipment
   h. Motor Control centers:
      1) Identify ampere rating.

2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify voltage and phase.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each starter. Do not identify spares and spaces.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with the Chicago Electrical Code.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
   c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with the Chicago Electrical Code.
6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with the City of Chicago Electrical Code.
7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
8. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
9. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances.
    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting.
12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by the Chicago Electrical Code, including but not limited to the following..
    a. Service equipment.
    b. Industrial control panels.
    c. Motor control centers.
    d. Elevator control panels.
    e. Industrial machinery.
13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels,

meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
a. Comply with NFPA 70E
b. Minimum Size: 3.5 by 5 inches.
c. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
d. Labels shall be machine printed, with no field-applied markings.
e. Service Equipment: Include the following information in accordance with the Chicago Electrical Code.
1) Nominal system voltage.
2) Available fault current.
3) Clearing time of service overcurrent protective device(s).
4) Date label applied.

14. Within all switchboard rooms, electrical closets, and other spaces containing electrical equipment provide the following:
a. Vitreous enameled metal sign, red on white, reading "Electrical Equipment Room - No Storage Permitted."
b. Mounted in clearly visible locations within rooms.
1) If wall space in room does not permit mounting, mount to door on inside of room.
15. In all switchboard rooms:
a. Install up-to-date black-lined print of feeder diagram of building completed with feeder schedules.
1) Print shall be installed in frame, behind glass.
2) Print to include up-to-date field record information.
3) Print to be on mylar.
4) Print to have lettering no smaller than 1/8 inch.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. At each source and load connection.
b. Within boxes where there are more than three branch circuits, provide metal tags. Provide source and circuit number for each ungrounded conductor..
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
d. Provide write-on tags to conductors and list source and circuit number for conductors to be extended in the future.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
5. Use underground warning tape to identify direct buried cables and cables buried in raceway for the following systems:
a. Power

b. Lighting
c. Communications
d. Control wiring
e. Optical Fiber
f. Connection to City OEMC network

C. Identification for Raceways:
1. Comply with ASME A13.1 for size of letters for legend and minimum length of color field for each raceway.
2. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
3. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
1) Color Code:
(a) Emergency Power System: Red.
(b) Fire Alarm System: Red.
(c) Control Wiring: Green and red.
(d) Telecommunication Systems:
(1) Provide blue colored conduit for telecommunication system raceway. Conduit to be in accordance with Section 26 05 33.13 - Conduit for Electrical Systems.
(e) Mechanical and Electrical Supervisory System: Green and blue.
(f) Security System: Blue and yellow.
(g) Fire-Suppression Supervisory and Control System: Red and yellow.
2) Field-Painting: Comply with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting.
3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
a. Provide one label or marker at each end of the pathway and at any exposed pints (i.e., screw cover boxes, pull points, etc.)
5. Exposed raceways shall be labeled at transitions into and out of inaccessible spaces.
6. Provide alphanumeric identifiers to designate locations for origin and the end of the pathway.
a. Type of pathways shall be identified:
1) CN-conduit
2) TCN-telecommunications conduit
3) RK-rack
4) W-workstation
b. Numbered from each origin point in series starting from 1.
7. Use underground warning tape to identify underground raceways.
8. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.

a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting per the same color code used for raceways.
b. For exposed boxes in public areas, do not color code.

3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
   a. For exposed boxes in public areas, use only identification labels.

E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26 - Wiring Devices.
2. Use identification label to identify fire alarm system devices.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
3. Use identification label to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
   a. Seton Identification Products: www.seton.com/#sle.
   b. Quentin D. Schwab.
   c. Joe Halm Building Specialties
   d. Mechanical Tag Systems
   e. N&E Specialty Company
2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
      1) With non-corroding screws.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or melamine with beveled edges; minimum thickness of 1/16 inch; engraved text.
4. Text:
   a. Text to be 1/2 inch high letters on 1-1/2 inch label for single line.
   b. Text to be 1/2 inch high letters on 2 inch label for 2 line text applications.
   c. Increase sizes of labels and letters to be viewed from floor in elevated applications.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1.5 inches by 2.5 inches.
2. Legend:
   a. System designation where applicable:
   b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1/2 inch.
   b. Equipment Designation: 1/2 inch.
5. Color:

a. Normal Power System: White text on black background.
b. Emergency Power System: White text on red background.
c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.03 IDENTIFICATION SIGNS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative

2.04 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, vinyl split sleeve, or metal tag type markers suitable for the conductor or cable to be identified.
B. Markers for Conductor and Cable Bundles: Use plastic marker tags or metal tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.
D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
E. Text Height: Comply with ANSI A13.1.
F. Color: Black text on orange background unless otherwise indicated.

2.05 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
C. Minimum Size:
    1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
    2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
    3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
    4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
D. Legend:
    1. Markers for Voltage Identification: Highest voltage present.
    2. Markers for System Identification:
        a. Emergency Power System: Text "EMERGENCY".
        b. Other Systems: Type of service.
E. Color: Black text on orange background unless otherwise indicated.

2.06 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
C. Legend: Type of service, continuously repeated over full length of tape.
    1. Legend shall be factory printed.
D. Color:
    1. Tape for Buried Power Lines: Black text on red background.

2.07 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with over laminate, 3 inches wide, with alternating black and white stripes.

2.08 WARNING SIGNS AND LABELS

A. Comply with City of Chicago Electrical Code and 29 CFR 1910.145.
B. Warning Signs:
    1. Materials:
        a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
        b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
    2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
    3. Minimum Size: 7 by 10 inches unless otherwise indicated.
C. Warning Labels:
    1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
        a. Do not use labels designed to be completed using handwritten text.
    2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
    3. Minimum Size: 2 by 4 inches unless otherwise indicated.
D. Shall include, but not limited to, the following legends:

1. Multiple power source warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace clearance warning: " WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

I. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   1. Power transfer switches.
   2. Controls with external control power connections.

3.03 PATHWAY IDENTIFICATION

A. Conduit labels shall be made adhesive and a minimum of ¾ inch wide, embossed with the designations in 5/16-inch high letters (numbers placed in 2 locations for all spaces and on all pathways at both ends) and legibly written with a permanent marker.

B. Minimum of two (2) labels, one at each end of the pathway and any exposed points (i.e., screw cover boxes, pull points, etc.).

C. Exposed raceways do not need to be labeled unless transitioning into or out of an inaccessible space. When necessary, raceway designation will be (RW).

D. All pathways shall be identified with an alphanumeric identifier to designate locations for the origin and the end of the pathway.

E. Pathways shall follow the hierarchy.

F. Final identification shall be required at the beginning and the end of the pathway and at all accessible points along the pathway (i.e. Pull boxes)
   1. Example: Conduit leaving MDF and ending at classroom concentrator 232:

ROOM PRIMARY SIGNIFICANCE **MDF**	**MDF-CCE232** ROOM OF SECONDARY SIGNIFICANCE

MAIN DISTRIBUTION FRAM	**CCE232** CLASSROOM CONCENTRATOR ENCLOSURE ROOM 232

2. Example: Telecommunications service entrance from the main service entrance to the MDF:

ROOM PRIMARY SIGNIFICANCE **MDF** MAIN DISTRIBUTION FRAME	**MDF-TCN** CONDUIT IDENTIFICATION **TCN** TELECOMMUNICATIONS SERVICE ENTRANCE

3. When multiple rooms of secondary significance are combined together (Branched off) within the same common conduit, leaving the room of significance, each label will be attached to the common conduit and Identified on a spreadsheet in the enclosure pockets and the MDF binder.
   a. Example:
      1) **MDF-SCE256**
      2) **MDF-TCE254**
4. When multiple conduits are extended from the MDF to a common location, a distinction is to be made between the conduits.
   a. Example: Two conduits from MDF to the Telecommunications Service Entrance:

ROOM PRIMARY SIGNIFICANCE **MDF** MAIN DISTRIBUTION FRAME	MDF-TCN-CN1 (2) CONDUIT IDENTIFICATION **TCN** TELECOMMUNICATIONS SERVICE ENTRANCE	CONDUIT IDENTIFICATION **CN1** CONDUIT 1

3.04 IDENTIFICATION SIGN INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Electronic shut off valves are to be identified with signs at the activating switch or button, including:
   1. Gas Shut Off
   2. Emergency Boiler Shut Off
   3. Emergency Generator Shut Off

3.05 WARNING SIGN INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Warning Signs are required for the following elements:
C. Warning Lights are to have an accompanying sign identifying the light meaning, including:
D. “Gas Usage in Space” for Science Labs and Prep Rooms
E. “Do Not Enter – Photo Developing” for Photography Dark Rooms
F. “Refrigerant Alarm” at Chiller Room

3.06 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 53 (MEP)
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Identification signs.
D. Wire and cable markers.
E. Voltage markers.
F. Underground warning tape.
G. Floor marking tape.
H. Warning signs and labels.

1.02 REFERENCE STANDARDS

A. 29 CFR 1910.145 - Accident Prevention Signs and Tags current edition.
B. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.
C. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
D. NFPA 70E - Standard for Electrical Safety in the Workplace 2018.
E. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
C. Samples:
   1. For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features..
D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE

A. Comply with ASME A13.1.
B. Comply with ANSI/IEEE 802.7.
C. Comply with 29 CFR 1910.145.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

1.07 COORDINATION

A. Coordinate all names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Designations and labeling shall be consistent throughout the project.
B. Coordinate installation with coverings and painting of surfaces.
C. Coordinate installation with location of access panels and doors.

D. Install identifying devices before installation of acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use identification nameplate to identify main overcurrent protective device.
      5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   b. Panelboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
      5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   c. Transformers:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify load(s) served. Include location when not within sight of equipment.
   d. Enclosed switches, circuit breakers, and motor controllers:
      1) Identify voltage and phase.
      2) Identify power source and circuit number. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.
   e. Transfer Switches:
      1) Identify voltage and phase.
      2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
      3) Identify load(s) served. Include location when not within sight of equipment.
      4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
   f. Electricity Meters:
      1) Identify load(s) metered.
   g. UPS:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify load(s) served. Include location when not within sight of equipment
   h. Motor Control centers:
      1) Identify ampere rating.

2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify voltage and phase.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each starter. Do not identify spares and spaces.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with the Chicago Electrical Code.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
   c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with the Chicago Electrical Code.
6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with the City of Chicago Electrical Code.
7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
8. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
9. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances.
    a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting.
12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by the Chicago Electrical Code, including but not limited to the following..
    a. Service equipment.
    b. Industrial control panels.
    c. Motor control centers.
    d. Elevator control panels.
    e. Industrial machinery.
13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels,

meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Comply with NFPA 70E
   b. Minimum Size: 3.5 by 5 inches.
   c. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
   d. Labels shall be machine printed, with no field-applied markings.
   e. Service Equipment: Include the following information in accordance with the Chicago Electrical Code.
      1) Nominal system voltage.
      2) Available fault current.
      3) Clearing time of service overcurrent protective device(s).
      4) Date label applied.
14. Within all switchboard rooms, electrical closets, and other spaces containing electrical equipment provide the following:
   a. Vitreous enameled metal sign, red on white, reading "Electrical Equipment Room - No Storage Permitted."
   b. Mounted in clearly visible locations within rooms.
      1) If wall space in room does not permit mounting, mount to door on inside of room.
15. In all switchboard rooms:
   a. Install up-to-date black-lined print of feeder diagram of building completed with feeder schedules.
      1) Print shall be installed in frame, behind glass.
      2) Print to include up-to-date field record information.
      3) Print to be on mylar.
      4) Print to have lettering no smaller than 1/8 inch.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. At each source and load connection.
   b. Within boxes where there are more than three branch circuits, provide metal tags. Provide source and circuit number for each ungrounded conductor..
   c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
   d. Provide write-on tags to conductors and list source and circuit number for conductors to be extended in the future.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
5. Use underground warning tape to identify direct buried cables and cables buried in raceway for the following systems:
   a. Power

b. Lighting
c. Communications
d. Control wiring
e. Optical Fiber
f. Connection to City OEMC network

C. Identification for Raceways:
1. Comply with ASME A13.1 for size of letters for legend and minimum length of color field for each raceway.
2. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
3. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
1) Color Code:
(a) Emergency Power System: Red.
(b) Fire Alarm System: Red.
(c) Control Wiring: Green and red.
(d) Telecommunication Systems:
(1) Provide blue colored conduit for telecommunication system raceway. Conduit to be in accordance with Section 26 05 33.13 - Conduit for Electrical Systems.
(e) Mechanical and Electrical Supervisory System: Green and blue.
(f) Security System: Blue and yellow.
(g) Fire-Suppression Supervisory and Control System: Red and yellow.
2) Field-Painting: Comply with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting.
3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
a. Provide one label or marker at each end of the pathway and at any exposed pints (i.e., screw cover boxes, pull points, etc.)
5. Exposed raceways shall be labeled at transitions into and out of inaccessible spaces.
6. Provide alphanumeric identifiers to designate locations for origin and the end of the pathway.
a. Type of pathways shall be identified:
1) CN-conduit
2) TCN-telecommunications conduit
3) RK-rack
4) W-workstation
b. Numbered from each origin point in series starting from 1.
7. Use underground warning tape to identify underground raceways.
8. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.

a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 - Interior Painting and 09 91 13 - Exterior Painting per the same color code used for raceways.
b. For exposed boxes in public areas, do not color code.

3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
   a. For exposed boxes in public areas, use only identification labels.

E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26 - Wiring Devices.
2. Use identification label to identify fire alarm system devices.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
3. Use identification label to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
   a. Seton Identification Products: www.seton.com/#sle.
   b. Quentin D. Schwab.
   c. Joe Halm Building Specialties
   d. Mechanical Tag Systems
   e. N&E Specialty Company
2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
      1) With non-corroding screws.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or melamine with beveled edges; minimum thickness of 1/16 inch; engraved text.
4. Text:
   a. Text to be 1/2 inch high letters on 1-1/2 inch label for single line.
   b. Text to be 1/2 inch high letters on 2 inch label for 2 line text applications.
   c. Increase sizes of labels and letters to be viewed from floor in elevated applications.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1.5 inches by 2.5 inches.
2. Legend:
   a. System designation where applicable:
   b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1/2 inch.
   b. Equipment Designation: 1/2 inch.
5. Color:

a. Normal Power System: White text on black background.
b. Emergency Power System: White text on red background.
c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.03 IDENTIFICATION SIGNS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches; 1/2 inch for viewing distances up to 72 inches; and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions. Provide additional information as required by Board Representative

2.04 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, vinyl split sleeve, or metal tag type markers suitable for the conductor or cable to be identified.
B. Markers for Conductor and Cable Bundles: Use plastic marker tags or metal tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.
D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
E. Text Height: Comply with ANSI A13.1.
F. Color: Black text on orange background unless otherwise indicated.

2.05 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
C. Minimum Size:
    1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
    2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
    3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
    4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
D. Legend:
    1. Markers for Voltage Identification: Highest voltage present.
    2. Markers for System Identification:
        a. Emergency Power System: Text "EMERGENCY".
        b. Other Systems: Type of service.
E. Color: Black text on orange background unless otherwise indicated.

2.06 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
C. Legend: Type of service, continuously repeated over full length of tape.
    1. Legend shall be factory printed.
D. Color:
    1. Tape for Buried Power Lines: Black text on red background.

2.07 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with over laminate, 3 inches wide, with alternating black and white stripes.

2.08 WARNING SIGNS AND LABELS

A. Comply with City of Chicago Electrical Code and 29 CFR 1910.145.
B. Warning Signs:
    1. Materials:
        a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
        b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
    2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
    3. Minimum Size: 7 by 10 inches unless otherwise indicated.
C. Warning Labels:
    1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
        a. Do not use labels designed to be completed using handwritten text.
    2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
    3. Minimum Size: 2 by 4 inches unless otherwise indicated.
D. Shall include, but not limited to, the following legends:

1. Multiple power source warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace clearance warning: " WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

I. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   1. Power transfer switches.
   2. Controls with external control power connections.

3.03 PATHWAY IDENTIFICATION

A. Conduit labels shall be made adhesive and a minimum of ¾ inch wide, embossed with the designations in 5/16-inch high letters (numbers placed in 2 locations for all spaces and on all pathways at both ends) and legibly written with a permanent marker.

B. Minimum of two (2) labels, one at each end of the pathway and any exposed points (i.e., screw cover boxes, pull points, etc.).

C. Exposed raceways do not need to be labeled unless transitioning into or out of an inaccessible space. When necessary, raceway designation will be (RW).

D. All pathways shall be identified with an alphanumeric identifier to designate locations for the origin and the end of the pathway.

E. Pathways shall follow the hierarchy.

F. Final identification shall be required at the beginning and the end of the pathway and at all accessible points along the pathway (i.e. Pull boxes)
   1. Example: Conduit leaving MDF and ending at classroom concentrator 232:

ROOM PRIMARY SIGNIFICANCE **MDF**	**MDF-CCE232** ROOM OF SECONDARY SIGNIFICANCE

MAIN DISTRIBUTION FRAM	**CCE232** CLASSROOM CONCENTRATOR ENCLOSURE ROOM 232

2. Example: Telecommunications service entrance from the main service entrance to the MDF:

ROOM PRIMARY SIGNIFICANCE **MDF** MAIN DISTRIBUTION FRAME	**MDF-TCN** CONDUIT IDENTIFICATION **TCN** TELECOMMUNICATIONS SERVICE ENTRANCE

3. When multiple rooms of secondary significance are combined together (Branched off) within the same common conduit, leaving the room of significance, each label will be attached to the common conduit and Identified on a spreadsheet in the enclosure pockets and the MDF binder.
   a. Example:
      1) **MDF-SCE256**
      2) **MDF-TCE254**
4. When multiple conduits are extended from the MDF to a common location, a distinction is to be made between the conduits.
   a. Example: Two conduits from MDF to the Telecommunications Service Entrance:

ROOM PRIMARY SIGNIFICANCE **MDF** MAIN DISTRIBUTION FRAME	MDF-TCN-CN1 (2) CONDUIT IDENTIFICATION **TCN** TELECOMMUNICATIONS SERVICE ENTRANCE	 CONDUIT IDENTIFICATION **CN1** CONDUIT 1

3.04 IDENTIFICATION SIGN INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Electronic shut off valves are to be identified with signs at the activating switch or button, including:
   1. Gas Shut Off
   2. Emergency Boiler Shut Off
   3. Emergency Generator Shut Off

3.05 WARNING SIGN INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Warning Signs are required for the following elements:
C. Warning Lights are to have an accompanying sign identifying the light meaning, including:
D. “Gas Usage in Space” for Science Labs and Prep Rooms
E. “Do Not Enter – Photo Developing” for Photography Dark Rooms
F. “Refrigerant Alarm” at Chiller Room

3.06 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 73 (LNK)

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock hazard assessment.
   1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

C. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

D. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

E. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

F. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

G. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations - Includes 1584, 1584A and 1584B; 2002 (Amended 2011).

H. NEMA MG 1 - Motors and Generators; 2017.

I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.

C. Sequencing:
1. Submit study reports prior to or concurrent with product submittals.
2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect/Engineer of Record.
3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Study preparer's qualifications.
1. For coordination-study specialist, submit name and references for at least five actual Arc-Flash Hazard Analysis performed in the past year.

C. Field testing agency's qualifications.

D. Study reports, stamped or sealed and signed by study preparer.

E. Product Data:
1. In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
a. Include characteristic time-current trip curves for protective devices.
b. Include impedance data for busway.
c. Include impedance data for engine generators.
d. Clearly indicate that proposed short circuit current ratings are fully rated.
e. Identify modifications made in accordance with studies that:
1) Can be made at no additional cost to Board.
2) As submitted will involve a change to the contract sum.
2. Provide product data and information for software program to be used for studies.

F. Arc Flash and Shock Hazard Warning Label Samples: One of each type and legend specified.

G. Field quality control reports.

H. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

I. Project Record Documents: Revise studies as required to reflect as-built conditions.
1. Include hard copies with operation and maintenance data submittals.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems, including but not limited to:
a. Coordination study input data (including program input data sheets).
b. Study and Equipment Evaluation Reports.
c. Coordination Study Report.
d. Arc Flash Study Report.
e. Shock Hazard Report

1.05 POWER SYSTEM STUDIES

A. Scope of Studies:
1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment

involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).

2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
   a. Known Operating Modes:
      1) Utility as source.
      2) Generator as source.
      3) Utility/generator in parallel.
      4) Maintenance settings.

B. General Study Requirements:
   1. Comply with the Chicago Electrical Code.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
   3. The studies shall be performed for As-Built condition reflecting all changes that occurred during construction and actual installed length of all the feeders.
   4. The studies shall be based on actual equipment submitted and reviewed by EOR.
   5. Include all power sources rated 50 V and greater.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Owner.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      e. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
         2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
      f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
      g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
   1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
   2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
      a. Maximum utility fault currents.
      b. Maximum motor contribution.
      c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
   3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Hazard Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
   a. To clarify IEEE 1584 statement that "equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger low-impedance transformer in its immediate power supply" for purposes of studies, study preparer to include equipment rated less than 240 V fed by transformers less than 125 kVA in calculations.
   b. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
   c. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584, yielding conservative results.
3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.

2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
3) Conductors: Damage curves.
4) Transformers: Inrush points and damage curves.
5) Motors: Full load current, starting curves, and damage curves.
6) Capacitors: Full load current and damage curves.

c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
2) Include ground fault pickup and delay.
3) Include fuse ratings.
4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Hazard Assessment:
a. For each scenario, identify at each bus location:
1) Calculated incident energy and associated working distance.
2) Calculated arc flash boundary.
3) Bolted fault current.
4) Arcing fault current.
5) Clearing time.
6) Arc gap distance.

b. For purposes of producing arc flash and shock hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

c. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq. cm.

d. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq. cm.

e. Include arc flash and shock hazard labels color images printed on regular 8.5x11 in paper.

1.06 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in Illinois and with minimum five years' experience in the preparation of studies of similar type and complexity using specified computer software.
1. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
2. Study preparer may not be employed by the manufacturer of the electrical distribution equipment.
3. Study preparer may be employed by field testing agency.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
1. Acceptable Software Products:
a. EasyPower LLC: www.easypower.com/#sle.
b. ETAP/Operation Technology, Inc.: www.etap.com.
c. SKM Systems Analysis, Inc.: www.skm.com.
d. CGI CYME; www.cyme.com.
e. EDSA Micro Corporation; www.poweranalytics.com

PART 2 - PRODUCTS

2.01 ARC FLASH AND SHOCK HAZARD WARNING LABELS

A. Provide warning labels complying with NFPA 70E to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
   1. Materials: Comply with Section 26 05 53 - Identification for Electrical Systems.
   2. Minimum Size: 4 by 6 inches.
   3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
      a. Include the following information:
         1) Arc flash boundary.
         2) Available incident energy and corresponding working distance.
         3) Nominal system voltage.
         4) Equipment identification.
         5) Date calculations were performed.

B. Comply with ANSI Z535.4.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install arc flash and shock hazard warning labels in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.02 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Adjust equipment and protective devices for compliance with studies and recommended settings.

C. Notify Architect/Engineer of Record of any conflicts with or deviations from studies. Obtain direction before proceeding.

D. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 78 23.1 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Training: Include as part of the base bid training for Board's personnel on electrical safety pertaining to arc flash and shock hazards.
   1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
   2. Provide minimum of eight hours of training.

END OF SECTION 26 05 73

SECTION 26 05 83 (LNK)

WIRING CONNECTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).

C. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

D. NFPA 70 - National Electrical Code; 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
2. Determine connection locations and requirements.
3. Review with all other trades and equipment installers all connection requirements prior to initiation of work.

B. Sequencing:
1. Install rough-in of electrical connections before installation of equipment is required.
2. Make electrical connections before required start-up of equipment.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Confirm to requirements of Chicago Electrical Code.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Disconnect Switches: As specified in Section 26 28 16.16 - Enclosed Switches and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26 - Wiring Devices

D. Flexible Conduit: As specified in Section 26 05 33.13 - Conduit for Electrical Systems.

E. Wire and Cable: As specified in Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

F. Boxes: As specified in Section 26 05 33.16 - Boxes for Electrical Systems.

2.02 EQUIPMENT CONNECTIONS

A. Equipment connections are as indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 26 05 83

SECTION 26 05 83 (MEP)

WIRING CONNECTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).

C. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

D. NFPA 70 - National Electrical Code; 2017.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
2. Determine connection locations and requirements.
3. Review with all other trades and equipment installers all connection requirements prior to initiation of work.

B. Sequencing:
1. Install rough-in of electrical connections before installation of equipment is required.
2. Make electrical connections before required start-up of equipment.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Confirm to requirements of Chicago Electrical Code.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Disconnect Switches: As specified in Section 26 28 16.16 - Enclosed Switches and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26 - Wiring Devices

D. Flexible Conduit: As specified in Section 26 05 33.13 - Conduit for Electrical Systems.

E. Wire and Cable: As specified in Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

F. Boxes: As specified in Section 26 05 33.16 - Boxes for Electrical Systems.

2.02 EQUIPMENT CONNECTIONS

A. Equipment connections are as indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26 05 83

SECTION 26 08 13 (LNK)

TESTING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for Electrical Testing including, but not limited to:
   1. Insulation resistance test.
   2. Continuity test.
   3. Voltage test.
   4. Phase relationship verification.

B. Testing of electrical components and systems including:

C. Correction of defective components or systems.

D. Retest of corrected components, systems.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

1.03 SUBMITTALS

A. Test reports: Submit six (6) copies of all test reports to Architect/Engineer of Record (3 copies), General Contractor (1) and the Principal and/or School Engineer.
   1. Type each test report on 8-1/2” x 11” paper. Include:
      a. Project title and location.
      b. Test performed.
      c. Data performed
      d. Test equipment used.
      e. Contractor’s name, address and telephone number.
      f. Testing firm’s name, address and telephone number.
      g. Names and tittles of persons:
         1) Performing the test.
         2) Observing test
         3) Statement verifying each test.
         4) Nameplate data from each motor and equipment item tested.
         5) Test results.
         6) Retest results after correction of defective components, systems.
         7) Dates and time of test.
   2. For each copy, assemble all test reports and bind them in a folder. Label each folder, “Electrical Test Reports” and include Chicago Board of Education Project Number, title and location.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Furnish all equipment, manpower and casual labor to perform specified testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure that all electrical work is completed and ready for testing.

B. Disconnect all devices or equipment that may be damaged by application of test voltages, voltage or reversed phase sequence or other procedures.

3.02 TESTING:

A. Conduct tests and adjust equipment to verify compliance with specified performance.

B. Comply with NETA ATS.

3.03 INSULATION RESISTANCE TESTS

A. Resistance measured: line-to-ground.

B. Perform testing on the following items:
1. Item Tested: No. 2 and Larger Cables (600V).
   a. Minimum Acceptance Voltage of Test: 1000V.
   b. Resistance in Mega ohms: 50.

3.04 CONTINUITY TESTS:

A. Test branch circuits and control circuits to determine continuity of wiring and connection.

3.05 VOLTAGE TESTS

A. Make and record voltage tests and record at the following listed points. Conduct tests under normal load conditions.
1. Terminals of all motors.
2. Terminals of all equipment, i.e., UPS, refrigeration compressors, etc.

3.06 PHASE RELATIONSHIP

A. Examine connections to equipment for proper phase relationships. Verify proper motor rotation.

3.07 CORRECTION OF DEFECTS

A. When tests disclose any unsatisfactory workmanship or equipment furnished under this Contract, correct defects and retest. Repeat tests until satisfactory results are obtained.

B. When any wiring or equipment is damaged by tests, repairs or replace such wiring or equipment. Test repaired items to ensure satisfactory operation.

3.08 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of test reports as outlined in this section.

END OF SECTION 26 08 13

SECTION 26 08 13 (MEP)

TESTING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for Electrical Testing including, but not limited to:
   1. Insulation resistance test.
   2. Continuity test.
   3. Voltage test.
   4. Phase relationship verification.

B. Testing of electrical components and systems including:

C. Correction of defective components or systems.

D. Retest of corrected components, systems.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

1.03 SUBMITTALS

A. Test reports: Submit six (6) copies of all test reports to Architect/Engineer of Record (3 copies), General Contractor (1) and the Principal and/or School Engineer.
   1. Type each test report on 8-1/2” x 11” paper. Include:
      a. Project title and location.
      b. Test performed.
      c. Data performed
      d. Test equipment used.
      e. Contractor’s name, address and telephone number.
      f. Testing firm’s name, address and telephone number.
      g. Names and tittles of persons:
         1) Performing the test.
         2) Observing test
         3) Statement verifying each test.
         4) Nameplate data from each motor and equipment item tested.
         5) Test results.
         6) Retest results after correction of defective components, systems.
         7) Dates and time of test.
   2. For each copy, assemble all test reports and bind them in a folder. Label each folder, “Electrical Test Reports” and include Chicago Board of Education Project Number, title and location.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Furnish all equipment, manpower and casual labor to perform specified testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure that all electrical work is completed and ready for testing.

B. Disconnect all devices or equipment that may be damaged by application of test voltages, voltage or reversed phase sequence or other procedures.

3.02 TESTING:

A. Conduct tests and adjust equipment to verify compliance with specified performance.

B. Comply with NETA ATS.

3.03 INSULATION RESISTANCE TESTS

A. Resistance measured: line-to-ground.

B. Perform testing on the following items:
1. Item Tested: No. 2 and Larger Cables (600V).
    a. Minimum Acceptance Voltage of Test: 1000V.
    b. Resistance in Mega ohms: 50.

3.04 CONTINUITY TESTS:

A. Test branch circuits and control circuits to determine continuity of wiring and connection.

3.05 VOLTAGE TESTS

A. Make and record voltage tests and record at the following listed points. Conduct tests under normal load conditions.
1. Terminals of all motors.
2. Terminals of all equipment, i.e., UPS, refrigeration compressors, etc.

3.06 PHASE RELATIONSHIP

A. Examine connections to equipment for proper phase relationships. Verify proper motor rotation.

3.07 CORRECTION OF DEFECTS

A. When tests disclose any unsatisfactory workmanship or equipment furnished under this Contract, correct defects and retest. Repeat tests until satisfactory results are obtained.

B. When any wiring or equipment is damaged by tests, repairs or replace such wiring or equipment. Test repaired items to ensure satisfactory operation.

3.08 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of test reports as outlined in this section.

END OF SECTION 26 08 13

SECTION 26 09 23 (LNK)
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Occupancy/Vacancy sensors.
B. Daylighting controls.
C. Low Voltage Wall Control Devices.
D. Lighting contactors.
E. Toggle Switches

1.02 REFERENCE STANDARDS

A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing 2010.
B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
C. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
D. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
E. IEEE C62.41.1 - IEEE Standard Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits 2002 (Reaffirmed 2008).
F. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).
G. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits 2002.
H. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
I. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.
K. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2000, with Errata (2008).
L. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).
M. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting Current Edition, Including All Revisions.
N. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control Current Edition, Including All Revisions.
O. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules Current Edition, Including All Revisions.
P. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
    2. Coordinate the placement of wall switch occupancy/vacancy sensors with actual installed door swings.
    3. Coordinate the placement of occupancy/vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
    4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.

5. Notify Architect/Engineer of Record of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
   5. Control locations.
   6. Load circuit wiring.
   7. Connections to other equipment.
   8. Installer responsibilities.

C. Sequencing:
   1. Do not install lighting control devices until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:
   1. Occupancy/Vacancy Sensors: Provide lighting plan indicating location, device coverage, model number, and orientation of each occupancy/vacancy sensor and associated system component.
   2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
   3. Interconnection diagrams for occupancy sensors and daylighting controls showing field-installed wiring.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Manufacturer's recommended operation and maintenance practices for each type of product including, but not limited to:
      a. Tools required.
      b. Acceptable cleaners and recommended cleaning practices.
      c. Replacement parts list.
      d. Manufacturer service department contact information.
      e. Submittal data.
      f. Intended operation narrative.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.05 QUALITY ASSURANCE

A. Listed and labeled as defined in the Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with City of Chicago Building Code, Chicago Energy Conservation Code and Chicago Electrical Code.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
B. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for all occupancy/vacancy sensors.
C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.
D. Provide two year manufacturer warranty for all daylighting controls.
E. Except as otherwise noted, products provided shall be warranted against defects in design, manufacture, and operation for a period of not less than five (5) years.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    1. Occupancy/Vacancy sensors: 1% of total devices; minimum of 2 devices
    2. Daylighting controls: Minimum one of each type.
    3. Powerpacks: Minimum one of each type.
    4. Low Voltage Wall Control Devices: Minimum two of each type.
    5. Lighting contactors: Minimum one of each type.
    6. Toggle Switches: Minimum two of each type.
    7. Line Voltage Dimmer Switches: Minimum two of each type.
    8. Switch Button Covers: equal to five percent of amount installed for each size/type indicated, but no fewer than five for each size/type.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.
B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 INDOOR OCCUPANCY/VACANCY SENSORS

A. Manufacturers:
    1. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
    2. Hubbell Building Automation: www.hubbellautomation.com.
    3. Lutron Electronics Company, Inc: www.lutron.com/sle.
    4. WattStopper: www.wattstopper.com/#sle.
B. All Occupancy/Vacancy Sensors:
    1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
    2. Sensor Technology:
        a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
        b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.

c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
d. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
5. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
6. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
   a. Coordinate both technologies within the same sensor to have the same coverage area.
7. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
8. Turn-Off Delay: Field adjustable, with time delay setting over a minimum range of 1 to 15 minutes.
9. Sensitivity: Field adjustable.
10. Compatibility (Non-Dimming Sensors): Suitable for controlling low-voltage lighting with electronic transformers, and fractional motor loads, with no minimum load requirements.
11. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings. Provide any power packs, relay and control components necessary for a fully functional complete system.
12. Where multiple occupancy sensors occur within the same space, connect sensors together to control the lights as a unit.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
14. Bypass Switch: Override the on function in case of sensor failure.

C. Wall Switch Occupancy/Vacancy Sensors:
   1. All Wall Switch Occupancy Sensors:
      a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
      b. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
      c. Where indicated, provide two button units for raise/lower dimming of a single lighting load.
      d. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
      e. Finish: Match finishes specified for wiring devices, unless otherwise indicated.
      f. Provide vandal resistant coated-steel wire cage for passive infrared (PIR) and dual technology wall switch occupancy sensors located in areas subject to damage or vandalism..

2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
    a. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 square inches.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
    a. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.
    b. Provide sensors operating at a minimum of 32 kHz and a maximum of 98dB.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
    a. Description: Low profile occupancy sensors designed for ceiling installation.
    b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
    c. Provide field selectable setting for disabling LED motion detector visual indicator.
    d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
    e. Locate sensors away from areas with strong air currents such as adjacent to HVAC diffusers.
    f. Layout of sensors shall account for sensitivity adjustments below maximum and any absorptive materials such as carpeting or material covered partitions.
    g. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Extended Range Sensors: Capable of detecting motion within 90 feet of sensor at a mounting height of 10 feet, with a field of view of 360 degrees.
    c. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.
    d. Provide sensors operating at a minimum of 32 kHz and a maximum of 98dB.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Medium Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    c. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
        1) Corridor Coverage: Capable of detecting motion within 90 feet at a mounting height of 10 feet in a corridor not wider than 14 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
5. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
    a. Do not use to initiate an ON sequence.
    b. Provide automatic gain control.

c. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
d. Extended Range Sensors: Capable of detecting motion within an area of 2,000 at a mounting height of 9 feet.
1) Corridor Coverage: Capable of detecting motion within 90 feet at a mounting height of 10 feet in a corridor not wider than 14 feet.

E. Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on drawings.

2.03 DAYLIGHTING CONTROLS

A. Manufacturers:
1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
3. ETC Company; https://www.etcconnect.com/
4. Hubbell Building Automation, Inc: www.hubbellautomation.com
5. Leviton Mfg. Company, Inc: www.lutron.com
6. Lutron Electronics Company, Inc: www.lutron.com/sle.
7. WattStopper: www.wattstopper.com.

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors, manual override controls, and lighting control system.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
1. Sensor Type: Filtered silicon photo diode.
2. Sensor Range:
a. Indoor Photo Sensors: 10 to 200 footcandles.
b. Atrium Photo Sensors: 100 to 1000 footcandles.
c. Corridor Photo Sensors: 100 to 1000 footcandles.
d. Skylight Photo Sensors: 1000 to 10,000 footcandles.
1) Housed in threaded plastic fitting for mounting under skylight, facing up at skylight.
3. Finish: White unless otherwise indicated.
4. Relay Unit: Power supply to sensor shall be 24V dc, 150 mA and Class 2 power source as defined by the Chicago Electrical Code.
5. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
6. Indicator: Two LEDs to indicate the beginning of on-off cycles.
7. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773AUL . Sensor shall be powered from the relay unit

2.04 LOW VOLTAGE WALL CONTROL DEVICES

A. Switch Control/Manual Override Stations: Control voltage, momentary contact, push button style switching devices providing the indicated switch function to interface with the modular/networked control system. Provided with the following:
1. 1,2,3,4, or 8 pushbutton actuators on a single gang device.
2. Removable buttons for field replacement

3. LED on the face of each pushbutton providing visual feedback of switch/load status and switch/programming assignment.
4. Thermoplastic construction designed for ganged wall box installation with other similar devices.
5. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

B. Scene Control Stations: Control voltage, solid state, devices providing dimming function(s) and ON/OFF function(s) from the same device and interfaces with the modular/networked control system. Provided with the following:
1. Pushbutton pre-set control of multiple loads as well as the ability to manually raise/lower the lighting levels of each of the pre-set loads.
2. Individual pre-set scene buttons and separate raise/lower control function shall be programmed and provided on a sign gang strap device.
3. Thermoplastic construction designed for ganged wall box installation with other similar devices.
4. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

C. Dimming Control Stations: Control voltage, solid state, devices providing dimming function to interface with the modular/networked control system. Provided with the following:
1. Single button style actuator to manually raise/lower and turn ON/OFF controlled luminaire(s) lighting level.
2. Multi-location (3-way and 4-way) control function of connected loads.
3. LED indicators provide visual feedback for programming and troubleshooting.
4. Thermoplastic construction designed for ganged wall box installation with other similar devices.
5. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

D. Touchscreen Stations: Flush to wall surface installed devices, providing a flat, planar, capacitive touch sensitive user interface to the networked control system. Provides the following functions:
1. User programmable and configurable
2. Brightness Level setting of the controlled luminaires and devices
3. Preset assignments, re-programming, and preset recall.
4. ON/OFF control of controlled luminaires and devices.
5. Interface with third party A/V equipment, to allow for control of third party equipment, devices, and components, via the touch screen.
6. Raise/lower dimming of controlled luminaires, shades, projectors, etc

2.05 LIGHTING CONTACTORS

A. Manufacturers:
1. ABB/GE: www.geindustrial.com/#sle.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co
3. Eaton Corporation: www.eaton.com/#sle.
4. Rockwell Automation Inc; Allen-Bradley Products: ab.rockwellautomation.com/#sle.
5. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

B. Description: Electrically operated and mechanically held lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.

C. Short Circuit Current Rating:
1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Enclosures:

1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: As indicated on the drawings.
3. Finish: Manufacturer's standard unless otherwise indicated.

2.06 TOGGLE SWITCHES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   2. Hubbell Incorporated: www.hubbell-wiring.com.
   3. Leviton Manufacturing Company, Inc: www.leviton.com.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking momentary contact wall switches: Heavy duty specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with Chicago Electrical Code.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

C. Protect installation from dust and debris of other construction activities.

3.03 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of lighting control devices provided under this section.
   1. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
   2. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect/Engineer of Record to obtain direction prior to proceeding with work.

C. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

D. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceiling or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

E. Install lighting control devices in accordance with manufacturer's instructions.

F. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

G. Install lighting control devices plumb and level, and held securely in place.

H. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26 - Wiring Devices - Lutron.

I. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

J. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

K. Identify components and power and control wiring according to Section 26 05 53 - Identification for Electrical Systems.
   1. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
   2. Label time switches with a unique designation.

L. Occupancy/Vacancy Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect/Engineer of Record.

M. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect/Engineer of Record.
   2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
   3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.
Q. Where indicated or required, provide cabinet or enclosure in accordance with Section 26 05 33.16 - Boxes for Electrical Systems for mounting of lighting control device system components.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each lighting control device for damage and defects.
C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
D. Test time switches to verify proper operation.
E. Test outdoor photo controls to verify proper operation, including time delays where applicable.
F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.
B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect/Engineer of Record.
C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
D. Where indicated or as directed by Architect/Engineer of Record, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect/Engineer of Record. Record settings in written report to be included with submittals.
F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect/Engineer of Record.
G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect/Engineer of Record. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect/Engineer of Record.
H. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

A. See Section 01 91 00 - General Commissioning Requirements for commissioning requirements.
B. After system checkout and adjustment, the contractor shall operate the system for the review of the Board Representative and Architect/Engineer of Record. Necessary

adjustments or modifications shall be made as required by the Board Representative or Architect/Engineer of Record.

3.08 CLOSEOUT ACTIVITIES

A. See Section 01 79 00.1 - Demonstration and Training, for additional requirements.
B. Demonstration: Demonstrate proper operation of lighting control devices to Architect/Engineer of Record, and correct deficiencies or make adjustments as directed.
C. Training: Train Board's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of two (2) sessions of four (4) hours of training. Provide a recording of one of the sessions for future use.
    3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
    4. Location: At project site.

END OF SECTION

SECTION 26 09 23 (MEP)
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Occupancy/Vacancy sensors.
B. Daylighting controls.
C. Low Voltage Wall Control Devices.
D. Lighting contactors.
E. Toggle Switches

1.02 REFERENCE STANDARDS

A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing 2010.
B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
C. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
D. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
E. IEEE C62.41.1 - IEEE Standard Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits 2002 (Reaffirmed 2008).
F. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).
G. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits 2002.
H. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
I. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.
K. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2000, with Errata (2008).
L. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).
M. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting Current Edition, Including All Revisions.
N. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control Current Edition, Including All Revisions.
O. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules Current Edition, Including All Revisions.
P. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy/vacancy sensors with actual installed door swings.
   3. Coordinate the placement of occupancy/vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
   4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.

5. Notify Architect/Engineer of Record of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
   5. Control locations.
   6. Load circuit wiring.
   7. Connections to other equipment.
   8. Installer responsibilities.

C. Sequencing:
   1. Do not install lighting control devices until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:
   1. Occupancy/Vacancy Sensors: Provide lighting plan indicating location, device coverage, model number, and orientation of each occupancy/vacancy sensor and associated system component.
   2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
   3. Interconnection diagrams for occupancy sensors and daylighting controls showing field-installed wiring.

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Manufacturer's recommended operation and maintenance practices for each type of product including, but not limited to:
      a. Tools required.
      b. Acceptable cleaners and recommended cleaning practices.
      c. Replacement parts list.
      d. Manufacturer service department contact information.
      e. Submittal data.
      f. Intended operation narrative.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.05 QUALITY ASSURANCE

A. Listed and labeled as defined in the Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with City of Chicago Building Code, Chicago Energy Conservation Code and Chicago Electrical Code.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
B. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for all occupancy/vacancy sensors.
C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.
D. Provide two year manufacturer warranty for all daylighting controls.
E. Except as otherwise noted, products provided shall be warranted against defects in design, manufacture, and operation for a period of not less than five (5) years.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Occupancy/Vacancy sensors: 1% of total devices; minimum of 2 devices
   2. Daylighting controls: Minimum one of each type.
   3. Powerpacks: Minimum one of each type.
   4. Low Voltage Wall Control Devices: Minimum two of each type.
   5. Lighting contactors: Minimum one of each type.
   6. Toggle Switches: Minimum two of each type.
   7. Line Voltage Dimmer Switches: Minimum two of each type.
   8. Switch Button Covers: equal to five percent of amount installed for each size/type indicated, but no fewer than five for each size/type.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.
B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 INDOOR OCCUPANCY/VACANCY SENSORS

A. Manufacturers:
   1. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   2. Hubbell Building Automation: www.hubbellautomation.com.
   3. Lutron Electronics Company, Inc: www.lutron.com/sle.
   4. WattStopper: www.wattstopper.com/#sle.
B. All Occupancy/Vacancy Sensors:
   1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
   2. Sensor Technology:
      a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
      b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.

c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
d. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
4. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
5. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
6. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
   a. Coordinate both technologies within the same sensor to have the same coverage area.
7. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
8. Turn-Off Delay: Field adjustable, with time delay setting over a minimum range of 1 to 15 minutes.
9. Sensitivity: Field adjustable.
10. Compatibility (Non-Dimming Sensors): Suitable for controlling low-voltage lighting with electronic transformers, and fractional motor loads, with no minimum load requirements.
11. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings. Provide any power packs, relay and control components necessary for a fully functional complete system.
12. Where multiple occupancy sensors occur within the same space, connect sensors together to control the lights as a unit.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
14. Bypass Switch: Override the on function in case of sensor failure.

C. Wall Switch Occupancy/Vacancy Sensors:
   1. All Wall Switch Occupancy Sensors:
      a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
      b. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
      c. Where indicated, provide two button units for raise/lower dimming of a single lighting load.
      d. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
      e. Finish: Match finishes specified for wiring devices, unless otherwise indicated.
      f. Provide vandal resistant coated-steel wire cage for passive infrared (PIR) and dual technology wall switch occupancy sensors located in areas subject to damage or vandalism..

2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
    a. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 square inches.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
    a. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.
    b. Provide sensors operating at a minimum of 32 kHz and a maximum of 98dB.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:
1. All Ceiling Mounted Occupancy Sensors:
    a. Description: Low profile occupancy sensors designed for ceiling installation.
    b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
    c. Provide field selectable setting for disabling LED motion detector visual indicator.
    d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
    e. Locate sensors away from areas with strong air currents such as adjacent to HVAC diffusers.
    f. Layout of sensors shall account for sensitivity adjustments below maximum and any absorptive materials such as carpeting or material covered partitions.
    g. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Extended Range Sensors: Capable of detecting motion within 90 feet of sensor at a mounting height of 10 feet, with a field of view of 360 degrees.
    c. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.
    d. Provide sensors operating at a minimum of 32 kHz and a maximum of 98dB.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Medium Range Sensors: Capable of detecting motion within an area of 1,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    c. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
        1) Corridor Coverage: Capable of detecting motion within 90 feet at a mounting height of 10 feet in a corridor not wider than 14 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
    a. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
    b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
5. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
    a. Do not use to initiate an ON sequence.
    b. Provide automatic gain control.

c. Standard Range Sensors: Capable of detecting motion within an area of 600 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
d. Extended Range Sensors: Capable of detecting motion within an area of 2,000 at a mounting height of 9 feet.
1) Corridor Coverage: Capable of detecting motion within 90 feet at a mounting height of 10 feet in a corridor not wider than 14 feet.

E. Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on drawings.

2.03 DAYLIGHTING CONTROLS

A. Manufacturers:
1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
3. ETC Company; https://www.etcconnect.com/
4. Hubbell Building Automation, Inc: www.hubbellautomation.com
5. Leviton Mfg. Company, Inc: www.lutron.com
6. Lutron Electronics Company, Inc: www.lutron.com/sle.
7. WattStopper: www.wattstopper.com.

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors, manual override controls, and lighting control system.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
1. Sensor Type: Filtered silicon photo diode.
2. Sensor Range:
a. Indoor Photo Sensors: 10 to 200 footcandles.
b. Atrium Photo Sensors: 100 to 1000 footcandles.
c. Corridor Photo Sensors: 100 to 1000 footcandles.
d. Skylight Photo Sensors: 1000 to 10,000 footcandles.
1) Housed in threaded plastic fitting for mounting under skylight, facing up at skylight.
3. Finish: White unless otherwise indicated.
4. Relay Unit: Power supply to sensor shall be 24V dc, 150 mA and Class 2 power source as defined by the Chicago Electrical Code.
5. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
6. Indicator: Two LEDs to indicate the beginning of on-off cycles.
7. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773AUL . Sensor shall be powered from the relay unit

2.04 LOW VOLTAGE WALL CONTROL DEVICES

A. Switch Control/Manual Override Stations: Control voltage, momentary contact, push button style switching devices providing the indicated switch function to interface with the modular/networked control system. Provided with the following:
1. 1,2,3,4, or 8 pushbutton actuators on a single gang device.
2. Removable buttons for field replacement

3. LED on the face of each pushbutton providing visual feedback of switch/load status and switch/programming assignment.
4. Thermoplastic construction designed for ganged wall box installation with other similar devices.
5. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

B. Scene Control Stations: Control voltage, solid state, devices providing dimming function(s) and ON/OFF function(s) from the same device and interfaces with the modular/networked control system. Provided with the following:
1. Pushbutton pre-set control of multiple loads as well as the ability to manually raise/lower the lighting levels of each of the pre-set loads.
2. Individual pre-set scene buttons and separate raise/lower control function shall be programmed and provided on a sign gang strap device.
3. Thermoplastic construction designed for ganged wall box installation with other similar devices.
4. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

C. Dimming Control Stations: Control voltage, solid state, devices providing dimming function to interface with the modular/networked control system. Provided with the following:
1. Single button style actuator to manually raise/lower and turn ON/OFF controlled luminaire(s) lighting level.
2. Multi-location (3-way and 4-way) control function of connected loads.
3. LED indicators provide visual feedback for programming and troubleshooting.
4. Thermoplastic construction designed for ganged wall box installation with other similar devices.
5. Modular wiring terminations for the connection of field wiring between modular/networked control devices.

D. Touchscreen Stations: Flush to wall surface installed devices, providing a flat, planar, capacitive touch sensitive user interface to the networked control system. Provides the following functions:
1. User programmable and configurable
2. Brightness Level setting of the controlled luminaires and devices
3. Preset assignments, re-programming, and preset recall.
4. ON/OFF control of controlled luminaires and devices.
5. Interface with third party A/V equipment, to allow for control of third party equipment, devices, and components, via the touch screen.
6. Raise/lower dimming of controlled luminaires, shades, projectors, etc

2.05 LIGHTING CONTACTORS

A. Manufacturers:
1. ABB/GE: www.geindustrial.com/#sle.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co
3. Eaton Corporation: www.eaton.com/#sle.
4. Rockwell Automation Inc; Allen-Bradley Products: ab.rockwellautomation.com/#sle.
5. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

B. Description: Electrically operated and mechanically held lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.

C. Short Circuit Current Rating:
1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Enclosures:

1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: As indicated on the drawings.
3. Finish: Manufacturer's standard unless otherwise indicated.

2.06 TOGGLE SWITCHES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   2. Hubbell Incorporated: www.hubbell-wiring.com.
   3. Leviton Manufacturing Company, Inc: www.leviton.com.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking momentary contact wall switches: Heavy duty specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with Chicago Electrical Code.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

C. Protect installation from dust and debris of other construction activities.

3.03 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of lighting control devices provided under this section.
   1. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
   2. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect/Engineer of Record to obtain direction prior to proceeding with work.

C. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

D. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceiling or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

E. Install lighting control devices in accordance with manufacturer's instructions.

F. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

G. Install lighting control devices plumb and level, and held securely in place.

H. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26 - Wiring Devices - Lutron.

I. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

J. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

K. Identify components and power and control wiring according to Section 26 05 53 - Identification for Electrical Systems.
   1. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
   2. Label time switches with a unique designation.

L. Occupancy/Vacancy Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect/Engineer of Record.

M. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect/Engineer of Record.
   2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
   3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.
Q. Where indicated or required, provide cabinet or enclosure in accordance with Section 26 05 33.16 - Boxes for Electrical Systems for mounting of lighting control device system components.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each lighting control device for damage and defects.
C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
D. Test time switches to verify proper operation.
E. Test outdoor photo controls to verify proper operation, including time delays where applicable.
F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.
B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect/Engineer of Record.
C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
D. Where indicated or as directed by Architect/Engineer of Record, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect/Engineer of Record. Record settings in written report to be included with submittals.
F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect/Engineer of Record.
G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect/Engineer of Record. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect/Engineer of Record.
H. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.
B. After system checkout and adjustment, the contractor shall operate the system for the review of the Board Representative and Architect/Engineer of Record. Necessary

adjustments or modifications shall be made as required by the Board Representative or Architect/Engineer of Record.

3.08 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of lighting control devices to Architect/Engineer of Record, and correct deficiencies or make adjustments as directed.
D. Training: Train Board's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of two (2) sessions of four (4) hours of training. Provide a recording of one of the sessions for future use.
    3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
    4. Location: At project site.

END OF SECTION

SECTION 26 09 36 (LNK)
MODULAR DIMMING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Standalone lighting control systems and associated components:
   1. Room Controllers
   2. Zone Controllers

1.02 DEFINITIONS

A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
B. Low Voltage: As defined in the Chicago Electrical Code for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
C. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
D. SCR: Silicon-controlled rectifier.
E. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.03 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
B. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
C. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
D. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test 2008.
E. ISO 9001 - Quality management systems -- Requirements 2015.
F. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
G. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 508 - Industrial Control Equipment Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
   4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
   5. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Control locations.
   5. Load circuit wiring.

6. Connections to other equipment.
7. Installer responsibilities.

C. Sequencing:
1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations and coverage.
C. Shop Drawings:
1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. System Performance-Verification Documentation: Include as part of the base bid additional costs for manufacturer's enhanced documentation detailing start-up performance-verification procedures and functional tests performed along with test results.
F. Project Record Documents: Record actual installed locations and settings for lighting control system components.
G. Qualification Data: For Installer and manufacturer.
H. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
I. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Board's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Manufacturer Qualifications:
1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
D. Maintenance Contractor Qualifications: Manufacturer's authorized service representative.
E. Conform to requirements of NFPA 101.
F. Complying with the City of Chicago Building Code, the Chicago Electrical Code and the Chicago Energy Conservation Code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
B. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
   1. Section 26 09 23 - Lighting Control Devices
   2. Section 26 09 43 - Lighting Controls

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.
   1. System Requirements, Unless Otherwise Indicated:
      a. Ambient Temperature:
         1) Lighting Control System Components, Except Those Listed Below: Between 32 and 104 degrees F.
      b. Relative Humidity: Less than 90 percent, non-condensing.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Dimmers: Full-size units equal to three percent of amount installed for each size indicated, but no fewer than two units.
   2. Fuses: Equal to three percent of amount installed for each size installed, but no fewer than three.

1.11 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's Standard Warranty; with Manufacturer Start Up.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
   2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   3. ETC Company; https://www.etcconnect.com/
   4. Hubbell Building Automation : www.hubbellautomation.com.
   5. Leviton Manufacturing Company, Inc: www.leviton.com .
   6. Lutron Electronics Company, Inc: www.lutron.com/sle .
   7. WattStopper: www.wattstopper.com/#sle.
B. Source Limitations: For all controls within a single lighting control system. Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, drivers, transformers, and lighting controls.
B. Dimmers and Dimmer Modules: Comply with UL 508.
   1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
   2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
C. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service:
   1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.

2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from date of Preliminary Acceptance to fine-tune sensor calibration per the agreed upon sequence of operations.

D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.
E. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
F. Design lighting control equipment for ten (10) year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F to 104 degrees F and 90 percent non-condensing relative humidity.
G. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

2.03 ROOM CONTROLLERS

A. Description: Individually addressable, solid state, electronic, relay-based devices that provide ON/OFF, step and continuous dimming types of control to room connected luminaires and devices, in response to control commands of connected lighting control devices.
B. Quantity of Relays/Controllers to meet drawing control intent.
C. Scene Control Operation: Automatically change variable dimmer settings of control zones simultaneously from one preset scent to another when a push button is operated.
D. Dimming Station Control Operation: Turn lighting zone ON upon push button operation. Raise and lower dimmer settings of individual zones when RAISE/LOWER push buttons are operated.
E. Multiple Wall Control Locations: Room controller shall accept commands from multiple wall control locations.

2.04 ZONE CONTROLLERS

A. Description: Individually addressable, solid state, electronic, relay-based devices that provide ON/OFF, step and continuous dimming types of control to corridor connected luminaires and devices, in response to control commands of connected lighting control devices and time clock.
B. Quantity of Relays/Controllers to meet drawing control intent.
C. Operation: Coordinate with Section “ 26 09 43 – Lighting Control System”.

2.05 EMERGENCY LIGHTING BYPASS DEVICE

A. Description: UL 924 listed and labeled solid state, electronic, relay-based device providing for luminaires connected to an emergency lighting branch circuit to be controlled, under “normal” operating conditions, and, upon loss of “normal” AC power, bypass all connected control functions and settings, forcing the connected emergency luminaires on to full brightness.
B. Remote Testing: Provides for a remote test input from a remote test switch, or fire alarm/security system alarm interface device.
C. Visual Feedback: LEDs provide indication of which AC power source (normal or emergency) is presently serving the connected load.

2.06 NETWORK BRIDGES

A. Description: Solid state, electronic device that provides a networked communications interface between zone controllers, room controllers and other area lighting control equipment devices, and provides for the expansion of the system/network.
B. Provides for small standalone room control devices to be interconnected into a building/area wide network.
C. Control voltage, class 2 (24VDC0 operating devices powered by and from remote adjacent networked devices or from a dedicated, remote, 120vac power supply.

2.07 NETWORK CONTROL UNIT

A. Description: Solid state, microprocessor based, electronic device that provides for, and stores, real time-based scheduling and programming of devices connected to the network, as well as providing an interface to the building LAN, BAS, or remote PC.
B. Provides a gateway for loading and retrieving system software to and from remote LAN, BAS, or PCs for the purpose of programming, monitoring, and performing diagnostic and troubleshooting functions of the lighting control system/network devices and components.
C. Control Voltage, Class 2 (15-28VDC) operating device.
D. Enclosure: Surface wall sheet metal enclosure for field installation of network control modules. Provide integral 120VAC to 15-28VDC power supply to power network devices. Provide integral 120VAC duplex receptacle.

2.08 POWER SUPPLY UNITS FOR LOW VOLTAGE CONTROL DEVICES

A. Description: Self-Contained transformer/rectifier/relay devices consisting of:
    1. Transformer/rectifier to transform and rectify input primary voltage (120/277VAC) to 24VDC secondary voltage for connection to low voltage sensors, and to relay holding circuit.
    2. Single pole, nominal 20A, switching type relay with 24VDC holding circuit and output contacts rated as follows:
    3. Fluorescent Ballasted Loads – 20A
        a. Incandescent Type Loads – 20A
        b. Motor Loads – 1HP @ 120V AC.
    4. Shall provide vacancy sensing mode operation of connected sensors and switches.
B. Relay: Where an isolated relay is not provided integral to an automatic sensor, the power supply shall provide the relay.
    1. Relay shall be 1PDT, rated not less than 1A @ 30VDC.

2.09 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 27 26 - Wiring Devices.
B. Network Interconnect Cable: For field interconnection of the lighting control equipment's peripheral networked devices, automatic sensors, switches, dimmers, etc..
    1. Provide manufacturer specific, multi-conductor jacketed cable with copper conductors as directed by the equipment manufacturer.
    2. Provide pre-terminated and un-terminated cables as directed by the equipment manufacturer.
    3. Provide a full conduit system for the lighting control cabling.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
B. Install products in accordance with manufacturer's instructions.
C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
E. Define each dimmer/relay load type, assign each load to a zone, and set control functions.
F. LED Light Engine/Array Lead Length: Do not exceed 100 feet.
G. Identify system components in accordance with Section 26 05 53 - Identification for Electrical Systems.
    1. Label each dimmer module with a unique designation.
    2. Label each scene control button with approved scene description.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Contractor shall inspect, test, and adjust components, assemblies, and equipment installations, including connections and report results in writing.
C. Tests and Inspections:
    1. Continuity tests of circuits.
    2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
        a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
D. Remove and replace malfunctioning modular dimming control components and retest as specified above.
E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 COMMISSIONING AND DEMONSTRATION

A. See Section 01 91 00 - General Commissioning Requirements for commissioning requirements.
B. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 79 00.1 - Demonstration and Training, for additional requirements.
B. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.
C. Training: Train Board's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of (2) sessions of four hours of training. Provide recording of one of the sessions for future use.

3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
4. Location: At project site.

3.07 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION

SECTION 26 09 36 (MEP)
MODULAR DIMMING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Standalone lighting control systems and associated components:
   1. Room Controllers
   2. Zone Controllers

1.02 DEFINITIONS

A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
B. Low Voltage: As defined in the Chicago Electrical Code for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
C. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
D. SCR: Silicon-controlled rectifier.
E. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.03 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
B. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
C. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
D. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test 2008.
E. ISO 9001 - Quality management systems -- Requirements 2015.
F. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
G. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 508 - Industrial Control Equipment Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
   4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
   5. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Control locations.
   5. Load circuit wiring.

6. Connections to other equipment.
7. Installer responsibilities.

C. Sequencing:
1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations and coverage.
C. Shop Drawings:
1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. System Performance-Verification Documentation: Include as part of the base bid additional costs for manufacturer's enhanced documentation detailing start-up performance-verification procedures and functional tests performed along with test results.
F. Project Record Documents: Record actual installed locations and settings for lighting control system components.
G. Qualification Data: For Installer and manufacturer.
H. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
I. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Board's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Manufacturer Qualifications:
1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
D. Maintenance Contractor Qualifications: Manufacturer's authorized service representative.
E. Conform to requirements of NFPA 101.
F. Complying with the City of Chicago Building Code, the Chicago Electrical Code and the Chicago Energy Conservation Code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
B. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
   1. Section 26 09 23 - Lighting Control Devices
   2. Section 26 09 33 - Central Dimming Controls
   3. Section 26 09 43 - Lighting Controls

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.
   1. System Requirements, Unless Otherwise Indicated:
      a. Ambient Temperature:
         1) Lighting Control System Components, Except Those Listed Below: Between 32 and 104 degrees F.
      b. Relative Humidity: Less than 90 percent, non-condensing.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Dimmers: Full-size units equal to three percent of amount installed for each size indicated, but no fewer than two units.
   2. Fuses: Equal to three percent of amount installed for each size installed, but no fewer than three.

1.11 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's Standard Warranty; with Manufacturer Start Up.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
   2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   3. ETC Company; https://www.etcconnect.com/
   4. Hubbell Building Automation : www.hubbellautomation.com.
   5. Leviton Manufacturing Company, Inc: www.leviton.com .
   6. Lutron Electronics Company, Inc: www.lutron.com/sle .
   7. WattStopper: www.wattstopper.com/#sle.
B. Source Limitations: For all controls within a single lighting control system. Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, drivers, transformers, and lighting controls.
B. Dimmers and Dimmer Modules: Comply with UL 508.
   1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
   2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
C. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service:
   1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.

2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from date of Preliminary Acceptance to fine-tune sensor calibration per the agreed upon sequence of operations.

D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.
E. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
F. Design lighting control equipment for ten (10) year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F to 104 degrees F and 90 percent non-condensing relative humidity.
G. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

2.03 ROOM CONTROLLERS

A. Description: Individually addressable, solid state, electronic, relay-based devices that provide ON/OFF, step and continuous dimming types of control to room connected luminaires and devices, in response to control commands of connected lighting control devices.
B. Quantity of Relays/Controllers to meet drawing control intent.
C. Scene Control Operation: Automatically change variable dimmer settings of control zones simultaneously from one preset scent to another when a push button is operated.
D. Dimming Station Control Operation: Turn lighting zone ON upon push button operation. Raise and lower dimmer settings of individual zones when RAISE/LOWER push buttons are operated.
E. Multiple Wall Control Locations: Room controller shall accept commands from multiple wall control locations.

2.04 PARTITION SENSORS: INTERFACE WALL CONTACT CLOSURES TO ROOM CONTROLLER.

A. Functions and Features:
B. Automatically combine and separate lighting and accessory function controls as spaces are configured with movable partitions; with controls for adjustment of the lighting level for each scene of each dimmer, and adjustment of fade-rate setting for each scene change from one preset scene to another.
1. Master controls shall accommodate partitioning the space into five adjacent rooms.
2. Manual controls to set up a minimum of six scenes for each room. Include wall stations in each room to control scenes.
3. Master channel to raise and lower the lighting level of all zones.
4. Emergency-control pushbutton to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.

C. Each manual modular multiscene dimming controller shall include a master control and remote controls.
D. Each zone shall be configurable to control the following:
1. LED luminaires.
2. Non-dimmed loads.

E. Memory: Retain preset scenes through power failures for at least seven days.
F. Device Plates: Style, material, and color shall comply with Section "26 27 26 - Wiring Devices. Coordinate with Section " 26 09 23 – Lighting Control Devices".

2.05 ZONE CONTROLLERS

A. Description: Individually addressable, solid state, electronic, relay-based devices that provide ON/OFF, step and continuous dimming types of control to corridor connected luminaires and devices, in response to control commands of connected lighting control devices and time clock.
B. Quantity of Relays/Controllers to meet drawing control intent.
C. Operation: Coordinate with Section " 26 09 43 – Lighting Control System".

2.06 EMERGENCY LIGHTING BYPASS DEVICE

A. Description: UL 924 listed and labeled solid state, electronic, relay-based device providing for luminaires connected to an emergency lighting branch circuit to be controlled, under "normal" operating conditions, and, upon loss of "normal" AC power, bypass all connected control functions and settings, forcing the connected emergency luminaires on to full brightness.
B. Remote Testing: Provides for a remote test input from a remote test switch, or fire alarm/security system alarm interface device.
C. Visual Feedback: LEDs provide indication of which AC power source (normal or emergency) is presently serving the connected load.

2.07 NETWORK BRIDGES

A. Description: Solid state, electronic device that provides a networked communications interface between zone controllers, room controllers and other area lighting control equipment devices, and provides for the expansion of the system/network.
B. Provides for small standalone room control devices to be interconnected into a building/area wide network.
C. Control voltage, class 2 (24VDC0 operating devices powered by and from remote adjacent networked devices or from a dedicated, remote, 120vac power supply.

2.08 NETWORK CONTROL UNIT

A. Description: Solid state, microprocessor based, electronic device that provides for, and stores, real time-based scheduling and programming of devices connected to the network, as well as providing an interface to the building LAN, BAS, or remote PC.
B. Provides a gateway for loading and retrieving system software to and from remote LAN, BAS, or PCs for the purpose of programming, monitoring, and performing diagnostic and troubleshooting functions of the lighting control system/network devices and components.
C. Control Voltage, Class 2 (15-28VDC) operating device.
D. Enclosure: Surface wall sheet metal enclosure for field installation of network control modules. Provide integral 120VAC to 15-28VDC power supply to power network devices. Provide integral 120VAC duplex receptacle.

2.09 POWER SUPPLY UNITS FOR LOW VOLTAGE CONTROL DEVICES

A. Description: Self-Contained transformer/rectifier/relay devices consisting of:
    1. Transformer/rectifier to transform and rectify input primary voltage (120/277VAC) to 24VDC secondary voltage for connection to low voltage sensors, and to relay holding circuit.
    2. Single pole, nominal 20A, switching type relay with 24VDC holding circuit and output contacts rated as follows:
    3. Fluorescent Ballasted Loads – 20A
        a. Incandescent Type Loads – 20A
        b. Motor Loads – 1HP @ 120V AC.
    4. Shall provide vacancy sensing mode operation of connected sensors and switches.
B. Relay: Where an isolated relay is not provided integral to an automatic sensor, the power supply shall provide the relay.

1. Relay shall be 1PDT, rated not less than 1A @ 30VDC.

2.10 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 27 26 - Wiring Devices.

B. Network Interconnect Cable: For field interconnection of the lighting control equipment's peripheral networked devices, automatic sensors, switches, dimmers, etc..

1. Provide manufacturer specific, multi-conductor jacketed cable with copper conductors as directed by the equipment manufacturer.
2. Provide pre-terminated and unterminated cables as directed by the equipment manufacturer.
3. Provide a full conduit system for the lighting control cabling.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.

B. Install products in accordance with manufacturer's instructions.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Define each dimmer/relay load type, assign each load to a zone, and set control functions.

F. LED Light Engine/Array Lead Length: Do not exceed 100 feet.

G. Identify system components in accordance with Section 26 05 53 - Identification for Electrical Systems.

1. Label each dimmer module with a unique designation.
2. Label each scene control button with approved scene description.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Contractor shall inspect, test, and adjust components, assemblies, and equipment installations, including connections and report results in writing.

C. Tests and Inspections:

1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
   a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

D. Remove and replace malfunctioning modular dimming control components and retest as specified above.

E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 COMMISSIONING AND DEMONSTRATION

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.
B. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.
D. Training: Train Board's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of (2) sessions of four hours of training. Provide recording of one of the sessions for future use.
    3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
    4. Location: At project site.

3.07 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION

SECTION 26 09 43 (LNK)
LIGHTING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manually operated, PC-based, digital lighting controls with external signal source relays and control module.

1.02 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices current edition.
B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020.
C. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
D. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments 2017.
E. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
F. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
G. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard. (consists of 3 Parts, listed below) Rev C, 2012, and latest addenda.
H. TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems 1998a (Reaffirmed 2012).

1.03 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE Std 135.
B. BAS: Building automation system.
C. Low Voltage: As defined in CEC for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
E. PC: Personal computer; sometimes plural as "PCs."
F. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
G. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485.
H. IP: Internet Protocol.

1.04 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "SYSTEM REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations and coverage.
C. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
    1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
    2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
    3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

4. Coordinate Lighting Controls with auditorium Lighting Controls and Audio Video System.

D. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

E. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

F. Field quality-control test reports.

G. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

H. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

I. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
   1. Lighting control components to be from same manufacturer as Modular Dimming Controls and Central Dimming Controls.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with the City of Chicago Building Code, City of Chicago Electrical Code and Chicago Energy Conservation Code.

1.06 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate with:
   1. Section 26 09 23 - Lighting Control Devices
   2. Section 26 09 36 - Modular Dimming Controls
   3. Section 26 51 00 - Interior Lighting

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.

3. Coordinate the placement of occupancy/vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
5. Control locations.
6. Load circuit wiring.
7. Connections to other equipment.
8. Installer responsibilities.

C. Sequencing:
1. Do not install lighting control devices until final surface finishes and painting are complete.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.
2. Warranty Period: Five (5) years from date of Preliminary Acceptance.
3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight (8) years.
4. Extended Warranty Period for Electrically Held Relays: Ten (10) years from date of Preliminary Acceptance.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Electrically Held Relays: Equal to 10-percent of amount installed for each size indicated, but no fewer than two (2) relays of each type.
2. Switches: Minimum one of each type.
3. Switch Button Covers: equal to three percent of amount installed for each size indicated, but no fewer than three.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Preliminary Acceptance, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Preliminary Acceptance. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
   1. Provide 30-day notice to Board to allow scheduling and access to system and to allow Board to upgrade computer equipment, if necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
   2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   3. ETC Company; https://www.etcconnect.com/
   4. Hubbell Building Automation : www.hubbellautomation.com.
   5. Leviton Manufacturing Company, Inc: www.leviton.com .
   6. Lutron Electronics Company, Inc: www.lutron.com/sle .
   7. WattStopper: www.wattstopper.com/#sle.

2.02 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service:
   1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.
   2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
   3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
   4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from date of Preliminary Acceptance to fine-tune sensor calibration per the agreed upon sequence of operations.

C. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.03 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); PC-based, solid-state, 365-day timing and control unit. Control units shall be networked and capable of receiving inputs from indicated sensors and hand-held programmer. Output circuits shall be pilot-duty relays or dimmer units compatible with power switching devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels shall include the following features:
   1. Multiple output with number of channels as indicated in Schedules.
   2. Multiple inputs and multichannel output arranged as indicated in Schedules.

3. Multiple inputs for occupancy sensors, daylight sensors, and dimming systems with associated daylight sensors.
4. Display: Single graphic display for programming each lighting control unit.
5. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
6. Interoperability: Control module shall be configured to connect to BACnet compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
7. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off from local control stations.
8. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90-days' duration.
9. Software: Lighting control software shall be capable of linking switch or sensor inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
10. Time Based Control shall include:
    a. 24-hour time-of-day programming.
    b. Automatic daylight savings adjustment.
    c. Holiday and weekend programming (365 days).
    d. Astronomic capability (dusk on/dawn off).
    e. A minimum of 8 ON and 5 OFF setpoints.
    f. Tie indicated on AM/PM format.
    g. Manual override to ON and OFF positions.
    h. Manual skip to next scheduled event.
    i. Battery backup to maintain time and program memory for a minimum of 7 days.
    j. Each circuit has capability for a low voltage input for remote override.
    k. Time Switch includes software for programming by computer and via Ethernet connection.
11. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation of each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
    a. Software shall interpret status signals, provide for their display, and initiate failure signals.
    b. Lamp or LED at control module or display panel shall identify status of each controlled circuit.
12. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include communications and control software, and remote computer compatibility verification for this purpose.
13. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
14. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override..
15. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
16. Programmed time signals shall change preset scenes and dimmer settings.
17. Energy Conservation: Bi-level control of special ballasts or dimming circuits to comply with local energy codes.

18. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
19. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
20. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and remotely programmable.

B. Provide line voltage terminals capable of accepting #8 AWG conductors.

2.04 POWER DISTRIBUTION COMPONENTS

A. LRP Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
   1. Cabinet: Steel with hinged, locking door.
      a. Barriers separate low-voltage and line-voltage components.
      b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
      c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
   2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
      a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
      b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
      c. Endurance: 100,000 cycles at rated capacity.
      d. Mounting: Provision for easy removal and installation in relay cabinet.
   3. Provide line voltage terminals capable of accepting #8 AWG conductors.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.05 LOCAL SWITCHES AND PLATES

A. Push-Button Switches: See Section 26 09 23 – Lighting Control Devices for local wall control devices description and function.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 26 27 26 - Wiring Devices.

C. Keyed Switch: Digital, low voltage type, ON/OFF or ENABLE/DISABLE switch.
   1. Pilot LED status indicator.
   2. Engraved position indicators.

D. Wall Plates: Single and multigang plates as specified in Section 26 27 26 - Wiring Devices.

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.06 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 27 15 00 - Data Communications Horizontal Cabling.

PART 3 EXECUTION

3.01 WIRING INSTALLATION

A. A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables26 05 83 - Wiring Connections and Section 27 15 00 - Data Communications Horizontal Cabling.

C. Minimum conduit size shall be 1/2 inch (13 mm).

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

E. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

F. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated in Contract Documents.

G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

H. Identify components and power and control wiring according to Section 26 05 53 - Identification for Electrical Systems.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by the Architect/Engineer of Record.

3.03 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Preliminary Acceptance, provide on-site assistance in adjusting sensors and to assist Board's personnel in making program changes to suit actual occupied conditions. Provide up to two (2) visits to Project during other than normal occupancy hours for this purpose.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

B. Protect components from dirt and debris from subsequent construction activities. Training shall last a minimum of 4 hours and at the end of the session, the owner' s maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain lighting controls. Refer to Section 01 79 00 - Demonstration and Training.

END OF SECTION

SECTION 26 09 43 (MEP)
LIGHTING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manually operated, PC-based, digital lighting controls with external signal source relays and control module.

1.02 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices current edition.
B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020.
C. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
D. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments 2017.
E. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
F. Chicago Energy Conservation Code - Municipal Code of the City of Chicago, Title 14N, Based on the International Energy Conservation Code with Amendments Current.
G. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard. (consists of 3 Parts, listed below) Rev C, 2012, and latest addenda.
H. TIA-485 - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems 1998a (Reaffirmed 2012).

1.03 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE Std 135.
B. BAS: Building automation system.
C. Low Voltage: As defined in CEC for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
E. PC: Personal computer; sometimes plural as "PCs."
F. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
G. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485.
H. IP: Internet Protocol.

1.04 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "SYSTEM REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations and coverage.
C. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
    1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
    2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
    3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

4. Coordinate Lighting Controls with auditorium Lighting Controls and Audio Video System.

D. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

E. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

F. Field quality-control test reports.

G. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

H. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

I. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
   1. Lighting control components to be from same manufacturer as Modular Dimming Controls and Central Dimming Controls.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with the City of Chicago Building Code, City of Chicago Electrical Code and Chicago Energy Conservation Code.

1.06 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
   3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate with:
   1. Section 26 09 23 - Lighting Control Devices
   2. Section 26 09 36 - Modular Dimming Controls
   3. Section 26 51 00 - Interior Lighting

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.

3. Coordinate the placement of occupancy/vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in under "LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
5. Control locations.
6. Load circuit wiring.
7. Connections to other equipment.
8. Installer responsibilities.

C. Sequencing:
1. Do not install lighting control devices until final surface finishes and painting are complete.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.
2. Warranty Period: Five (5) years from date of Preliminary Acceptance.
3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight (8) years.
4. Extended Warranty Period for Electrically Held Relays: Ten (10) years from date of Preliminary Acceptance.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Electrically Held Relays: Equal to 10-percent of amount installed for each size indicated, but no fewer than two (2) relays of each type.
2. Switches: Minimum one of each type.
3. Switch Button Covers: equal to three percent of amount installed for each size indicated, but no fewer than three.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Preliminary Acceptance, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Preliminary Acceptance. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
   1. Provide 30-day notice to Board to allow scheduling and access to system and to allow Board to upgrade computer equipment, if necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands Lighting, Inc: https://www.acuitybrands.com/
   2. Cooper Lighting Solutions, Inc: https://www.cooperlighting.com/
   3. ETC Company; https://www.etcconnect.com/
   4. Hubbell Building Automation : www.hubbellautomation.com.
   5. Leviton Manufacturing Company, Inc: www.leviton.com .
   6. Lutron Electronics Company, Inc: www.lutron.com/sle .
   7. WattStopper: www.wattstopper.com/#sle.

2.02 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service:
   1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.
   2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
   3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
   4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from date of Preliminary Acceptance to fine-tune sensor calibration per the agreed upon sequence of operations.

C. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.03 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); PC-based, solid-state, 365-day timing and control unit. Control units shall be networked and capable of receiving inputs from indicated sensors and hand-held programmer. Output circuits shall be pilot-duty relays or dimmer units compatible with power switching devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels shall include the following features:
   1. Multiple output with number of channels as indicated in Schedules.
   2. Multiple inputs and multichannel output arranged as indicated in Schedules.

3. Multiple inputs for occupancy sensors, daylight sensors, and dimming systems with associated daylight sensors.
4. Display: Single graphic display for programming each lighting control unit.
5. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
6. Interoperability: Control module shall be configured to connect to BACnet compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
7. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off from local control stations.
8. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90-days' duration.
9. Software: Lighting control software shall be capable of linking switch or sensor inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
10. Time Based Control shall include:
    a. 24-hour time-of-day programming.
    b. Automatic daylight savings adjustment.
    c. Holiday and weekend programming (365 days).
    d. Astronomic capability (dusk on/dawn off).
    e. A minimum of 8 ON and 5 OFF setpoints.
    f. Tie indicated on AM/PM format.
    g. Manual override to ON and OFF positions.
    h. Manual skip to next scheduled event.
    i. Battery backup to maintain time and program memory for a minimum of 7 days.
    j. Each circuit has capability for a low voltage input for remote override.
    k. Time Switch includes software for programming by computer and via Ethernet connection.
11. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation of each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
    a. Software shall interpret status signals, provide for their display, and initiate failure signals.
    b. Lamp or LED at control module or display panel shall identify status of each controlled circuit.
12. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include communications and control software, and remote computer compatibility verification for this purpose.
13. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
14. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override..
15. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
16. Programmed time signals shall change preset scenes and dimmer settings.
17. Energy Conservation: Bi-level control of special ballasts or dimming circuits to comply with local energy codes.

18. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
19. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
20. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and remotely programmable.

B. Provide line voltage terminals capable of accepting #8 AWG conductors.

2.04 POWER DISTRIBUTION COMPONENTS

A. LRP Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
   1. Cabinet: Steel with hinged, locking door.
      a. Barriers separate low-voltage and line-voltage components.
      b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
      c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
   2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
      a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
      b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
      c. Endurance: 100,000 cycles at rated capacity.
      d. Mounting: Provision for easy removal and installation in relay cabinet.
   3. Provide line voltage terminals capable of accepting #8 AWG conductors.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.05 LOCAL SWITCHES AND PLATES

A. Push-Button Switches: See Section 26 09 23 – Lighting Control Devices for local wall control devices description and function.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 26 27 26 - Wiring Devices.

C. Keyed Switch: Digital, low voltage type, ON/OFF or ENABLE/DISABLE switch.
   1. Pilot LED status indicator.
   2. Engraved position indicators.

D. Wall Plates: Single and multigang plates as specified in Section 26 27 26 - Wiring Devices.

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.06 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 27 15 00 - Data Communications Horizontal Cabling.

PART 3 EXECUTION

3.01 WIRING INSTALLATION

A. A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables26 05 83 - Wiring Connections and Section 27 15 00 - Data Communications Horizontal Cabling.

C. Minimum conduit size shall be 1/2 inch (13 mm).

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

E. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

F. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated in Contract Documents.

G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

H. Identify components and power and control wiring according to Section 26 05 53 - Identification for Electrical Systems.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by the Architect/Engineer of Record.

3.03 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Preliminary Acceptance, provide on-site assistance in adjusting sensors and to assist Board's personnel in making program changes to suit actual occupied conditions. Provide up to two (2) visits to Project during other than normal occupancy hours for this purpose.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

B. Protect components from dirt and debris from subsequent construction activities. Training shall last a minimum of 4 hours and at the end of the session, the owner' s maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain lighting controls. Refer to Section 01 79 00 - Demonstration and Training.

END OF SECTION

SECTION 26 21 00 (LNK)

LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in the City of Chicago Electrical Code, and as designated by the Utility Company.

1.03 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; 2017.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

A. No later than two (2) weeks following date of the Agreement, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
   5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Board.

E. Preinstallation Meetings:
   1. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.
   2. Ensure required submittals have been provided with sufficient time for review prior to scheduling the preinstallation meeting.

3. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work. Require attendance by all affected installers including but not limited to:
   a. Contractor's Superintendent.
   b. Installer.
   c. Manufacturer/Fabricator Representative.
   d. Utility Company representative.
   e. Other affected Subcontractors.
   f. Architect/Engineer of Record.
   g. Board's Representative.
4. Record minutes and distribute copies within five (5) days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

F. Scheduling:
1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Board.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations and arrangement of Utility Company and service entrance equipment, metering provisions, required clearances, and proposed service routing.
1. Obtain Utility company approval of shop drawings prior to submittal.
2. Coordination drawings with dimensional relationship of exterior pad-mounted electrical service entrance equipment with surrounding fencing and building(s) and associated underground raceway installations relative to property line. Show minimum clearances, installed devices, and major features. Include sections depicting underground and aerial equipment clearances relative to grade.

D. Drawings prepared by Utility Company.

E. Project Record Documents: Record actual locations of equipment and installed service routing.

1.06 QUALITY ASSURANCE

A. Comply with the following:
1. IEEE C2 (National Electrical Safety Code).
2. The requirements of the Utility Company.
3. The requirements of the local authorities having jurisdiction.
4. Comply with the City of Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: As indicated on drawings.

D. Division of Responsibility:
1. Pad-Mounted Utility Transformers:
    a. Transformer Vaults and Pads: Furnished and installed by Contractor per Utility Company requirements.
    b. Transformers: Furnished and installed by Utility Company.
    c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
    d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
    e. Primary:
        1) Trenching and Backfilling: Provided by Contractor.
        2) Conduits: Furnished and installed by Contractor.
        3) Conductors: Furnished and installed by Utility Company.
    f. Secondary:
        1) Trenching and Backfilling: Provided by Contractor.
        2) Conduits: Furnished and installed by Contractor.
        3) Conductors: Furnished and installed by Contractor (Service Point at transformer).
2. Terminations at Service Point: Provided by Utility Company.
3. Metering Provisions:
    a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.
    b. Metering Transformer Cabinets: Furnished and installed by Contractor per Utility Company requirements.
    c. Metering Compartments in Service Entrance Equipment: Furnished and installed by Contractor per Utility Company requirements.
    d. Metering Transformers: Furnished and installed by Utility Company.

e. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.
f. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.
g. Communications Conduits for Meters: Furnished and installed by Contractor per Utility Company requirements.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

F. Metered Voltage and service characteristics as indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling in accordance with Section 31 23 17.

E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements and Section 03 30 00.

F. Provide required protective bollards in accordance with Utility Company requirements.

G. Provide required support and attachment components in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.04 CLEANING

A. Clean dirt and debris from equipment, enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.05 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 26 21 00

SECTION 26 22 00 (LNK)

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

B. K-factor transformers rated for nonlinear loads.

C. Control transformers.

1.02 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2011.

C. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

D. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

G. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

I. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.

J. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; 2005.

K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

M. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

N. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers. Concrete, reinforcement, and formwork requirements as specified in Division 03.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
1. Vibration Isolators: Include attachment method and rated load and deflection.
2. K-factor Rated Transformers: Include K-factor ratings.
3. Buck-boost Transformers: Include voltage selection tables and wiring diagrams for autotransformer configurations.
4. Shielded Transformers: Include shielding method and noise attenuation performance.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
1. Small Power Centers: Include panel arrangements.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

F. Field Quality Control Test Reports.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

H. Maintenance Data: Include recommended maintenance procedures and intervals.

I. Project Record Documents: Record actual locations of transformers.

1.05 QUALITY ASSURANCE

A. Conform to requirements of the City of Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers".

F. Factory Sound-Level Tests: Conduit sound-level tests on equipment for this Project.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
1. Greater than 10 kVA: 104 degrees F maximum.
2. Less than 10 kVA: 77 degrees F maximum.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com

C. Schneider Electric; Square D Products: www.schneider-electric.us

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Magnetek Power Electronics Group; www.magnetek.com.

F. Sola/Hevi-Duty; www.solahevidutysales.com

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
1. Altitude: Less than 3,300 feet.
2. Ambient Temperature:
a. Greater than 10 kVA: Not exceeding 104 degrees F.
b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise. nameplates and label products are specified in Section 26 05 53 - Identification for Electrical Systems.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Primary Voltage: As indicated elsewhere in the construction documents.

C. Secondary Voltage: As indicated elsewhere in the construction documents.

D. Insulation System and Allowable Average Winding Temperature Rise:
1. Class 220 degrees C insulation system with 115 degrees C average winding temperature rise above 40 degrees ambient temperature.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:
1. Less than 3 kVA: One 5 percent tap above normal full capacity..
2. 3 kVA through 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
3. 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K, current edition.

H. Sound Levels: Standard sound levels complying with NEMA ST 20. Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

I. Mounting Provisions:
1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor clean, dry locations: Type 2.
   b. Outdoor locations: Type 3R.
2. Construction: Steel.
   a. Less than 15 kVA: Totally enclosed, non-ventilated.
   b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.

4. Provide lifting eyes or brackets.

K. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

L. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

2.04 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.

B. K-factor Rating: K-4, or higher as indicated in construction documents.

C. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 115 degrees C average winding temperature rise above 40 degrees ambient temperature.

D. Coil Conductors: Continuous copper windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.

E. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

F. K-factor shall not exceed value indicated. Provide value of K-factor on transformer nameplate.

G. Transformer shall incorporate electrostatic shield grounded to the transformer core, designed per requirements as stated in "Accessories" Paragraph below.

H. The neutral bus shall be sized and configured for at least 200 percent of the secondary full load current.

I. Transformer impedance shall be a minimum of 3 and a maximum of 5 percent.

J. Winding Taps:
1. Less than 3 kVA: One 5 percent tap above normal full capacity..
2. 3 kVA through 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
3. 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

K. Neutral Bus: Sized to accommodate twice the rated secondary current.

L. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

M. Sound Levels: Standard sound levels complying with NEMA ST 20.

N. Mounting Provisions:
1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
2. Larger than 75 kVA: Suitable for floor mounting.

O. Electrostatic Shield: Provide grounded full-width copper electrostatic shield between primary and secondary windings to attenuate electrical noise.

P. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor clean, dry locations: Type 2.
b. Outdoor locations: Type 3R.
2. Construction: Steel, ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

Q. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.
4. Vibration isolators to reduce transfer of a vibration.

R. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.05 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type.

B. Comply with NEMA ST 1 “Specialty transformers” and UL Standard UL 506 “Specialty Transformers”.

C. Enclosure: Suitable for the environment.
1. Finish Color: Manufacturers standard paint over corrosion resistant pretreatment and primer.

D. Ratings: Continuous Duty. Where ratings are not indicated, provide capacity exceeding peak load by 50 percent minimum.

2.06 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

C. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

E. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

G. Use flexible conduit, under the provisions of Section 26 05 33.13 - Conduit for Electrical Systems, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

H. Tighten electrical connections and terminals according to manufacturer’s published torque-tightening values. Where manufacturer’s values are not furnished use those specified in UL 486A-486B.

I. Arrange equipment to provide minimum clearances as specified on transformer nameplate for air circulation for cooling, and in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

J. Mount floor mounted transformers on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

K. Mount floor mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.
   1. Transformers above 300 kVA located within the building shall be mounted on isolation units utilizing type MS springs. Spring units shall have a minimum static deflection of 1.5 inches.
   2. Construct concrete bases and anchor floor mounting transformers according to manufacturer's written instructions.

L. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

M. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

N. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

O. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

P. Identify transformers in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
1. 167 kVA single phase, 500 kVA three phase and smaller:
    a. Perform turns ratio tests at all tap positions.
2. Larger than 167 kVA single phase and 500 kVA three phase:
    a. Verify that control and alarm settings on temperature indicators are as specified.
    b. Perform excitation-current tests on each phase.
    c. Measure the resistance of each winding at each tap connection.
    d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 COMMISSIONING AND DEMONSTRATION

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

D. After completing installation, cleaning and testing, touch up scratches and mars on finish to match original finish.

END OF SECTION 26 22 00

SECTION 26 24 13 (LNK)

SWITCHBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.02 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

G. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

H. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

M. UL 891 - Switchboards; Current Edition, Including All Revisions.

N. UL 977 - Fused Power-Circuit Devices; Current Edition, Including All Revisions.

O. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by the City of Chicago Electrical Code.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   a. Notify Board no fewer than seven (7) days in advance of proposed interruption of electric service.
   b. Indicate method of providing temporary electric service if interruption will last longer than eight (8) hours.
   c. Do not proceed with interruption of electric service without Board's written permission
6. Installation Pathway: Remove and replace access, fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
7. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:
1. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.
2. Ensure required submittals have been provided with sufficient time for review prior to scheduling the preinstallation meeting.
3. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work. Require attendance by all affected installers including but not limited to:
   a. Contractor's Superintendent.
   b. Installer.
   c. Manufacturer/Fabricator Representative.
   d. Utility Company representative.
   e. Other affected Subcontractors.
   f. Architect/Engineer of Record.
   g. Board's Representative.
4. Record minutes and distribute copies within five (5) days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

C. Service Entrance Switchboards:
1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Board to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   4. Include documentation of listed series ratings upon request.
   5. Include documentation demonstrating selective coordination.

D. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Field Quality Control Test Reports.

H. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

J. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Enclosure Keys: Two (2) of each different key.
   3. Electronic Trip Circuit Breakers: Provide one (1) portable test set.
   4. Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than one (1) of each size and type.
   5. Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than two (2) of each size and type.
   6. Control-Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than two (2) of each size and type.

K. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.05 QUALITY ASSURANCE

A. Conform to requirements of the City of Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Obtain switchboards through one source from a single manufacturer.

D. Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent equipment and surfaces. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA PB 2, "Deadfront Distribution Switchboards".

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Board no fewer than seven (7) days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service in interruption will last longer than eight (8) hours.
   3. Do not proceed with interruption of electric service without Board's written permission.

1.08 WARRANTY

A. Each piece of equipment shall be warranted by the equipment manufacturer to be free of defects in material and workmanship for a period of twelve (12) months from the date of Preliminary Acceptance. The equipment supplier shall provide a full year of warranty on the entire system, including on-the-premises maintenance service during normal working hours at no cost to Board for parts or labor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Switchboards - Other Acceptable Manufacturers:

1. ABB/GE: www.geindustrial.com/#sle.
2. Eaton Corporation: www.eaton.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us
4. Siemens Industry, Inc: www.usa.siemens.com
5. Chicago Switchboard Company; www.chiswbd.com.
6. Gus Berthold Electric Company; www.berthold.com

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish switchboards and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Hinged Front Panels: Allow access to circuit breakers, metering, accessory, and blank compartments.

E. Front-Connected Switchboards:
1. Main Device(s): Fixed, individually-mounted..
2. Feeder Devices: Panel/group-mounted.
3. Arrangement: Front accessible only (not rear accessible), front and rear aligned..
4. Gutter Access: Bolted covers.

F. Service Entrance Switchboards:
1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.
   a. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
4. Utility Metering Provisions: Provide separate barrier compartment complying with Utility Company requirements where indicated or where required by Utility Company. Include hinged sealable door and provisions for Utility Company current transformers (CTs), potential transformers (PTs), or potential taps as required.
5. See Section 26 21 00 - Low-Voltage Electrical Service Entrance for additional requirements.

G. Nominal System Voltage: Indicated on Drawings.

H. Main-Bus Continuous Amperage: Indicated on Drawings.

I. Service Conditions:
   1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
      a. Altitude: Less than 6,600 feet.
      b. Ambient Temperature:
         1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
         2) Switchboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

J. Short Circuit Current Rating, Fully Rated:
   1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.

K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

L. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

M. Bussing: Sized in accordance with UL 891 temperature rise requirements.
   1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
   2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   4. Phase and Neutral Bus Material: Hand-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
   5. Ground Bus Material: 1/4-by-2-inch minimum-size, hard-drawn copper. of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   6. Contact Surface of Buses: Silver-plated.
   7. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
   8. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   9. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus shall be braced.

N. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Hard-drawn copper of 98 percent conductivity, suitable for terminating coper conductors only..
         1) Plating: Silver-Plated.
      b. Main and Neutral Lug Type: Mechanical.
   2. Load Conductor Terminations:
      a. Lug Material: Copper, suitable for terminating copper conductors only.
         1) Plating: Silver-plated.

b. Lug Type:
1) Provide mechanical lugs unless otherwise indicated.

O. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
2. Finish: Manufacturer's standard unless otherwise indicated.

P. Comply with NFPA 70E for arc flash labels.

Q. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
3. Where designated spaces for future device provisions are not indicated, include provisions for minimum of 4 device(s) rated at 10 percent of rating of switchboard main or incoming feed.
4. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.

R. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00 - Surge Protective Devices, list switchboards as a complete assembly including surge protective device.

S. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

T. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

U. Board Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
3. Measured Parameters:
a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
b. Current (Amps): For each phase and neutral.
c. Frequency (Hz).
d. Real power (kW): For each phase, 3-phase total.
e. Reactive power (kVAR): For each phase, 3-phase total.
f. Apparent power (kVA): For each phase, 3-phase total.

g. Power factor.
h. Real energy (kWh).
i. Reactive energy (kVARh).
j. Apparent energy (kVAh).
k. Current demand.
l. Power demand: Real, reactive, and apparent.

4. Meter Accuracy: Plus/minus 1.0 percent.
5. Features:
   a. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
   b. KYZ pulse output.
   c. Adjustable demand interval.
   d. Remote monitoring capability via PC.

V. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers:
   a. Connect secondary to shorting terminal blocks.
   b. Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
4. Potential Transformers:
   a. Include primary and secondary fuses with disconnecting means.
   b. Secondary voltage rating of 120V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
5. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3kV.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. General:
1. Provide with provisions for locking in the open/off position with a maximum of three (3) padlocks.
2. Provide key interlocking according to the scheme described and shown on the drawings.
3. Ground fault protection shall be provided for solidly grounded wye connected services over 150 volts to ground for all main and feeder devices rated 1000 amperes and as indicated on the drawings.

B. Circuit Breakers:
1. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. NEMA AB 3 with Minimum Interrupting Capacity: Fully rated.
   d. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 250 amperes and larger.
2) Provide interchangeable trip units where indicated.

e. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

f. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1) Provide the following field-adjustable trip response settings:
a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
b) Long time delay.
c) Short time pickup and delay.
d) Instantaneous pickup.
e) Ground fault pickup and delay where ground fault protection is indicated.
2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
3) Provide communication capability where indicated: Compatible with system indicated.

g. Provide the following circuit breaker types where indicated:
1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

h. Provide the following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
3) Auxiliary Switch: Two SPDT switches suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
a) With "a" and "b" contacts, "a" contacts mimic circuit-breaker contracts, "b" contacts operate in reverse of circuit-breaker contacts.
4) Undervoltage Release: Set to operate at 35 to 75 percent of rated voltage with field-adjustable time delay to prevent nuisance tripping.
5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

i. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
1) Integrally mounted relay and trip with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

j. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

k. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Insulated Case Circuit Breakers:
a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
b. Operation:

1) Provide manually operated circuit breakers unless otherwise indicated.
2) Provide electrically operated circuit breakers where indicated.
3) Pad-Lock Provision: For preventing circuit breaker closing operation. Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

c. Construction:
1) Provide fixed-mount circuit breakers unless otherwise indicated.

d. Minimum Interrupting Capacity: Fully rated.

e. Trip Units: Solid state, microprocessor-based, true rms sensing with LED trip indicators.
1) Provide the following field-adjustable trip response settings:
a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
b) Long time delay.
c) Short time pickup and delay.
d) Instantaneous pickup.
e) Ground fault pickup and delay where ground fault protection is indicated. Solid-state type, field wiring terminals and interface devices to accommodate zone selective control, adjustable pickup current from 100 to 1200 amperes, field-adjustable time delay from instantaneous to 1 second, UL 1053, Class II, monitor panel with ground fault indicators, control power indicators, TEST and RESET buttons.
2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
3) Provide communication capability where indicated: Compatible with system indicated.

f. Provide the following circuit breaker types where indicated:
1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
2) Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

g. Provide the following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
5) Truck-Operated Cell Switch: For indicating circuit breaker racking position.

2.04 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.05 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
1. Dielectric tests.
2. Mechanical operation tests.
3. Grounding of instrument transformer cases test.
4. Electrical operation and control wiring tests, including polarity and sequence tests.
5. Ground-fault sensing equipment test.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment components in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

H. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

I. Install all field-installed devices, components, and accessories.

J. Provide fuses complying with Section 26 28 13 - Fuses for fusible switches as indicated.

K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73 - Power System Studies.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in switchboards.

O. Identify switchboards in accordance with Section 26 05 53 - Identification for Electrical Systems.

P. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

Q. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

H. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

I. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by the City of Chicago Electrical Code.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

J. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

K. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

L. Test shunt trips to verify proper operation.

M. Correct deficiencies and replace damaged or defective switchboards or associated components.

N. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 78 23.1 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Training: Train Board's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four (4) hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

3.07 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 24 13

SECTION 26 24 16 (LNK)

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.02 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.

B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

F. NEMA PB 1 - Panelboards; 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

L. UL 67 - Panelboards; Current Edition, Including All Revisions.

M. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

N. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

O. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

P. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

Q. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

R. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by the City of Chicago Electrical Code.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate short circuit current ratings.
4. Include documentation of listed series ratings.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
1. Panelboard Schedules: For installation in panelboards. Submit final typewritten versions after load balancing.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

I. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Panelboard Keys: Six (6) spares of each different key.
3. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Conform to the City of Chicago Electrical Code.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through on source from a single manufacturer.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA PB 1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

B. Altitude: Not exceeding 6600 feet.

C. Interruption of Existing Electrical Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Short Circuit Current Rating, Fully Rated:
1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to the City of Chicago Electrical Code..
3. Label equipment utilizing series ratings as required by the City of Chicago Electrical Code.

C. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

D. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

E. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
5. Split Bus: Vertical buses divided into individual verticals.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.
   c. Kitchen Areas: NEMA 250, Type 4x, stainless steel.
   d. Other Wet of Damp Indoor Locations: NEMA 250, Type 4.
2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.
b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.
5. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
6. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
7. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panels.
8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

H. Comply with NFPA 70E for arc flash labels.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00 - Surge Protective Devices, list and label panelboards as a complete assembly including surge protective device.

K. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2, Class 2.
1. Ampere Rating: Not less than ampere rating of panelboard bus.
2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
3. Coil Voltage: As required for connection to control system indicated.
4. Combination controller equipped for panelboard mounting and including the following accessories:
   a. Individual control-power transformers.
   b. Fuses for control-power transformers.
   c. Indicating lights.
   d. Seal-in contact.
   e. Two convertible auxiliary contacts.
   f. Push buttons.
   g. Selector switches.
   h. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
   i. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Provide the following features and accessories where indicated or where required to complete installation:
1. Feed-through lugs.
2. Sub-feed lugs.

O. Circuit Monitors for panelboard Circuit Breakers
1. Provide space and voltage taps in each panel with electrical submetering equipment.
a. Voltage taps will be designed for 14 to 12 gage wire.
b. To determine space requirements use Veris H8053 with 3 current transformers.
c. The submeter maybe field or factory installed. The Division 24 BAS system installer will provide submeter.
d. If indicated on the drawings, two sets of submeters will be provided. For example, if a panel to be monitored includes both lighting and plug loads.

P. Phase and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors and insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual verticals.
6. Integral TVSS or provision for the connection of the remote TVSS.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Compression.

C. Bussing:
1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:
1. Main Overcurrent Protective Devices: Circuit breaker.
2. Provide bolt-on type or plug-in type secured with locking mechanical restraints for circuit breaker frame sizes 125A and smaller.
3. For Circuit-Breaker Frame Sizes Larger than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
4. Provide thermal magnetic circuit breakers unless otherwise indicated.

5. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Compression.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Emergency and Exit Lighting Branch Circuit Panelboards: Provide overcurrent protective devices Type S pug fuses within panelboards in compliance with applicable codes.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. For Circuit-Breaker Frame Sizes 125A and Smaller: Bolt-on circuit breakers.
3. For Circuit-Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breaker; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
4. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
5. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.

b. Provide compression lugs where indicated.
c. Lug Material: Copper, suitable for terminating copper conductors only. Mechanical style, suitable for number, size, trip ratings, and conductor materials.

6. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 250 amperes and larger.
   b. Provide interchangeable trip units where indicated.
7. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.
   b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
   c. Provide communication capability where indicated: Compatible with system indicated.
8. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
9. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
   d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
   e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
10. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting; Type HACR for heating, air-conditioning, and refrigerating equipment.
11. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
12. Do not use tandem circuit breakers.
13. Do not use handle ties in lieu of multi-pole circuit breakers.
14. Provide multi-pole circuit breakers for multi-wire branch circuits as required by the City of Chicago Electrical Code.
15. Provide the following features and accessories where indicated or where required to complete installation:
   a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage where indicated on drawings.
   b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
   c. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
h. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

16. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front mounted, field-adjustable trip setting.

2.06 CIRCUIT MONITORS - FOR PANELBOARD CIRCUIT BREAKERS

A. Provide space and voltage taps in each panel with electrical submetering equipment.
1. Voltage taps will be designated for 14 to 12 gage wire.
2. To determine space requirements use Veris H8053 with three (3) current transformers.
3. The submeter maybe field or factory installed. the Division 23 BAS system installer will provide submeter.
4. If indicated on the Drawings, two (2) sets of submeters will be provided. For example, if a panel to be monitored includes both lighting and plug loads.

2.07 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the top of trim is 74 inches above the finished floor, unless otherwise indicated.

H. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00 - Cast-in-Place Concrete.

I. Provide minimum of four spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

J. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

K. Install all field-installed branch devices, components, and accessories.

L. Provide fuses complying with Section 26 28 13 - Fuses for fusible switches as indicated.

M. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

N. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by the City of Chicago Electrical Code.

O. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73 - Power System Studies.

P. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

Q. Provide filler plates to cover unused spaces in panelboards.

R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also, provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

S. Identify panelboards in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 250 amperes. Tests listed as optional are not required.
   1. Perform insulation-resistance tests on all control wiring with respect to ground.
   2. Test functions of the trip unit by means of secondary injection.

E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by the City of Chicago Electrical Code.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

F. Test GFCI circuit breakers to verify proper operation.

G. Test AFCI circuit breakers to verify proper operation.

H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 COMMISSIONING AND DEMONSTRATION

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate Panelboards and OCPD’s and train Board’s maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Division 01 Section “Closeout Procedures”. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days’ advance notice.

D. Balancing Loads: After Preliminary Acceptance, but not more than two (2) months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
   1. Perform measurements during period of normal working load as advised by Board.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Board to avoid disrupting critical 24-hour

services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding twenty (20) percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

E. Contractor Start-Up and Reporting. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

F. Contractor Start-Up and Reporting. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 26 24 16

SECTION 26 24 16 (MEP)

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.02 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.

B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

F. NEMA PB 1 - Panelboards; 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

L. UL 67 - Panelboards; Current Edition, Including All Revisions.

M. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

N. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

O. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

P. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

Q. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

R. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by the City of Chicago Electrical Code.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate short circuit current ratings.
4. Include documentation of listed series ratings.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
1. Panelboard Schedules: For installation in panelboards. Submit final typewritten versions after load balancing.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

I. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Six (6) spares of each different key.
   3. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Conform to the City of Chicago Electrical Code.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through on source from a single manufacturer.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA PB 1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
   2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

B. Altitude: Not exceeding 6600 feet.

C. Interruption of Existing Electrical Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Short Circuit Current Rating, Fully Rated:
1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to the City of Chicago Electrical Code..
3. Label equipment utilizing series ratings as required by the City of Chicago Electrical Code.

C. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

D. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

E. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
5. Split Bus: Vertical buses divided into individual verticals.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.
   c. Kitchen Areas: NEMA 250, Type 4x, stainless steel.
   d. Other Wet of Damp Indoor Locations: NEMA 250, Type 4.
2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.
b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.
5. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
6. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
7. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panels.
8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

H. Comply with NFPA 70E for arc flash labels.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00 - Surge Protective Devices, list and label panelboards as a complete assembly including surge protective device.

K. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2, Class 2.
1. Ampere Rating: Not less than ampere rating of panelboard bus.
2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
3. Coil Voltage: As required for connection to control system indicated.
4. Combination controller equipped for panelboard mounting and including the following accessories:
   a. Individual control-power transformers.
   b. Fuses for control-power transformers.
   c. Indicating lights.
   d. Seal-in contact.
   e. Two convertible auxiliary contacts.
   f. Push buttons.
   g. Selector switches.
   h. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
   i. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
   a. Use zero sequence ground fault detection method unless otherwise indicated.
   b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Provide the following features and accessories where indicated or where required to complete installation:
1. Feed-through lugs.
2. Sub-feed lugs.

O. Circuit Monitors for panelboard Circuit Breakers
1. Provide space and voltage taps in each panel with electrical submetering equipment.
   a. Voltage taps will be designed for 14 to 12 gage wire.
   b. To determine space requirements use Veris H8053 with 3 current transformers.
   c. The submeter maybe field or factory installed. The Division 24 BAS system installer will provide submeter.
   d. If indicated on the drawings, two sets of submeters will be provided. For example, if a panel to be monitored includes both lighting and plug loads.

P. Phase and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors and insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual verticals.
6. Integral TVSS or provision for the connection of the remote TVSS.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Compression.

C. Bussing:
1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:
1. Main Overcurrent Protective Devices: Circuit breaker.
2. Provide bolt-on type or plug-in type secured with locking mechanical restraints for circuit breaker frame sizes 125A and smaller.
3. For Circuit-Breaker Frame Sizes Larger than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
4. Provide thermal magnetic circuit breakers unless otherwise indicated.

5. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Compression.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Emergency and Exit Lighting Branch Circuit Panelboards: Provide overcurrent protective devices Type S pug fuses within panelboards in compliance with applicable codes.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. For Circuit-Breaker Frame Sizes 125A and Smaller: Bolt-on circuit breakers.
3. For Circuit-Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breaker; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
4. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 14,000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
5. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.

b. Provide compression lugs where indicated.
c. Lug Material: Copper, suitable for terminating copper conductors only. Mechanical style, suitable for number, size, trip ratings, and conductor materials.

6. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 250 amperes and larger.
   b. Provide interchangeable trip units where indicated.
7. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.
   b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
   c. Provide communication capability where indicated: Compatible with system indicated.
8. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
9. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
   d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
   e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
10. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting; Type HACR for heating, air-conditioning, and refrigerating equipment.
11. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
12. Do not use tandem circuit breakers.
13. Do not use handle ties in lieu of multi-pole circuit breakers.
14. Provide multi-pole circuit breakers for multi-wire branch circuits as required by the City of Chicago Electrical Code.
15. Provide the following features and accessories where indicated or where required to complete installation:
   a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage where indicated on drawings.
   b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.
   c. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
h. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

16. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front mounted, field-adjustable trip setting.

2.06 CIRCUIT MONITORS - FOR PANELBOARD CIRCUIT BREAKERS

A. Provide space and voltage taps in each panel with electrical submetering equipment.
1. Voltage taps will be designated for 14 to 12 gage wire.
2. To determine space requirements use Veris H8053 with three (3) current transformers.
3. The submeter maybe field or factory installed. the Division 23 BAS system installer will provide submeter.
4. If indicated on the Drawings, two (2) sets of submeters will be provided. For example, if a panel to be monitored includes both lighting and plug loads.

2.07 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the top of trim is 74 inches above the finished floor, unless otherwise indicated.

H. Mount floor mounted power distribution panelboards (switchboard construction) on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00 - Cast-in-Place Concrete.

I. Provide minimum of four spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

J. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

K. Install all field-installed branch devices, components, and accessories.

L. Provide fuses complying with Section 26 28 13 - Fuses for fusible switches as indicated.

M. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

N. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by the City of Chicago Electrical Code.

O. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73 - Power System Studies.

P. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

Q. Provide filler plates to cover unused spaces in panelboards.

R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also, provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

S. Identify panelboards in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 250 amperes. Tests listed as optional are not required.
   1. Perform insulation-resistance tests on all control wiring with respect to ground.
   2. Test functions of the trip unit by means of secondary injection.

E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by the City of Chicago Electrical Code.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

F. Test GFCI circuit breakers to verify proper operation.

G. Test AFCI circuit breakers to verify proper operation.

H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 COMMISSIONING AND DEMONSTRATION

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate Panelboards and OCPD’s and train Board’s maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Division 01 Section “Closeout Procedures”. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days’ advance notice.

D. Balancing Loads: After Preliminary Acceptance, but not more than two (2) months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
   1. Perform measurements during period of normal working load as advised by Board.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Board to avoid disrupting critical 24-hour

services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding twenty (20) percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

E. Contractor Start-Up and Reporting. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

F. Contractor Start-Up and Reporting. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 26 24 16

SECTION 26 27 26 (LNK)
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.
B. Receptacles.
   1. Tamper Resistant Devices
   2. GFCI Devices
   3. Isolated Ground Devices
   4. USB Charging Devices
C. Wall plates.

1.02 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
B. FS W-C-596 - Connector, Electrical, Power, General Specification for 2017h.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.
F. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2015).
G. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2016.
H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.
J. UL 355 - UL Standard for Safety Cord Reels 2004 (amendments through October 7, 2020).
K. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
L. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
M. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.
N. UL 1310 - Class 2 Power Units Current Edition, Including All Revisions.
O. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.
P. UL 1917 - Solid-State Fan Speed Controls Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
   4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
   6. Notify Architect/Engineer of Record of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449, 3rd Edition.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data:

1. GFCI Receptacles: Include information on status indicators.
2. Surge Protection Receptacles: Include information on status indicators.
3. Acceptable cleaners and recommended cleaning practices for all wiring devices.
4. Replacement parts list for all wiring devices.
5. Manufacturer's service department contact information.

H. Project Record Documents: Record actual installed locations of wiring devices.

I. Maintenance Materials: Furnish the following for Board's Representative's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two (2) for each type of screw.
3. Extra Keys for Locking Switches: Two (2) of each type.
4. Extra Surge Protection Receptacles: Two (2) of each type.
5. Extra Wall Plates: One (1) of each style, size, and finish.
6. Extra Flush Floor Service Fittings: One (1) for every ten, but not less than one (1) of each type.
7. Extra Poke-Through Core Hole Closure Plugs: One (1) for every ten, but not less than two (2) for each core size.

1.05 QUALITY ASSURANCE

A. Conform to NFPA 101.

B. Comply with the City of Chicago Electrical Code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Products: Listed and labeled as suitable for the purpose intended.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

G. Source Limitations: Obtain all wiring devices and associated wall plates from a single manufacturer and one source if available. Obtain each type of wiring device and associated wall plate through one source from a single manufacturer if not all wiring devices are available from a single source.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
E. Provide GFCI protection for receptacles installed in kitchens.
F. Provide GFCI protection for receptacles serving electric drinking fountains.
G. Provide isolated ground receptacles for receptacles serving computers and electronic cash registers and as requested by AV consultants.
H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.
    1. Wiring Devices, Unless Otherwise Indicated: Ivory with satin-finished stainless steel wall plate.
    2. Wiring Devices Installed in Finished Spaces: Ivory with satin-finished stainless steel wall plate.
    3. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
    4. Wiring Devices Installed Damp Locations: White with cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet location".
    5. Isolated Ground Convenience Receptacles: Orange.
    6. Surge Protection Receptacles: Blue.
    7. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.03 WALL SWITCHES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
    1. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com
    2. Hubbell Incorporated: www.hubbell.com/#sle.
    3. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
    4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
    1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
C. Standard Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
D. Lighted Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
E. Pilot Light Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with

load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.04 RECEPTACLES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc: {HL#1115380}.
   3. Pass & Seymour, a brand of Legrand North America, Inc: {HL#1115365}.
   4. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com.
   5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
   1. Standard Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   2. Automatically Controlled Convenience Receptacles: Heavy duty specification grade 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per the City of Chicago Electrical Code; single or duplex as indicated on the drawings. Permanent power control signage affixed to face plate.
   3. Isolated Ground Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
      a. Isolation shall be integral to receptacle construction and not dependent on removable parts.
   4. Weather Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
   5. Tamper Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
   6. Tamper Resistant and Weather Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant

type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

7. Illuminated Convenience Receptacles: Heavy duty specification grade20A, 125V, NEMA 5-20R; illuminated face or indicator light to indicate power is being supplied to receptacle; single or duplex as indicated on the drawings.

D. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, non-feed-through type with light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
   3. Weather Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
   4. Tamper Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

E. Tamper Resistant and Weather Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

F. USB Charging Devices:
   1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
      a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
      b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
   2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
   3. USB Charging Noncombination Devices: Four-port (Type A); rectangular decorator style.

G. Surge Protection Receptacles:
   1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 498 and UL 1449, Type 2or 3.
      a. Energy Dissipation: Not less than 240 J per mode.
      b. Protected Modes: L-N, L-G, N-G.
      c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
      d. Diagnostics:
         1) Visual Notification: Provide indicator light to report functional status of surge protection.
         2) Audible Notification: Provide audible alarm to report that surge protection is not functional.
      e. Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts.
   2. Standard Surge Protection Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Isolated Ground Surge Protection Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, with ground contacts isolated from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

H. Locking Receptacles: Heavy duty specification grade, configuration as indicated on the drawings.
   1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

I. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

J. Hazardous Location Receptacles: Wiring Devices for Hazardous (Classified) Location: Comply with NEMA FB 11 and UL 1010.

2.05 WALL PLATES

A. Manufacturers:
   1. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com
   2. Hubbell Incorporated: www.hubbell-wiring.com.
   3. Leviton Manufacturing Company, Inc: www.leviton.com.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
   5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer.

B. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.
   4. Provide screwless wall plates with concealed mounting hardware where indicated.

C. Finish Spaces shall use Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

D. Aluminum Wall Plates: Smooth satin finish, clear anodized, factory-coated to inhibit oxidation.

E. Unfinished Spaces shall use Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

F. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

G. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.
   1. NEMA 250, flush-type, units suitable for wiring method used. Die-cast aluminum with satin finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with the City of Chicago Electrical Code.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
G. Verify that core drilled holes for poke-through assemblies are in proper locations.
H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of wiring devices provided under this section.
    1. Mounting Heights: Unless otherwise indicated, as follows:
        a. Wall Switches: 48 inches above finished floor.
        b. Fan Speed Controllers: 48 inches above finished floor.
        c. Receptacles: 18 inches above finished floor or 6 inches above counter.
    2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
    3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
    4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect/Engineer of Record to obtain direction prior to proceeding with work.
    5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
C. Install wiring devices in accordance with manufacturer's instructions.
D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
E. Conductors:
    1. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
    2. The length of free conductors at outlets for devices shall meet provision of the City of Chicago Electrical Code, without pigtails.
    3. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
    4. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
    5. Strip insulation evenly around conductors using tool designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
    6. Pigtailing existing conductors is permitted provided the outlet box is large enough.
    7. Damaged existing conductors shall be removed and replaced.
F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

L. Install wall switches with OFF position down.

M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

P. Install ceiling mounted industrial cord reel assemblies utilizing Board's standard mounting detail. The reel shall be installed in the fire treated ½"plywood box FDR painted, flash with the ceiling soffit above the ceiling. Attach hangers to angled brackets bolted to the concrete deck. Power junction box shall be integrated into housing.

Q. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.

R. Identify wiring devices in accordance with Section 26 05 53 - Identification for Electrical Systems.
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
   2. Switches: Where three or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved with black-filled lettering on face of wall plate.

S. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

T. Do not used oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

U. Pendant Cord-Connector Devices:
   1. Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
      a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
      b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

V. Comply with Section 26 05 53 - Identification for Electrical Systems for labeling of wiring devices.
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot stamped or engraved machine printing with black-filled lettering on face plate, and durable wire markers or tags inside of outlet boxes.

2. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved with black-filled lettering on face of wall plate.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

1. Perform tests and inspections and prepare test reports.
   a. Test Instruments: Use instruments that comply with UL 1436.
   b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
   c. Test Wiring Devices: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
2. Tests for Convenience Receptacles:
   a. Line Voltage: Acceptable range is 105 to 132 V.
   b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   c. Ground Impedance: Values of up to 2 ohms are acceptable.
   d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   e. Using the test plug, verify that the device and its outlet box are securely mounted.
   f. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Inspect each surge protection receptacle to verify surge protection is active.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

G. Contactor Startup and Reporting:

1. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.

H. Commissioning and Demonstration:

1. After system checkout and adjustment, the Contractor shall operate the system for the review of the Board and Architect/Engineer of Record. Necessary adjustments or modifications shall be made as required by the Board or Architect/Engineer of Record.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect/Engineer of Record.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

END OF SECTION

SECTION 26 27 26 (MEP)
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.
B. Receptacles.
   1. Tamper Resistant Devices
   2. GFCI Devices
   3. Isolated Ground Devices
   4. USB Charging Devices
C. Wall plates.

1.02 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
B. FS W-C-596 - Connector, Electrical, Power, General Specification for 2017h.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2010.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.
F. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2015).
G. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2016.
H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.
J. UL 355 - UL Standard for Safety Cord Reels 2004 (amendments through October 7, 2020).
K. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
L. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
M. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.
N. UL 1310 - Class 2 Power Units Current Edition, Including All Revisions.
O. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.
P. UL 1917 - Solid-State Fan Speed Controls Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
   4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
   6. Notify Architect/Engineer of Record of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

C. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449, 3rd Edition.

E. Field Quality Control Test Reports.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data:

1. GFCI Receptacles: Include information on status indicators.
2. Surge Protection Receptacles: Include information on status indicators.
3. Acceptable cleaners and recommended cleaning practices for all wiring devices.
4. Replacement parts list for all wiring devices.
5. Manufacturer's service department contact information.

H. Project Record Documents: Record actual installed locations of wiring devices.

I. Maintenance Materials: Furnish the following for Board's Representative's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two (2) for each type of screw.
3. Extra Keys for Locking Switches: Two (2) of each type.
4. Extra Surge Protection Receptacles: Two (2) of each type.
5. Extra Wall Plates: One (1) of each style, size, and finish.
6. Extra Flush Floor Service Fittings: One (1) for every ten, but not less than one (1) of each type.
7. Extra Poke-Through Core Hole Closure Plugs: One (1) for every ten, but not less than two (2) for each core size.

1.05 QUALITY ASSURANCE

A. Conform to NFPA 101.

B. Comply with the City of Chicago Electrical Code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Products: Listed and labeled as suitable for the purpose intended.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

G. Source Limitations: Obtain all wiring devices and associated wall plates from a single manufacturer and one source if available. Obtain each type of wiring device and associated wall plate through one source from a single manufacturer if not all wiring devices are available from a single source.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
E. Provide GFCI protection for receptacles installed in kitchens.
F. Provide GFCI protection for receptacles serving electric drinking fountains.
G. Provide isolated ground receptacles for receptacles serving computers and electronic cash registers and as requested by AV consultants.
H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.
   1. Wiring Devices, Unless Otherwise Indicated: Ivory with satin-finished stainless steel wall plate.
   2. Wiring Devices Installed in Finished Spaces: Ivory with satin-finished stainless steel wall plate.
   3. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
   4. Wiring Devices Installed Damp Locations: White with cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet location".
   5. Isolated Ground Convenience Receptacles: Orange.
   6. Surge Protection Receptacles: Blue.
   7. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.

2.03 WALL SWITCHES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com
   2. Hubbell Incorporated: www.hubbell.com/#sle.
   3. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
C. Standard Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
D. Lighted Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
E. Pilot Light Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Heavy Duty specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.04 RECEPTACLES

A. Manufacturers subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc: {HL#1115380}.
   3. Pass & Seymour, a brand of Legrand North America, Inc: {HL#1115365}.
   4. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com.
   5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
   1. Standard Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   2. Automatically Controlled Convenience Receptacles: Heavy duty specification grade 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per the City of Chicago Electrical Code; single or duplex as indicated on the drawings. Permanent power control signage affixed to face plate.
   3. Isolated Ground Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
      a. Isolation shall be integral to receptacle construction and not dependent on removable parts.
   4. Weather Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
   5. Tamper Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
   6. Tamper Resistant and Weather Resistant Convenience Receptacles: Heavy duty specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

7. Illuminated Convenience Receptacles: Heavy duty specification grade20A, 125V, NEMA 5-20R; illuminated face or indicator light to indicate power is being supplied to receptacle; single or duplex as indicated on the drawings.

D. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, non-feed-through type with light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
   3. Weather Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
   4. Tamper Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

E. Tamper Resistant and Weather Resistant GFCI Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

F. USB Charging Devices:
   1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
      a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
      b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
   2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
   3. USB Charging Noncombination Devices: Four-port (Type A); rectangular decorator style.

G. Surge Protection Receptacles:
   1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 498 and UL 1449, Type 2or 3.
      a. Energy Dissipation: Not less than 240 J per mode.
      b. Protected Modes: L-N, L-G, N-G.
      c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
      d. Diagnostics:
         1) Visual Notification: Provide indicator light to report functional status of surge protection.
         2) Audible Notification: Provide audible alarm to report that surge protection is not functional.
      e. Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts.
   2. Standard Surge Protection Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
   3. Isolated Ground Surge Protection Receptacles: Heavy duty specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, with ground contacts isolated from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

H. Locking Receptacles: Heavy duty specification grade, configuration as indicated on the drawings.
   1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.
I. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.
J. Hazardous Location Receptacles: Wiring Devices for Hazardous (Classified) Location: Comply with NEMA FB 11 and UL 1010.

2.05 WALL PLATES

A. Manufacturers:
   1. Cooper Wiring Devices, a division of Cooper Industries, Inc.; http://www.cooperindustries.com
   2. Hubbell Incorporated: www.hubbell-wiring.com.
   3. Leviton Manufacturing Company, Inc: www.leviton.com.
   4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
   5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer.
B. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.
   4. Provide screwless wall plates with concealed mounting hardware where indicated.
C. Finish Spaces shall use Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
D. Aluminum Wall Plates: Smooth satin finish, clear anodized, factory-coated to inhibit oxidation.
E. Unfinished Spaces shall use Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
F. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
G. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.
   1. NEMA 250, flush-type, units suitable for wiring method used. Die-cast aluminum with satin finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with the City of Chicago Electrical Code.
C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
D. Verify that final surface finishes are complete, including painting.
E. Verify that floor boxes are adjusted properly.
F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
G. Verify that core drilled holes for poke-through assemblies are in proper locations.
H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of wiring devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:
   a. Wall Switches: 48 inches above finished floor.
   b. Fan Speed Controllers: 48 inches above finished floor.
   c. Receptacles: 18 inches above finished floor or 6 inches above counter.
2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect/Engineer of Record to obtain direction prior to proceeding with work.
5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Conductors:

1. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
2. The length of free conductors at outlets for devices shall meet provision of the City of Chicago Electrical Code, without pigtails.
3. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
4. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
5. Strip insulation evenly around conductors using tool designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
6. Pigtailing existing conductors is permitted provided the outlet box is large enough.
7. Damaged existing conductors shall be removed and replaced.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.
L. Install wall switches with OFF position down.
M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
P. Install ceiling mounted industrial cord reel assemblies utilizing Board's standard mounting detail. The reel shall be installed in the fire treated ½"plywood box FDR painted, flash with the ceiling soffit above the ceiling. Attach hangers to angled brackets bolted to the concrete deck. Power junction box shall be integrated into housing.
Q. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.
R. Identify wiring devices in accordance with Section 26 05 53 - Identification for Electrical Systems.
    1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
    2. Switches: Where three or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved with black-filled lettering on face of wall plate.
S. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.
T. Do not used oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
U. Pendant Cord-Connector Devices:
    1. Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
        a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
        b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.
V. Comply with Section 26 05 53 - Identification for Electrical Systems for labeling of wiring devices.
    1. Receptacles: Identify panelboard and circuit number from which served. Use hot stamped or engraved machine printing with black-filled lettering on face plate, and durable wire markers or tags inside of outlet boxes.
    2. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved with black-filled lettering on face of wall plate.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
D. Test each receptacle to verify operation and proper polarity.

1. Perform tests and inspections and prepare test reports.
    a. Test Instruments: Use instruments that comply with UL 1436.
    b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
    c. Test Wiring Devices: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
2. Tests for Convenience Receptacles:
    a. Line Voltage: Acceptable range is 105 to 132 V.
    b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
    c. Ground Impedance: Values of up to 2 ohms are acceptable.
    d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
    e. Using the test plug, verify that the device and its outlet box are securely mounted.
    f. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Inspect each surge protection receptacle to verify surge protection is active.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

G. Contactor Startup and Reporting:
1. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.

H. Commissioning and Demonstration:
1. After system checkout and adjustment, the Contractor shall operate the system for the review of the Board and Architect/Engineer of Record. Necessary adjustments or modifications shall be made as required by the Board or Architect/Engineer of Record.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect/Engineer of Record.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

END OF SECTION

SECTION 26 28 13 (LNK)

FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses.

B. Spare fuse cabinet.

1.02 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
1. Spare Fuse Cabinet: Include dimensions.
2. Fuse size for elevator feeders and elevator disconnect switches.

C. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Fuses: Quantity equal to twenty percent of each fuse type and size, but no fewer than one (1) set of three (3) of each type and size.
3. Fuse Pullers: One (1) set(s) compatible with each type and size installed.
4. Spare Fuse Cabinet Keys: Two (2).
5. Operation and Maintenance Manual:
   a. Include the following:
      1) Let-through current curves for fuses with current-limiting characteristics.
      2) Time-current curves, coordination charts and tables, and related data.
      3) Ambient temperature adjustment information.

1.04 QUALITY ASSURANCE

A. Comply with the City of Chicago Electrical Code.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.

B. Littelfuse, Inc: www.littelfuse.com.

C. Ferraz Shawmut, Inc.: www.ferrazfuses.com.

2.02 APPLICATIONS

A. Service Entrance:
1. Fusible Switches up to 600 Amperes: Class RK1, fast-acting, non-time-delay.
2. Fusible Switches Larger Than 600 Amperes: Class L, fast-acting, non-time-delay.

B. Feeders:
1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

F. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. All fuses shall be of the same manufacture to insure retention of selective coordination as designed.

H. General: Apply current limiting fuses as indicated and as follows:
1. New general purpose fusible switches: Apply for the following class types:
   a. 0-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.
   b. 601-1,200 Amperes, Motor or Transformer Circuit: Class L, time delay; Lo-Peak KRPC.
2. Bolted Pressure Switches: Class L, time delay.
3. Switches in Switchboards: Apply the following classes and types:
   a. 60-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.

b. 601 Amperes and Above: Class L, time delay; Lo-Peak KRPC.

4. Existing General-Purpose Switches:
   a. 30-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.
   b. 601-1,200 Amperes: Class L, time delay; Lo-Peak KRPC.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Provide the following accessories where indicated or where required to complete installation:
1. Fuse holders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.
3. Fuse pullers.
4. Fuse pull rings.
5. Handling poles with extensions.
6. Pole grapplers, prongs, clamps, etc.

K. Provide fuseholders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable. Provide pins or other physical rejection features when current limiting fuses are specified, and non-current limiting fuses of the same dimensions are available.

L. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

M. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Fuses shall not be installed in the equipment until the installation is complete, tested and ready to be energized. Paralleling of fuses will not be permitted.

G. All fuses shall be sized as indicated on the Contract Drawings. Where fuse ratings are not indicated for fuses used to provide motor backup protection or as short circuit protection, such fuses shall be sized in accordance with the heavy service recommendations of the fuse manufacturer.

3.02 FUSE APPLICATIONS

A. Service Entrance: Class L, fast acting.

B. Feeders: Class L, time delay.

C. Motor Branch Circuits: Class RK1, time delay.

D. Other Branch Circuits: Class RK1, time delay.

3.03 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet where indicated.

D. Identify spare fuse cabinet in accordance with Section 26 05 53 - Identification for Electrical Systems.

E. Fuses shall not be installed in the equipment until the installation is complete, tested and ready All low voltage fuses are sized based on the results of short circuit and coordination study as specified in Section 26 05 73 - Power System Studies.

F. The Contractor shall affix to the inside of the door of each fuse enclosure a label or sticker indicating the proper type and rating of fuse. The fuse manufacturer’s labels shall be used.

G. Install typewritten labels indicating fuse replacement information on inside door of each fused switch.

3.04 DEMONSTRATION AND TRAINING

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPD’s and train Board's maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Section 01 79 00.1 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days’ advance notice.

END OF SECTION 26 28 13

SECTION 26 28 13 (MEP)

FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses.

B. Spare fuse cabinet.

1.02 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
1. Spare Fuse Cabinet: Include dimensions.
2. Fuse size for elevator feeders and elevator disconnect switches.

C. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Fuses: Quantity equal to twenty percent of each fuse type and size, but no fewer than one (1) set of three (3) of each type and size.
3. Fuse Pullers: One (1) set(s) compatible with each type and size installed.
4. Spare Fuse Cabinet Keys: Two (2).
5. Operation and Maintenance Manual:
   a. In addition to items specified in Sections 01 77 00 - Closeout Procedures and 01 78 00 - Closeout Submittals, include the following:
      1) Let-through current curves for fuses with current-limiting characteristics.
      2) Time-current curves, coordination charts and tables, and related data.
      3) Ambient temperature adjustment information.

1.04 QUALITY ASSURANCE

A. Comply with the City of Chicago Electrical Code.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.

B. Littelfuse, Inc: www.littelfuse.com.

C. Ferraz Shawmut, Inc.: www.ferrazfuses.com.

2.02 APPLICATIONS

A. Service Entrance:
1. Fusible Switches up to 600 Amperes: Class RK1, fast-acting, non-time-delay.
2. Fusible Switches Larger Than 600 Amperes: Class L, fast-acting, non-time-delay.

B. Feeders:
1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

F. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. All fuses shall be of the same manufacture to insure retention of selective coordination as designed.

H. General: Apply current limiting fuses as indicated and as follows:
1. New general purpose fusible switches: Apply for the following class types:
   a. 0-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.
   b. 601-1,200 Amperes, Motor or Transformer Circuit: Class L, time delay; Lo-Peak KRPC.
2. Bolted Pressure Switches: Class L, time delay.
3. Switches in Switchboards: Apply the following classes and types:
   a. 60-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.

b. 601 Amperes and Above: Class L, time delay; Lo-Peak KRPC.

4. Existing General-Purpose Switches:
   a. 30-600 Amperes: Class RK1, dual element time delay; LPN-RK, LPS-RK.
   b. 601-1,200 Amperes: Class L, time delay; Lo-Peak KRPC.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Provide the following accessories where indicated or where required to complete installation:
1. Fuse holders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.
3. Fuse pullers.
4. Fuse pull rings.
5. Handling poles with extensions.
6. Pole grapplers, prongs, clamps, etc.

K. Provide fuseholders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable. Provide pins or other physical rejection features when current limiting fuses are specified, and non-current limiting fuses of the same dimensions are available.

L. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

M. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.

C. Verify that conditions are satisfactory for installation prior to starting work.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Fuses shall not be installed in the equipment until the installation is complete, tested and ready to be energized. Paralleling of fuses will not be permitted.

G. All fuses shall be sized as indicated on the Contract Drawings. Where fuse ratings are not indicated for fuses used to provide motor backup protection or as short circuit protection, such fuses shall be sized in accordance with the heavy service recommendations of the fuse manufacturer.

3.02 FUSE APPLICATIONS

A. Service Entrance: Class L, fast acting.

B. Feeders: Class L, time delay.

C. Motor Branch Circuits: Class RK1, time delay.

D. Other Branch Circuits: Class RK1, time delay.

3.03 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet where indicated.

D. Identify spare fuse cabinet in accordance with Section 26 05 53 - Identification for Electrical Systems.

E. Fuses shall not be installed in the equipment until the installation is complete, tested and ready All low voltage fuses are sized based on the results of short circuit and coordination study as specified in Section 26 05 73 - Power System Studies.

F. The Contractor shall affix to the inside of the door of each fuse enclosure a label or sticker indicating the proper type and rating of fuse. The fuse manufacturer’s labels shall be used.

G. Install typewritten labels indicating fuse replacement information on inside door of each fused switch.

3.04 DEMONSTRATION AND TRAINING

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPD’s and train Board's maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in the Sections 01 77 00 - Closeout Procedures and 01 79 00 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days’ advance notice.

END OF SECTION 26 28 13

SECTION 26 28 16.13 (LNK)

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

E. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

L. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by the Chicago Electrical Code.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of circuit breaker.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
1. Spare Indicating Lights: Provide three (3) of each type installed.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 COMPATIBILITY

A. Protective devices added to existing assemblies shall have compatible interrupting ratings with the existing assembly and shall be of the original manufacturer. If not available, modify or extend the assembly to accept compatible protective devices of same manufacturer as supplied in new assemblies.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated.
   1. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide electronic trip circuit breakers where indicated.

I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
   3. Provide surface-mounted enclosures unless otherwise indicated.

L. Provide externally operable handle with means for locking in the OFF position.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
      c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.
      d. Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
   a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
   b. 14,000 rms symmetrical amperes at 480 VAC.
2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:
1. Provide mechanical lugs unless otherwise indicated.
2. Provide compression lugs where indicated.
3. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 250 amperes and larger.
2. Provide interchangeable trip units where indicated.

E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1. Provide the following field-adjustable trip response settings:
   a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
   b. Long time delay.
   c. Short time pickup and delay.
   d. Instantaneous pickup.
   e. Ground fault pickup and delay where ground fault protection is indicated.

F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

G. Provide the following circuit breaker types where indicated:
1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

I. Provide listed HACR marked circuit breaker for heating, air-conditioning, and refrigerating equipment.

J. Provide the following features and accessories where indicated or where required to complete installation:
1. Shunt Trip: Provide 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
2. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
3. Undervoltage Trip: Set to operate at 35 to 86 percent of rated voltage with field-adjustable 0.1 to 0.6 second time delay.
4. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

K. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

L. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1, NEMA PB 1.1, and NEMA PB 2.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install enclosed circuit breakers plumb.

F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73 - Power System Studies.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Identify enclosed circuit breakers in accordance with Section 26 05 53 - Identification for Electrical Systems.

M. Install wiring between OCPDs and control/indication devices as specified.

N. Install new circuit protective devices to existing assemblies when shown on drawings. Rearrange existing circuit protective devices and provide bus extensions, hardware, enclosure modifications, etc., to accomplish the installations. Modify assemblies, directories or add nameplates to match existing.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance. Tests listed as optional are not required.

C. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by the Chicago Electrical Code.
1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

D. Test GFCI circuit breakers to verify proper operation.

E. Test shunt trips to verify proper operation.

F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Training: Arrange and pay for the services of factory-authorized service representative to demonstrate OCPDs and train Board's maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Section 01 79 00.1 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days' advance notification.

END OF SECTION 26 28 16.13

SECTION 26 28 16.13 (MEP)

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

E. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

L. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by the Chicago Electrical Code.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of circuit breaker.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
1. Spare Indicating Lights: Provide three (3) of each type installed.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 COMPATIBILITY

A. Protective devices added to existing assemblies shall have compatible interrupting ratings with the existing assembly and shall be of the original manufacturer. If not available, modify or extend the assembly to accept compatible protective devices of same manufacturer as supplied in new assemblies.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated.
   1. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide electronic trip circuit breakers where indicated.

I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
   3. Provide surface-mounted enclosures unless otherwise indicated.

L. Provide externally operable handle with means for locking in the OFF position.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
      c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.
      d. Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
   a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
   b. 14,000 rms symmetrical amperes at 480 VAC.
2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:
1. Provide mechanical lugs unless otherwise indicated.
2. Provide compression lugs where indicated.
3. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 250 amperes and larger.
2. Provide interchangeable trip units where indicated.

E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1. Provide the following field-adjustable trip response settings:
   a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
   b. Long time delay.
   c. Short time pickup and delay.
   d. Instantaneous pickup.
   e. Ground fault pickup and delay where ground fault protection is indicated.

F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

G. Provide the following circuit breaker types where indicated:
1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

I. Provide listed HACR marked circuit breaker for heating, air-conditioning, and refrigerating equipment.

J. Provide the following features and accessories where indicated or where required to complete installation:
1. Shunt Trip: Provide 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
2. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
3. Undervoltage Trip: Set to operate at 35 to 86 percent of rated voltage with field-adjustable 0.1 to 0.6 second time delay.
4. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

K. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

L. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1, NEMA PB 1.1, and NEMA PB 2.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install enclosed circuit breakers plumb.

F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73 - Power System Studies.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Identify enclosed circuit breakers in accordance with Section 26 05 53 - Identification for Electrical Systems.

M. Install wiring between OCPDs and control/indication devices as specified.

N. Install new circuit protective devices to existing assemblies when shown on drawings. Rearrange existing circuit protective devices and provide bus extensions, hardware, enclosure modifications, etc., to accomplish the installations. Modify assemblies, directories or add nameplates to match existing.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance. Tests listed as optional are not required.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by the Chicago Electrical Code.
1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test shunt trips to verify proper operation.

G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Training: Arrange and pay for the services of factory-authorized service representative to demonstrate OCPDs and train Board’s maintenance personnel.

C. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in the Sections 01 77 00 - Closeout Procedures and 01 79 00 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

D. Schedule training with at least seven (7) days’ advance notification.

END OF SECTION 26 28 16.13

SECTION 26 28 16.16 (LNK)

ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

K. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by the Chicago Electrical Code.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual locations of enclosed switches.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Architect/Engineer of Record and Board Representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Architect/Engineer of Record and Board Representative's written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Boltswitch, Inc.: www.boltswitch.com.

F. Source Limitations: Furnish enclosed switches and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Minimum Ratings:
a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.

b. General Duty Single Throw Switches Protected by Class R Fuses: 100,000 rms symmetrical amperes.
c. Heavy Duty Single Throw Switches Protected by Class R or Class L Fuses: 200,000 rms symmetrical amperes.
d. Double Throw Switches Protected by Class R Fuses: 100,000 rms symmetrical amperes.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Kitchen Areas: Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: Type 4.
2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:
1. Comply with NEMA KS 1.
2. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.
b. Provide compression lugs where indicated.
c. Lug Material: Copper, suitable for terminating copper conductors only.
3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
a. Provide means for locking handle in the ON position where indicated.

O. Provide the following features and accessories where indicated or where required to complete installation:
1. Hubs: As required for environment type; sized to accept conduits to be installed.
2. Integral fuse pullers.
3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.
4. Viewing Window: Positioned over switch blades for visual confirmation of contact position with door closed.
5. Interlocked Receptacle: Integral pre-wired three phase, three wire, grounded type receptacle interlocked with switch mechanism to prevent insertion or removal of plug with switch in the ON position and to prevent switch from being placed in the ON position

without matching plug inserted. Provide receptacle configuration as required to accept plug as indicated on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1, NEMA PB 1.1, and NEMA PB 2.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

H. Provide fuses complying with Section 26 28 13 - Fuses for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Identify enclosed switches in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Training: Arrange and pay for the services of factory-authorized service representative to demonstrate OCPDs and train Board's maintenance personnel.

B. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Section 01 79 00.1 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven (7) days' advance notification.

END OF SECTION 26 28 16.16

SECTION 26 28 16.16 (MEP)

ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

K. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by the Chicago Electrical Code.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.

D. Field Quality Control Test Reports.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

F. Project Record Documents: Record actual locations of enclosed switches.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three (3) years documented experience.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Architect/Engineer of Record and Board Representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Architect/Engineer of Record and Board Representative's written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Boltswitch, Inc.: www.boltswitch.com.

F. Source Limitations: Furnish enclosed switches and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Minimum Ratings:
a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.

b. General Duty Single Throw Switches Protected by Class R Fuses: 100,000 rms symmetrical amperes.
c. Heavy Duty Single Throw Switches Protected by Class R or Class L Fuses: 200,000 rms symmetrical amperes.
d. Double Throw Switches Protected by Class R Fuses: 100,000 rms symmetrical amperes.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Kitchen Areas: Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: Type 4.
2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:
1. Comply with NEMA KS 1.
2. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.
b. Provide compression lugs where indicated.
c. Lug Material: Copper, suitable for terminating copper conductors only.
3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
a. Provide means for locking handle in the ON position where indicated.

O. Provide the following features and accessories where indicated or where required to complete installation:
1. Hubs: As required for environment type; sized to accept conduits to be installed.
2. Integral fuse pullers.
3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.
4. Viewing Window: Positioned over switch blades for visual confirmation of contact position with door closed.
5. Interlocked Receptacle: Integral pre-wired three phase, three wire, grounded type receptacle interlocked with switch mechanism to prevent insertion or removal of plug with switch in the ON position and to prevent switch from being placed in the ON position

without matching plug inserted. Provide receptacle configuration as required to accept plug as indicated on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1, NEMA PB 1.1, and NEMA PB 2.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

H. Provide fuses complying with Section 26 28 13 - Fuses for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Identify enclosed switches in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Training: Arrange and pay for the services of factory-authorized service representative to demonstrate OCPDs and train Board's maintenance personnel.

C. Conduct a minimum of one half (1/2) day of training in operation and maintenance as specified in Sections 01 77 00 - Closeout Procedures and 01 79 00 - Demonstration and Training. Include both classroom training and hands on equipment operation and maintenance procedures.

D. Schedule training with at least seven (7) days' advance notification.

END OF SECTION 26 28 16.16

SECTION 26 29 13 (LNK)

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. Manual motor starters.
   3. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

C. Control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.
   3. Control and timing relays.
   4. Control power transformers.
   5. Control terminal blocks.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

F. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

G. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

H. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

I. NEMA MG 1 - Motors and Generators; 2017.

J. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

M. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by the Chicago Electrical Code.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated.
   a. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
   b. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.
7. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings.
5. Include documentation demonstrating selective coordination.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
   1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
   2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.
   3. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
   4. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load current
   5. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Electronic Trip Circuit Breakers: Provide one (1) portable test set.
   3. Indicating Lights: Two (2) of each different type.
   4. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and that maintains within 50miles of project site a service center capable of providing training, parts, and emergency maintenance and repairs.

D. Installer Qualifications: Company with minimum five years documented experience of successful installation on projects utilizing motor controllers similar to that required for this project.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Architect/Engineer of Record and Board Representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Architect/Engineer of Record and Board Representative's written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.
1. Motor-starting switches without overload protection may be produced by the same manufacturer as the wiring devices used for this project.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
a. Altitude:

1) Class 1 Km Equipment (devices utilizing power semiconductors): Less than 3,300 feet.
2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.

b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Starters shall be manual type for motors 1/3 HP and smaller and magnetic type motors 1/2 HP and larger.

F. Contracts shall open each underground connection to the motor.

G. Starter contact shall be twin-break, silver-to-silver, renewable contacts with one set of contacts for each phase.

H. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to the Chicago Electrical Code..
3. Label equipment utilizing series ratings as required by the Chicago Electrical Code.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Enclosures:
1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Kitchen Areas: Type 4X, stainless steel.
d. Other Wet or Damp Locations: Type 4.
e. Hazardous (Classified) Locations: Type 7C , as required for the classification of the installed location.
3. Finish: Manufacturer's standard unless otherwise indicated.

L. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

M. Magnetic Motor Starters: Combination type unless otherwise indicated.
1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s) and overload relay(s).
3. Configuration: Full voltage, non-reversing unless otherwise indicated..
4. Minimum Starter Size: NEMA Size 0.

5. Use of non-standard starter sizes smaller than specified standard NEMA sizes is not permitted.
6. Disconnects: Circuit breaker type.
   a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
   c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   d. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
   e. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
7. Overload Relays: Bimetallic thermal type, melting alloy and solid state unless otherwise indicated.
   a. Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
   b. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
8. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
   b. Single-Speed, Non-Reversing Starters:
      1) Pushbuttons: START-STOP.
      2) Selector Switches: HAND/OFF/AUTO.
      3) Indicating Lights: Green ON, Red OFF.
   c. Single-Speed, Reversing Starters:
      1) Pushbuttons: FOR-REV-STOP.
      2) Selector Switches: FOR/OFF/REV.
      3) Indicating Lights: Green FOR, Green REV, Red OFF.
   d. Two-Speed Starters:
      1) Pushbuttons: FAST-OFF-SLOW.
      2) Selector Switches: SLOW/OFF/FAST.
      3) Indicating Lights: Green FAST, Red OFF, Amber SLOW.
9. 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

N. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s) and "quick-make, quick breaker" toggle action.
2. Configuration: Non-reversing unless otherwise indicated.
3. Marked to show whether unit is "OFF", "ON", or "TRIPPED".
4. Where the motor is interlocked and controlled by another device, the motor starter shall be marked “Hand-Off-Auto”.
5. Fractional-Horsepower Manual Motor Starters:
   a. Furnish with toggle operator.
   b. Overload Relays: Bimetallic or melting alloy thermal type with heater rating clearly indicated.

c. Provide means for locking operator in the OFF position.
d. Single pole for 120 Volt, two pole for 208 Volt operation.
e. Trip-free toggle operated with on-off-reset position clearly indicated with neon pilot light for run indication.
f. Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 20 tripping characteristics. Provide one overload for single pole switch and two overloads for two pole switch. Sensor shall match to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

6. Integral-Horsepower Manual Motor Starters:
a. Furnish with toggle or pushbutton operator.
b. Overload Relays: Bimetallic or melting alloy thermal type.
c. Provide means for locking operator in the OFF position.
d. Provide auxiliary contact where indicated; normally open (NO) or normally closed (NC) as indicated or as required.

O. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

P. Reduced-Voltage Enclosed Controller: Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges ten (10) percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:
a. Control power available.
b. Controller on.
c. Overload trip.
d. Loss of phase.
e. Shorted silicon-controlled rectifier.
4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.
6. Shorting contactor:
a. A microprocessor shall control the operation of the shorting contactor via an output relay.
b. The shorting contractor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating ramp complete), and open on a stop command to allow deceleration ramp.
7. Motor must be automatically protected from solid state component failure by one of the following means:
a. Shunt trip coil to trip disconnect in the event of a controller fault condition including a shorted thyristor.
b. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted thyristor.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and the Chicago Electrical Code; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.

4. Visible trip indication.
5. Resettable.
   a. Employ manual reset unless otherwise indicated.
   b. Do not employ automatic reset with two-wire control.
6. Bimetallic Thermal Overload Relays:
   a. Interchangeable current elements/heaters.
   b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
   c. Trip test function.
   d. Provide isolated alarm contact where indicated.
7. Melting Alloy Thermal Overload Relays:
   a. Interchangeable current elements/heaters.
   b. Provide isolated alarm contact where indicated.
8. Solid-State Overload Relays:
   a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
   b. Adjustable full load current.
   c. Phase loss protection.
   d. Phase imbalance protection.
   e. Ground fault protection.
   f. Ambient temperature insensitive.
   g. Thermal memory.
   h. Repeat Trip Accuracy: Plus/minus 2 percent, minimum.
   i. Trip test function.
   j. Provide isolated alarm contact.
   k. Provide communication capability where indicated: Compatible with system indicated.

B. Circuit Breakers:
1. Interrupting Capacity (not applicable to motor circuit protectors):
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Motor Circuit Protectors:
   a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
   b. Provide field-adjustable magnetic instantaneous trip setting.
   c. Provide the following features and accessories where indicated or where required to complete installation:
      1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
      2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
      3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
      4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
      5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
3. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

1) Provide thermal magnetic circuit breakers unless otherwise indicated.
2) Provide electronic trip circuit breakers where indicated.

b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
2) Provide interchangeable trip units where indicated.

c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1) Provide the following field-adjustable trip response settings:
a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
b) Long time delay.
c) Short time pickup and delay.
d) Instantaneous pickup.
e) Ground fault pickup and delay where ground fault protection is indicated.

d. Provide the following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
2. Nominal Size: 30 mm.
3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
5. Indicating Lights: Push-to-test type unless otherwise indicated.
6. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
2. Provide number and type of relays indicated or required to perform necessary functions.
3. Timing Relays: Electronic.
a. Adjustable Timing Range: As required for application.
4. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 25 percent spare capacity.
   2. Include primary and secondary fuses.

E. Control Terminal Blocks: Include 25 percent spare terminals.

F. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

G. Elapsed Time Meters: Heavy duty with digital readout in hours.

H. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

I. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

J. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required support and attachment components in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.
   1. Install freestanding equipment on concrete bases. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

G. Install all field-installed devices, components, and accessories.

H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and the Chicago Electrical Code.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73 - Power System Studies.

K. Identify enclosed controllers in accordance with Section 26 05 53 - Identification for Electrical Systems.

L. Install wiring between enclosed controlled according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables. Buckle, train, and support wiring in enclosures.

M. Connect hand-off-automatic switch and other automatic-control devices where applicable.
1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required, except for the following:
1. Verify motor-running protection.
2. Perform insulation-resistance tests on all control wiring with respect to ground.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 100 amperes. Tests listed as optional are not required, except for the following:
1. Perform insulation-resistance tests on all control wiring with respect to ground.
2. Test functions of the trip unit by means of secondary injection.

E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Comply with NETA ATS Article 7.16.

B. Prepare for acceptance tests as follows:
1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
1. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
2. Report results in writing.

D. Pretesting: On completing installation of the system, perform the following preparations for tests:
1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer’s instructions for installation and testing of motor control devices to test personnel.

E. Visual and mechanical inspection: Include the following inspections and related work:
1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit load current and overload relay heater list.
2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
3. Exercise and perform operational tests of mechanical components and other devices in accordance with manufacturer’s instructions.
4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer’s recommended torque values.
5. Clean devices using manufacturer’s approved methods and materials.
6. Verify proper fuse types and ratings in fusible devices.

F. Electrical Tests: Perform the following in accordance with manufacturer’s instructions:
1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer’s instructions. Insulation resistance less than 10 megohms is not acceptable.
2. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer’s published time-current tolerances are not acceptable.
3. Make adjustments for final settings of adjustable-trip devices.
4. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.
5. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened.

G. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

H. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Board, and correct deficiencies or make adjustments as directed.

B. Training: Train Board's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four (4) hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.
5. Schedule training with at least seven (7) days advance notice.

3.08 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26 29 13

SECTION 26 29 13 (MEP)

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. Manual motor starters.
   3. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

C. Control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.
   3. Control and timing relays.
   4. Control power transformers.
   5. Control terminal blocks.

1.02 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

F. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

G. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

H. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

I. NEMA MG 1 - Motors and Generators; 2017.

J. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

L. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

M. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by the Chicago Electrical Code.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated.
   a. Notify Architect/Engineer of Record and Board's Representative not fewer than seven (7) working days in advance of proposed interruption of electrical service.
   b. Do not proceed with interruption of electrical service without Architect/Engineer of Record's and Board's Representative written permission.
7. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.
2. Include wiring diagrams showing all factory and field connections.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings.
5. Include documentation demonstrating selective coordination.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Field Quality Control Test Reports.

F. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
   1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
   2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.
   3. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
   4. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load current
   5. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Board's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Electronic Trip Circuit Breakers: Provide one (1) portable test set.
   3. Indicating Lights: Two (2) of each different type.
   4. See Section 26 28 13 - Fuses for requirements for spare fuses and spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and that maintains within 50miles of project site a service center capable of providing training, parts, and emergency maintenance and repairs.

D. Installer Qualifications: Company with minimum five years documented experience of successful installation on projects utilizing motor controllers similar to that required for this project.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Board or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Architect/Engineer of Record and Board Representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Architect/Engineer of Record and Board Representative's written permission.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

E. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.
1. Motor-starting switches without overload protection may be produced by the same manufacturer as the wiring devices used for this project.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
a. Altitude:

1) Class 1 Km Equipment (devices utilizing power semiconductors): Less than 3,300 feet.
2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.

b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Starters shall be manual type for motors 1/3 HP and smaller and magnetic type motors 1/2 HP and larger.

F. Contracts shall open each underground connection to the motor.

G. Starter contact shall be twin-break, silver-to-silver, renewable contacts with one set of contacts for each phase.

H. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73 - Power System Studies.
2. Listed series ratings are acceptable, except where not permitted by motor contribution according to the Chicago Electrical Code..
3. Label equipment utilizing series ratings as required by the Chicago Electrical Code.

I. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Enclosures:
1. Comply with NEMA ICS 6.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Kitchen Areas: Type 4X, stainless steel.
d. Other Wet or Damp Locations: Type 4.
e. Hazardous (Classified) Locations: Type 7C , as required for the classification of the installed location.
3. Finish: Manufacturer's standard unless otherwise indicated.

L. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

M. Magnetic Motor Starters: Combination type unless otherwise indicated.
1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A noncombination motor controllers with magnetic contactor(s) and overload relay(s).
3. Configuration: Full voltage, non-reversing unless otherwise indicated..
4. Minimum Starter Size: NEMA Size 0.

5. Use of non-standard starter sizes smaller than specified standard NEMA sizes is not permitted.
6. Disconnects: Circuit breaker type.
   a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
   c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   d. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
   e. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
7. Overload Relays: Bimetallic thermal type, melting alloy and solid state unless otherwise indicated.
   a. Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
   b. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
8. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
   b. Single-Speed, Non-Reversing Starters:
      1) Pushbuttons: START-STOP.
      2) Selector Switches: HAND/OFF/AUTO.
      3) Indicating Lights: Green ON, Red OFF.
   c. Single-Speed, Reversing Starters:
      1) Pushbuttons: FOR-REV-STOP.
      2) Selector Switches: FOR/OFF/REV.
      3) Indicating Lights: Green FOR, Green REV, Red OFF.
   d. Two-Speed Starters:
      1) Pushbuttons: FAST-OFF-SLOW.
      2) Selector Switches: SLOW/OFF/FAST.
      3) Indicating Lights: Green FAST, Red OFF, Amber SLOW.
9. 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

N. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s) and "quick-make, quick breaker" toggle action.
2. Configuration: Non-reversing unless otherwise indicated.
3. Marked to show whether unit is "OFF", "ON", or "TRIPPED".
4. Where the motor is interlocked and controlled by another device, the motor starter shall be marked “Hand-Off-Auto”.
5. Fractional-Horsepower Manual Motor Starters:
   a. Furnish with toggle operator.
   b. Overload Relays: Bimetallic or melting alloy thermal type with heater rating clearly indicated.

c. Provide means for locking operator in the OFF position.
d. Single pole for 120 Volt, two pole for 208 Volt operation.
e. Trip-free toggle operated with on-off-reset position clearly indicated with neon pilot light for run indication.
f. Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 20 tripping characteristics. Provide one overload for single pole switch and two overloads for two pole switch. Sensor shall match to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

6. Integral-Horsepower Manual Motor Starters:
a. Furnish with toggle or pushbutton operator.
b. Overload Relays: Bimetallic or melting alloy thermal type.
c. Provide means for locking operator in the OFF position.
d. Provide auxiliary contact where indicated; normally open (NO) or normally closed (NC) as indicated or as required.

O. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

P. Reduced-Voltage Enclosed Controller: Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges ten (10) percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:
a. Control power available.
b. Controller on.
c. Overload trip.
d. Loss of phase.
e. Shorted silicon-controlled rectifier.
4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.
6. Shorting contactor:
a. A microprocessor shall control the operation of the shorting contactor via an output relay.
b. The shorting contractor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating ramp complete), and open on a stop command to allow deceleration ramp.
7. Motor must be automatically protected from solid state component failure by one of the following means:
a. Shunt trip coil to trip disconnect in the event of a controller fault condition including a shorted thyristor.
b. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted thyristor.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and the Chicago Electrical Code; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.

4. Visible trip indication.
5. Resettable.
   a. Employ manual reset unless otherwise indicated.
   b. Do not employ automatic reset with two-wire control.
6. Bimetallic Thermal Overload Relays:
   a. Interchangeable current elements/heaters.
   b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
   c. Trip test function.
   d. Provide isolated alarm contact where indicated.
7. Melting Alloy Thermal Overload Relays:
   a. Interchangeable current elements/heaters.
   b. Provide isolated alarm contact where indicated.
8. Solid-State Overload Relays:
   a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
   b. Adjustable full load current.
   c. Phase loss protection.
   d. Phase imbalance protection.
   e. Ground fault protection.
   f. Ambient temperature insensitive.
   g. Thermal memory.
   h. Repeat Trip Accuracy: Plus/minus 2 percent, minimum.
   i. Trip test function.
   j. Provide isolated alarm contact.
   k. Provide communication capability where indicated: Compatible with system indicated.

B. Circuit Breakers:
1. Interrupting Capacity (not applicable to motor circuit protectors):
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Motor Circuit Protectors:
   a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
   b. Provide field-adjustable magnetic instantaneous trip setting.
   c. Provide the following features and accessories where indicated or where required to complete installation:
      1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
      2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
      3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
      4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
      5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.
3. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

1) Provide thermal magnetic circuit breakers unless otherwise indicated.
2) Provide electronic trip circuit breakers where indicated.

b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
2) Provide interchangeable trip units where indicated.

c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1) Provide the following field-adjustable trip response settings:
a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
b) Long time delay.
c) Short time pickup and delay.
d) Instantaneous pickup.
e) Ground fault pickup and delay where ground fault protection is indicated.

d. Provide the following features and accessories where indicated or where required to complete installation:
1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
3) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
4) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
5) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
2. Nominal Size: 30 mm.
3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
5. Indicating Lights: Push-to-test type unless otherwise indicated.
6. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
1. Comply with NEMA ICS 5.
2. Provide number and type of relays indicated or required to perform necessary functions.
3. Timing Relays: Electronic.
a. Adjustable Timing Range: As required for application.
4. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 25 percent spare capacity.
   2. Include primary and secondary fuses.

E. Control Terminal Blocks: Include 25 percent spare terminals.

F. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

G. Elapsed Time Meters: Heavy duty with digital readout in hours.

H. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

I. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

J. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and the Chicago Electrical Code.

D. Provide required support and attachment components in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.
   1. Install freestanding equipment on concrete bases. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

G. Install all field-installed devices, components, and accessories.

H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and the Chicago Electrical Code.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73 - Power System Studies.

K. Identify enclosed controllers in accordance with Section 26 05 53 - Identification for Electrical Systems.

L. Install wiring between enclosed controlled according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables. Buckle, train, and support wiring in enclosures.

M. Connect hand-off-automatic switch and other automatic-control devices where applicable.
1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required, except for the following:
1. Verify motor-running protection.
2. Perform insulation-resistance tests on all control wiring with respect to ground.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 100 amperes. Tests listed as optional are not required, except for the following:
1. Perform insulation-resistance tests on all control wiring with respect to ground.
2. Test functions of the trip unit by means of secondary injection.

E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 STARTUP AND REPORTING

A. Comply with NETA ATS Article 7.16.

B. Prepare for acceptance tests as follows:
1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
1. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
2. Report results in writing.

D. Pretesting: On completing installation of the system, perform the following preparations for tests:
1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer’s instructions for installation and testing of motor control devices to test personnel.

E. Visual and mechanical inspection: Include the following inspections and related work:
1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit load current and overload relay heater list.
2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
3. Exercise and perform operational tests of mechanical components and other devices in accordance with manufacturer’s instructions.
4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer’s recommended torque values.
5. Clean devices using manufacturer’s approved methods and materials.
6. Verify proper fuse types and ratings in fusible devices.

F. Electrical Tests: Perform the following in accordance with manufacturer’s instructions:
1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer’s instructions. Insulation resistance less than 10 megohms is not acceptable.
2. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer’s published time-current tolerances are not acceptable.
3. Make adjustments for final settings of adjustable-trip devices.
4. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.
5. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened.

G. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

H. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Demonstration: Demonstrate proper operation of controllers to Board, and correct deficiencies or make adjustments as directed.

C. Training: Train Board's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four (4) hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.
5. Schedule training with at least seven (7) days advance notice.

3.08 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 26 29 13

SECTION 26 29 23 (LNK)

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable frequency controllers (VFC).

1.02 REFERENCE STANDARDS

A. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2014a.

B. IEEE 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems; 2014.

C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

D. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2014.

E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2014.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

G. NEMA MG 1 - Motors and Generators; 2017.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70 - National Electrical Code; 2017.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings:
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For manufacturer and testing agency.

F. Field Quality-Control Test Reports: Submit reports documenting the activities performed. These reports are to be submitted two weeks after startup is completed.

G. Training Reports: Submit reports on training documenting dates and attendance.

H. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

I. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Award the work to a single firm that specializes in the production of variable frequency drives, with not less than 5 years experience in the production of variable frequency drives similar in design and performance to those required for the Project, and whose work has resulted in a history of successful in-service performance. The manufacturer shall have sufficient production capacity, and have organized quality control and testing procedures, to be capable of producing the equipment required for the Project without causing a delay in the Work. The manufacturer shall maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

E. Source Limitations: Obtain all VFCs required for the Project through one source from a single manufacturer.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Regulatory Requirements: Comply with the Chicago Building Code, including requirements for components and installation.

H. Comply with IEEE 519-1992, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

1.05 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances, including clearances required for maintenance, and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Deliver setting templates in time to allow casting of anchor-bolt inserts into bases.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.06 COORDINATION WITH ENERGY MANAGEMENT SYSTEM

A. General: The equipment specified in this Section is required to be interfaced with the Energy Management System (EMS) as specified in Division 23 Section "Building Automation System." Provide all devices, hardware, programming, startup and commissioning required to establish the interface.

B. Coordinate with EMS supplier for their review and acceptance of the communications interface to be provided. Include evidence of the coordination and review process with the required submittals for this Section.

C. Provide a list of all read/write and read-only points available through the user interface. Provide software, hardware or paperwork that the contractor installing the EMS will require in order to accomplish the interface.

D. The equipment supplier is solely responsible for the proper performance of their equipment provided the correct information is provided through the communications interface.

E. Provide a prefunctional checklist, startup checklist and demonstration report to the Engineer, Commissioning Agent, or Board Authorized Representative for acceptance of system.

F. Provide a startup technician on-site during the establishment of the interface. Coordinate this activity with the EMS installer.

G. BACNet compliant manufacturer-provided controls
1. Provide any information necessary to allow the BACNet compliant device to be directly connected to the existing network, and send/receive information to the system installed under Division 23 sections.
2. The EMS shall then read and present the information made available by the equipment manufacturer, and transmit information receivable by the equipment manufacturer. This shall be accomplished by user configuration of point information, but shall not require recompiling or downloading of control programs.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store VFCs in manufacturer's original protective packaging, with original labels detailing contents intact. Store VFCs indoors, off of ground, under cover, in clean, dry location

with uniform temperature and humidity to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components or equipment that fail in materials or workmanship within the specified warranty period. Manufacturer's warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer in providing on-site service and repair or replacement.
1. Warranty Period: Three years from the date of Preliminary Acceptance.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Design - Environmental: Equipment shall be rated for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
1. Temperature Range, Ambient: 32 deg F to 105 deg F.
2. Relative Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.
4. Conditions: Winter: -10 deg F DB; Summer: 95 deg F DB / 75 deg F WB.

B. Noise: The VFC shall not produce motor noise in excess of the manufacturers published noise standards for 60 Hz operation.

2.02 MANUFACTURERS

A. Variable Frequency Motor Controllers:
1. ABB Power
2. Danfoss
3. Rockwell Automation, Inc.; Allen-Bradley Products
4. Siemens Industry, Inc
5. Toshiba International Corp.
6. Yaskawa

2.03 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places restricted to persons employed on the premises.

C. All PWM AC Variable Frequency Drives of 40 hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of reflected harmonic distortion. Provide harmonic mitigation for drives less than 40 hp where required to meet IEEE 519.
1. The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).

2. The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
3. Harmonic mitigation shall be by passive inductor/capacitor network or internal phase shifting transformer. Active electronic components shall not be used.
4. Power factor shall be 0.98 lagging to 0.95 leading in operating range from full to half load.
5. To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR) that is greater than 15% of its kVA rating.
6. The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
7. The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements of IEEE 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
8. Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
9. Total Demand Distortion (TDD) of the current at the input terminals of the harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE 519 . For Isc/Il ratio < 20, TDD must be less than 5%. For all other Isc/Il ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
10. The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

D. Design and Rating: Match load type such as fans, blowers, and pumps, and type of connection used between motor and load, such as direct or through a power-transmission connection.

2.04 OPERATING REQUIREMENTS

A. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

B. Input ac voltage ranges of 208 V, plus or minus 10 percent or 480 V, plus or minus 10 percent as indicated on equipment schedules.

C. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

D. Minimum Efficiency: 96 percent at 60 Hz, full load.

E. Minimum Displacement Primary-Side Power Factor: 96 percent.

F. Overload Capability: 1.2 times the base load current for 60 seconds; 1.8 times the base load current for 3 seconds.

G. Starting Torque: 100 percent of rated torque or as indicated.

H. Speed Regulation: Plus or minus 1 percent.

2.05 COMPONENTS AND FEATURES

A. Isolated Control Interface: To allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.

B. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.
   4. Deceleration: 2 to a minimum of 22 seconds.
   5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

C. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter over-temperature, overload, and overcurrent trips.
   3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
   4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   6. Loss-of-phase protection.
   7. Reverse-phase protection.
   8. Short-circuit protection.
   9. Motor over temperature fault where motor is equipped with RTD.

D. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

E. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

F. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

G. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

H. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

I. Input Line Conditioning: dc bus link reactors, isolation transformers, active and passive harmonic filters, and phase shifting transformers.

J. VFD Output Filtering: Line inductors, output limit filters, sine wave filters, and motor termination filters shall be provided where the motor to drive conductor lengths exceed manufacturer's recommended lengths.

K. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.

5. Overcurrent.
6. External fault.

L. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

M. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

N. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the EMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.
3. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

O. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via EMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

P. Integral Disconnecting Means: NEMA AB 1, molded-case switch with lockable handle.

Q. Operation and Maintenance Features:
1. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.

2. Manual Bypass: Magnetic contactor arranged to safely transfer the motor from the controller to the power line, or from the line to the controller while the motor is at zero speed. Include VFC-bypass selector switch and indicator lights to indicate mode selection. The operator shall have full control of the bypass starter by operation of the selector switch.
3. Integral Main Disconnect: Circuit breaker connected to shut down all power to both the controller and the bypass. Interlock breaker with cabinet door.
4. Auxiliary Motor Contactors: Electrically interlocked. One contactor connected between the controller output and the motor, controlled by the controller regulator; and one between the bypass power line and the motor, providing across-the-line starting capability in the bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
5. Isolating Circuit Breaker: Arranged to electrically isolate the variable-speed controller to permit safe trouble-shooting and testing of the controller, both energized and de-energized, while the motor is operating in the bypass mode.
6. Form C output contacts for run and fault conditions.
7. Terminal strip for N.C. safety shutdown contacts.
8. N.C. input for remote start/stop control in Auto mode.

R. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

S. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

T. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

U. Standard Displayed information, display shall be interchangeable for all VFDs installed:
1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).
8. Fault history with analytical data.

V. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

W. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.06 FINISH

A. Finish: Manufacturer's standard paint finish, applied to factory-assembled and -tested VFCs.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

C. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

D. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Harmonic Analysis: Obtain the electrical system one-line diagram from the contract document, provide a harmonic analysis demonstrating that the proposed VFDs (along with harmonic mitigation equipment provided) conform with IEEE 519.

3.03 SELECTION

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

B. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

C. Select horsepower rating of controllers to suit motor controlled.

3.04 INSTALLATION

A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

D. Install VFDs on concrete bases where indicated to be installed on the floor. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

E. VFD’s are not to be installed inside air handlers or air plenums due to the potentially high humidity or temperatures.

F. Install wiring between VFCs and remote devices according to Division 26 sections. Power and control wiring shall not be run in the same conduit, and shall follow manufacturer's recommendations.

G. Bundle, train, and support wiring in enclosures.

H. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

I. Install conduit and ground equipment in accordance with Division 26 sections.

3.05 ADJUSTING

A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Reports: Prepare written reports certified by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made. Harmonic compliance shall be verified with on-site field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

C. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:
1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Prepare written reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.07 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain air handling units.
1. Train Board's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining the equipment. The training will occur after the startup report has been provided to the Board and the trainer will provide two (2) Installation and Operations manuals for the use of the Board's personnel during training.
2. Review data in maintenance manuals. Refer to Section 01 78 23.1 - Closeout Submittals. All required and recommended maintenance will be reviewed as well as

operational troubleshooting. If the IOM does not include a written troubleshooting guide one shall be provided.

3. Schedule training with Board, through Architect/Engineer of Record, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or Board's designated personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Divisions 01 and 23 sections.

END OF SECTION 26 29 23

SECTION 26 29 23 (MEP)

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable frequency controllers (VFC).

1.02 REFERENCE STANDARDS

A. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2014a.

B. IEEE 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems; 2014.

C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

D. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2014.

E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2014.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

G. NEMA MG 1 - Motors and Generators; 2017.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70 - National Electrical Code; 2017.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings:
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For manufacturer and testing agency.

F. Field Quality-Control Test Reports: Submit reports documenting the activities performed. These reports are to be submitted two weeks after startup is completed.

G. Training Reports: Submit reports on training documenting dates and attendance.

H. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

I. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Award the work to a single firm that specializes in the production of variable frequency drives, with not less than 5 years experience in the production of variable frequency drives similar in design and performance to those required for the Project, and whose work has resulted in a history of successful in-service performance. The manufacturer shall have sufficient production capacity, and have organized quality control and testing procedures, to be capable of producing the equipment required for the Project without causing a delay in the Work. The manufacturer shall maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

E. Source Limitations: Obtain all VFCs required for the Project through one source from a single manufacturer.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Regulatory Requirements: Comply with the Chicago Building Code, including requirements for components and installation.

H. Comply with IEEE 519-1992, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

1.05 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances, including clearances required for maintenance, and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Deliver setting templates in time to allow casting of anchor-bolt inserts into bases.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.06 COORDINATION WITH ENERGY MANAGEMENT SYSTEM

A. General: The equipment specified in this Section is required to be interfaced with the Energy Management System (EMS) as specified in Division 23 Section "Building Automation System." Provide all devices, hardware, programming, startup and commissioning required to establish the interface.

B. Coordinate with EMS supplier for their review and acceptance of the communications interface to be provided. Include evidence of the coordination and review process with the required submittals for this Section.

C. Provide a list of all read/write and read-only points available through the user interface. Provide software, hardware or paperwork that the contractor installing the EMS will require in order to accomplish the interface.

D. The equipment supplier is solely responsible for the proper performance of their equipment provided the correct information is provided through the communications interface.

E. Provide a prefunctional checklist, startup checklist and demonstration report to the Engineer, Commissioning Agent, or Board Authorized Representative for acceptance of system.

F. Provide a startup technician on-site during the establishment of the interface. Coordinate this activity with the EMS installer.

G. BACNet compliant manufacturer-provided controls
1. Provide any information necessary to allow the BACNet compliant device to be directly connected to the existing network, and send/receive information to the system installed under Division 23 sections.
2. The EMS shall then read and present the information made available by the equipment manufacturer, and transmit information receivable by the equipment manufacturer. This shall be accomplished by user configuration of point information, but shall not require recompiling or downloading of control programs.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store VFCs in manufacturer's original protective packaging, with original labels detailing contents intact. Store VFCs indoors, off of ground, under cover, in clean, dry location

with uniform temperature and humidity to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components or equipment that fail in materials or workmanship within the specified warranty period. Manufacturer's warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer in providing on-site service and repair or replacement.
1. Warranty Period: Three years from the date of Preliminary Acceptance.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Design - Environmental: Equipment shall be rated for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
1. Temperature Range, Ambient: 32 deg F to 105 deg F.
2. Relative Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.
4. Conditions: Winter: -10 deg F DB; Summer: 95 deg F DB / 75 deg F WB.

B. Noise: The VFC shall not produce motor noise in excess of the manufacturers published noise standards for 60 Hz operation.

2.02 MANUFACTURERS

A. Variable Frequency Motor Controllers:
1. ABB Power
2. Danfoss
3. Rockwell Automation, Inc.; Allen-Bradley Products
4. Siemens Industry, Inc
5. Toshiba International Corp.
6. Yaskawa

2.03 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places restricted to persons employed on the premises.

C. All PWM AC Variable Frequency Drives of 40 hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of reflected harmonic distortion. Provide harmonic mitigation for drives less than 40 hp where required to meet IEEE 519.
1. The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).

2. The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
3. Harmonic mitigation shall be by passive inductor/capacitor network or internal phase shifting transformer. Active electronic components shall not be used.
4. Power factor shall be 0.98 lagging to 0.95 leading in operating range from full to half load.
5. To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR) that is greater than 15% of its kVA rating.
6. The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
7. The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements of IEEE 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
8. Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
9. Total Demand Distortion (TDD) of the current at the input terminals of the harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE 519 . For Isc/Il ratio < 20, TDD must be less than 5%. For all other Isc/Il ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
10. The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

D. Design and Rating: Match load type such as fans, blowers, and pumps, and type of connection used between motor and load, such as direct or through a power-transmission connection.

2.04 OPERATING REQUIREMENTS

A. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

B. Input ac voltage ranges of 208 V, plus or minus 10 percent or 480 V, plus or minus 10 percent as indicated on equipment schedules.

C. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

D. Minimum Efficiency: 96 percent at 60 Hz, full load.

E. Minimum Displacement Primary-Side Power Factor: 96 percent.

F. Overload Capability: 1.2 times the base load current for 60 seconds; 1.8 times the base load current for 3 seconds.

G. Starting Torque: 100 percent of rated torque or as indicated.

H. Speed Regulation: Plus or minus 1 percent.

2.05 COMPONENTS AND FEATURES

A. Isolated Control Interface: To allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.

B. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.
   4. Deceleration: 2 to a minimum of 22 seconds.
   5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

C. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter over-temperature, overload, and overcurrent trips.
   3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
   4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   6. Loss-of-phase protection.
   7. Reverse-phase protection.
   8. Short-circuit protection.
   9. Motor over temperature fault where motor is equipped with RTD.

D. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

E. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

F. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

G. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

H. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

I. Input Line Conditioning: dc bus link reactors, isolation transformers, active and passive harmonic filters, and phase shifting transformers.

J. VFD Output Filtering: Line inductors, output limit filters, sine wave filters, and motor termination filters shall be provided where the motor to drive conductor lengths exceed manufacturer's recommended lengths.

K. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.

5. Overcurrent.
6. External fault.

L. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

M. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

N. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the EMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.
3. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

O. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via EMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

P. Integral Disconnecting Means: NEMA AB 1, molded-case switch with lockable handle.

Q. Operation and Maintenance Features:
1. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.

2. Manual Bypass: Magnetic contactor arranged to safely transfer the motor from the controller to the power line, or from the line to the controller while the motor is at zero speed. Include VFC-bypass selector switch and indicator lights to indicate mode selection. The operator shall have full control of the bypass starter by operation of the selector switch.
3. Integral Main Disconnect: Circuit breaker connected to shut down all power to both the controller and the bypass. Interlock breaker with cabinet door.
4. Auxiliary Motor Contactors: Electrically interlocked. One contactor connected between the controller output and the motor, controlled by the controller regulator; and one between the bypass power line and the motor, providing across-the-line starting capability in the bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
5. Isolating Circuit Breaker: Arranged to electrically isolate the variable-speed controller to permit safe trouble-shooting and testing of the controller, both energized and de-energized, while the motor is operating in the bypass mode.
6. Form C output contacts for run and fault conditions.
7. Terminal strip for N.C. safety shutdown contacts.
8. N.C. input for remote start/stop control in Auto mode.

R. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

S. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

T. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

U. Standard Displayed information, display shall be interchangeable for all VFDs installed:
1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).
8. Fault history with analytical data.

V. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

W. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.06 FINISH

A. Finish: Manufacturer's standard paint finish, applied to factory-assembled and -tested VFCs.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

C. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

D. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Harmonic Analysis: Obtain the electrical system one-line diagram from the contract document, provide a harmonic analysis demonstrating that the proposed VFDs (along with harmonic mitigation equipment provided) conform with IEEE 519.

3.03 SELECTION

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

B. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

C. Select horsepower rating of controllers to suit motor controlled.

3.04 INSTALLATION

A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

D. Install VFDs on concrete bases where indicated to be installed on the floor. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

E. VFD’s are not to be installed inside air handlers or air plenums due to the potentially high humidity or temperatures.

F. Install wiring between VFCs and remote devices according to Division 26 sections. Power and control wiring shall not be run in the same conduit, and shall follow manufacturer's recommendations.

G. Bundle, train, and support wiring in enclosures.

H. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

I. Install conduit and ground equipment in accordance with Division 26 sections.

3.05 ADJUSTING

A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Reports: Prepare written reports certified by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made. Harmonic compliance shall be verified with on-site field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

C. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:
1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Prepare written reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.07 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain air handling units.
1. Train Board's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining the equipment. The training will occur after the startup report has been provided to the Board and the trainer will provide two (2) Installation and Operations manuals for the use of the Board's personnel during training.
2. Review data in maintenance manuals. Refer to Section 01 78 00 - Closeout Submittals. All required and recommended maintenance will be reviewed as well as operational

troubleshooting. If the IOM does not include a written troubleshooting guide one shall be provided.

3. Schedule training with Board, through Architect/Engineer of Record, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or Board's designated personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Divisions 01 and 23 sections.

END OF SECTION 26 29 23

SECTION 26 43 00 (LNK)

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surge Protection devices for service entrance locations.

B. Surge protective devices for branch panelboard locations.

1.02 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

C. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment; 2005.

D. IEEE C62.41.1 - IEEE Standard Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (Reaffirmed 2008).

E. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits; 2002.

F. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

J. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

K. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect/Engineer of Record of any

conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Board's Representative or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect/Engineer of Record and Board's Representative not less than seven (7) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's/Engineer of Record and Board's Representative written permission.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
1. UL 1449.
2. UL 1283 (for Type 2 SPDs).

E. Field Quality Control Test Reports.
1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Board's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.06 QUALITY ASSURANCE

A. Comply with City of Chicago Building Code.

B. Comply with IEEE 1100, IEEE C62.41.1 and test devices according to IEEE C62.45.

C. Comply with UL 1449

D. Permanently affix surge ratings to the unit.

E. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

F. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
1. Manufacturer shall be certified ISO 9001 or 9002.

G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.08 FIELD CONDITIONS

A. Deliver SPD in original factory shipping cartons, with manufacturer's labels intact.

B. Store SPD indoors in clean, dry space, protected from weather, with uniform temperature and humidity to prevent condensation. Protect SPD from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle SPD in accordance with manufacturer's instructions and to avoid damage.

1.09 WARRANTY

A. See Section 01 78 23.1 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum ten (10) year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

D. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:
1. ABB/GE: www.geindustrial.com/#sle.
2. Advanced Protection Technologies, Inc (APT): www.aptsurge.com.

3. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com.
4. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com.
5. Cutler-Hammer, Inc.; Eaton Corporation: www.eaton.com.
6. LEA International: www.powerlogics.com/lea-international
7. Liebert Corporation; a division of Emerson: Emerson.com
8. Siemens: www.siemens.com

B. Factory-installed, Internally Mounted Surge Protective Devices:
1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
2. Delta Systems: L-G, L-L.
3. Single Split Phase Systems: L-N, L-G, N-G, L-L.
4. High Leg Delta Systems: L-N, L-G, N-G, L-L.

C. UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
2. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
3. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
4. 480V Delta System Voltage: Not more than 1,800 V for L-G mode and 3,000 V for L-L mode.

D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

E. Operating Frequency: 47 to 63 Hertz.

F. Integral OCPD for Suppression: The unit shall require the associated switchgear assembly to have an integral OCPD as a means of disconnecting the suppression/filter system for maintenance and/or test purposes without interruption of power to the facility's distribution system. The OCPD shall be 3-pole for three-phase applications and shall be padlockable.

G. Refer To Section 26 05 53 - Identification for Electrical Systems for labeling requirements.

H. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.

I. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:

1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

J. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
1. Switchboards: See Section 26 43 13 - Switchboards.
2. Panelboards: See Section 26 24 16 - Panelboards.

2.03 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 50 kA per mode/100 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 2,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

I. All primary transient path wiring shall be of a No, 6 AWG copper minimum or via bus bar of equivalent capacity to provide equal impedance interconnection between phased. No plug-in modules, components, or printed circuit boards shall be in use in surge carrying paths.

J. Diagnostics:
1. Protection Status Monitoring: Provide indicator lights to report the protection status.
2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

K. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

L. Integral disconnect switch when required by contract documents.

M. Voltage Protection Rating shall be in compliance with test and evaluation procedures described in UL 1449.

N. Nominal Discharge Current Rating: 10 kA minimum as determined by the actual Nominal Discharge Current test.

O. Fabrication using bolted compression lugs for internal wiring.

P. Redundant suppression circuits.

Q. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

R. The system protection modules shall contain an array of metal oxide varistors (MOV). The SPD shall be listed in accordance with UL 1449.

S. Provide visible status indicator mounted on the front of the panel or a glass window shall be installed on the enclosing cabinet to make indicators on the modules visible.

2.04 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and additional accessories:
1. LED indicator lights for reverse polarity and open outlet ground.
2. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
3. Close-coupled direct plug-in.
4. Rocker-type on-off switch, illuminated when in the on position.
5. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and No. 4.

B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.

C. Protection modes and UL 1449 VPR shall be as follows:
1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Installation shall be in accordance with the NEC 280 & 285 and Chicago Electrical Code.

C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

D. Provide conductors with minimum ampacity as indicated on the drawings, as required by the City of Chicago Electrical Code, and not letss than manufacturer's recommended minimum conductor size.

E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance. Installation of leads shall avoid sharp and unnecessary bends. Terminals shall be provided for all necessary power and ground connections.
   1. Where SPD cannot be mounted within five (5) feet of the panel at the service entrance, an internal SPD mounting shall be utilized.
   2. Where SPD cannot be mounted within eighteen (18) inches of the panelboard, an internal SPD mounting shall be utilized.

F. Install devices for panelboard and auxiliary panels with conductors or buses between SPD and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   1. Comply with manufacturer's written recommendation for conductor and circuit-breaker size for connecting SPD to distribution system. Match circuit-breaker size to conductor size. Coordinate with Drawings.
   2. Provide multipole, 30-A circuit breaker as a dedicated disconnect for SPD if mounted exterior to the switchboard or panelboard, unless otherwise indicated.
   3. Where SPD cannot be mounted within 18-inches of the panel, high performance, low impedance cable as recommended by the manufacturer may be provided to eliminate any potential degradation of voltage protection.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

I. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

J. System shall not require removal and replacement for warranty and/or other repairs. All internal component replacements shall be capable of being completed by a licensed electrician.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CONTRACTOR START UP AND REPORTING

A. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Do not energize or connect service entrance equipment, panelboards, control terminals or data terminals to their sources until surge protection devices are installed and connected.

C. Testing: Perform the following field tests and inspections and prepare test reports:
1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with manufacturer’s requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

D. Remove and replace malfunctioning units and retest as specified above.

3.05 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

B. Do not used compressed air for cleaning.

END OF SECTION 26 43 00

SECTION 26 43 00 (MEP)

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surge Protection devices for service entrance locations.

B. Surge protective devices for branch panelboard locations.

1.02 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.

B. SPD: Surge Protective Device.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

C. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment; 2005.

D. IEEE C62.41.1 - IEEE Standard Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (Reaffirmed 2008).

E. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits; 2002.

F. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

J. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

K. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect/Engineer of Record of any

conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Board's Representative or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect/Engineer of Record and Board's Representative not less than seven (7) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's/Engineer of Record and Board's Representative written permission.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
1. SPDs with EMI/RFI filter: Include noise attenuation performance.

C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.

D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
1. UL 1449.
2. UL 1283 (for Type 2 SPDs).

E. Field Quality Control Test Reports.
1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

F. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

H. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Board's name and registered with manufacturer.

I. Project Record Documents: Record actual connections and locations of surge protective devices.

1.06 QUALITY ASSURANCE

A. Comply with City of Chicago Building Code.

B. Comply with IEEE 1100, IEEE C62.41.1 and test devices according to IEEE C62.45.

C. Comply with UL 1449

D. Permanently affix surge ratings to the unit.

E. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

F. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
1. Manufacturer shall be certified ISO 9001 or 9002.

G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.08 FIELD CONDITIONS

A. Deliver SPD in original factory shipping cartons, with manufacturer's labels intact.

B. Store SPD indoors in clean, dry space, protected from weather, with uniform temperature and humidity to prevent condensation. Protect SPD from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle SPD in accordance with manufacturer's instructions and to avoid damage.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum ten (10) year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

D. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:
1. ABB/GE: www.geindustrial.com/#sle.
2. Advanced Protection Technologies, Inc (APT): www.aptsurge.com.

3. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com.
4. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com.
5. Cutler-Hammer, Inc.; Eaton Corporation: www.eaton.com.
6. LEA International: www.powerlogics.com/lea-international
7. Liebert Corporation; a division of Emerson: Emerson.com
8. Siemens: www.siemens.com

B. Factory-installed, Internally Mounted Surge Protective Devices:
1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.
2. Delta Systems: L-G, L-L.
3. Single Split Phase Systems: L-N, L-G, N-G, L-L.
4. High Leg Delta Systems: L-N, L-G, N-G, L-L.

C. UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
2. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
3. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
4. 480V Delta System Voltage: Not more than 1,800 V for L-G mode and 3,000 V for L-L mode.

D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

E. Operating Frequency: 47 to 63 Hertz.

F. Integral OCPD for Suppression: The unit shall require the associated switchgear assembly to have an integral OCPD as a means of disconnecting the suppression/filter system for maintenance and/or test purposes without interruption of power to the facility's distribution system. The OCPD shall be 3-pole for three-phase applications and shall be padlockable.

G. Refer To Section 26 05 53 - Identification for Electrical Systems for labeling requirements.

H. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.

I. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:

1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

J. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
1. Switchboards: See Section 26 43 13 - Switchboards.
2. Panelboards: See Section 26 24 16 - Panelboards.

2.03 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 50 kA per mode/100 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 2,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

I. All primary transient path wiring shall be of a No, 6 AWG copper minimum or via bus bar of equivalent capacity to provide equal impedance interconnection between phased. No plug-in modules, components, or printed circuit boards shall be in use in surge carrying paths.

J. Diagnostics:
1. Protection Status Monitoring: Provide indicator lights to report the protection status.
2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

K. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

L. Integral disconnect switch when required by contract documents.

M. Voltage Protection Rating shall be in compliance with test and evaluation procedures described in UL 1449.

N. Nominal Discharge Current Rating: 10 kA minimum as determined by the actual Nominal Discharge Current test.

O. Fabrication using bolted compression lugs for internal wiring.

P. Redundant suppression circuits.

Q. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

R. The system protection modules shall contain an array of metal oxide varistors (MOV). The SPD shall be listed in accordance with UL 1449.

S. Provide visible status indicator mounted on the front of the panel or a glass window shall be installed on the enclosing cabinet to make indicators on the modules visible.

2.04 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and additional accessories:
1. LED indicator lights for reverse polarity and open outlet ground.
2. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
3. Close-coupled direct plug-in.
4. Rocker-type on-off switch, illuminated when in the on position.
5. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and No. 4.

B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.

C. Protection modes and UL 1449 VPR shall be as follows:
1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Installation shall be in accordance with the NEC 280 & 285 and Chicago Electrical Code.

C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.

D. Provide conductors with minimum ampacity as indicated on the drawings, as required by the City of Chicago Electrical Code, and not letss than manufacturer's recommended minimum conductor size.

E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance. Installation of leads shall avoid sharp and unnecessary bends. Terminals shall be provided for all necessary power and ground connections.
   1. Where SPD cannot be mounted within five (5) feet of the panel at the service entrance, an internal SPD mounting shall be utilized.
   2. Where SPD cannot be mounted within eighteen (18) inches of the panelboard, an internal SPD mounting shall be utilized.

F. Install devices for panelboard and auxiliary panels with conductors or buses between SPD and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
   1. Comply with manufacturer's written recommendation for conductor and circuit-breaker size for connecting SPD to distribution system. Match circuit-breaker size to conductor size. Coordinate with Drawings.
   2. Provide multipole, 30-A circuit breaker as a dedicated disconnect for SPD if mounted exterior to the switchboard or panelboard, unless otherwise indicated.
   3. Where SPD cannot be mounted within 18-inches of the panel, high performance, low impedance cable as recommended by the manufacturer may be provided to eliminate any potential degradation of voltage protection.

G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

I. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

J. System shall not require removal and replacement for warranty and/or other repairs. All internal component replacements shall be capable of being completed by a licensed electrician.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

D. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CONTRACTOR START UP AND REPORTING

A. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Do not energize or connect service entrance equipment, panelboards, control terminals or data terminals to their sources until surge protection devices are installed and connected.

C. Testing: Perform the following field tests and inspections and prepare test reports:
1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with manufacturer’s requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

D. Remove and replace malfunctioning units and retest as specified above.

3.05 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

B. Do not used compressed air for cleaning.

END OF SECTION 26 43 00

SECTION 26 51 00 (LNK)
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Drivers.
E. Lamps.
F. Accessories.

1.02 REFERENCE STANDARDS

A. ANSI C78.379 - Classification of the Beam Patterns of Reflector Lamps 2015.
B. ANSI C82.1 - American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts 2004 (R2015).
C. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements 2017.
D. ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment 2002.
E. ANSI C82.SSL1 - SSL Drivers Current.
F. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
G. ASTM D788 - Standard Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds 2016.
H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
I. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
J. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments 2017.
K. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information 2002 (Reaffirmed 2008).
L. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products 2008.
M. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules 2015, with Errata (2017).
N. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
O. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems 2006.
P. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
Q. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts 2016.
R. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012.
S. NEMA LE 5 - Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires 2001.
T. NEMA LE 5A - Procedure for Determining Luminaire Efficacy Ratings for Commercial, Non-Residential Downlight Luminaires 1999.
U. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
V. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
W. UL 844 - Luminaires for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.
X. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.
Y. UL 1598 - Luminaires Current Edition, Including All Revisions.

Z. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.03 SYSTEM DESCRIPTION

A. The interior lighting system shall include all lighting fixtures, LED modules, switches, mounting, wiring, control equipment, and accessories required for complete system, whether or not they are indicated or specified, as indicated in the Drawings and as specified.

B. The luminaire schedules in the Drawings indicate manufacturer, fixture design, appearance and performance desired.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Provide separate submittal product data/shop drawings for each fixture type clearly indicating the fixture type designation used in the Drawings and all pertinent options and accessories. Do not group similar fixture types together on a single cut sheet. Submittals that do not indicate option data where multiple selections exist will be returned without being reviewed.

C. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. For custom, non-standard, and continuous row / length luminaires. Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Wiring Diagrams: For power, signal, and control wiring.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
    a. Include estimated useful life, calculated based on IES LM-80 test data.
    b. Include IES LM-79 test report upon request.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
3. LED Drivers: Include information as to input watts. Indicate mounting distance limitation and standard wire sizes for remote drivers, indicate dimming type and range.
4. LED modules: per luminaire tag, including life, lumen output, correlated color temperature (CC), color rendering index (CRI) and energy-efficiency data.
5. Battery and charger information for emergency lighting units.
6. Remote Drivers: Indicate mounting distance limitation and standard wire sizes for remote drivers/transformers.
7. Efficiency Data: Provide both lumen performance efficiency and luminaire efficiency rating (LER).
8. Special Warranty: Provide documentation of compliance with special warranties as part of the product data.

E. Certification of Compatibility: Submit a written statement, signed by the Contractor, Installer, and Controls Manufacturers, certifying the power supplies and drivers, automatic lighting control devices, including occupancy sensors and daylight harvesting controls, and related components being supplied for the Project are compatible equipment. Statement shall

include that system components do not compromise the proper operation, or the design criterion, of the supplied power supplies, drivers, and automatic control devices.

F. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
   1. Include DOE "Lighting Facts" Information
   2. Include DLC listing status.
   3. Include Efficacy information.

G. Field quality control reports (by contractor).

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Operation and Maintenance Manuals: Provide a collection of manufacturer recommended maintenance practices for each lighting fixture type. Including the following:
   1. Tools required.
   2. Acceptable cleaners and recommended cleaning practices.
   3. Replacement parts list.
   4. Dates of installation.
   5. Replacement parts order information.
   6. LED module and driver re-ordering information and replacement schedule.
   7. Contact information for manufacturer's service department or qualified service agencies.
   8. Submittal data.
   9. Operation data.
   10. Intended operation narrative.
   11. Disposal information.

J. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components within thirty (30) days of date of Preliminary Acceptance.

K. Re-Commissioning Data: Submit manual containing all information required for re-commissioning of the installations.
   1. Submit two (2) copies of manual within thirty (30) days of date of Preliminary Acceptance.
   2. Submit re-commissioning manuals in heavy-duty, 3-ring binders.

1.05 QUALITY ASSURANCE

A. Comply with City of Chicago Building Code.

B. Comply with EPA, State of Illinois, and City of Chicago regulations for proper recycling or disposal of existing lamps and ballasts removed from the Site.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the ANSI/IEEE 802.7 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Commissioning: When required for the Project, Contractor shall assign representative(s) with expertise and authority to act on its behalf. The representative(s) shall perform commissioning activities including, but not limited to, the following:
   1. Review submittals relative to interior lighting systems being commissioned.

G. Sample Installations: Before installing lighting fixtures, install sample installations for each type of light fixture indicated or required by Architect/Engineer of Record or Board's Representative. Sample installations shall be used to verify selections made on submittals and to demonstrate aesthetic affects and qualities of materials and workmanship. Install

sample installations to comply with the following requirements, using materials indicated for the completed work:

1. Each sample installation shall include not less than two (2) light fixtures.
   a. Where light fixtures are indicated to be installed in a continuous row, sample installation shall include all fixtures in the row.
2. Install each sample installation in the location indicated or as directed by Architect/Engineer of Record.
3. Each sample installation shall include all accessories and components necessary for a complete installation.
4. Obtain Architect/Engineer of Record's approval of sample installations before proceeding with installation of lighting fixtures.
5. Maintain sample installations during installation in an undisturbed condition as a standard for judging the completed work.
6. Approved sample installations may become part of the completed work if undisturbed at time of Preliminary Acceptance.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.
C. Protect luminaires, lamps, and accessories during transit, delivery, storage, and handling to prevent damage.
D. Deliver luminaires to the Site factory-assembled and wired to the greatest extent possible and in accordance with approved submittals.
E. Store luminaires and accessories in accordance with manufacturer's instructions in a clean, dry location, protected from weather and away from dust generating construction activities. As required, cover materials with tarpaulin or polyethylene sheeting in a manner that allows air circulation and prevents condensation beneath the covering.
F. Keep handling on site to a minimum. Exercise particular care to avoid damage to exposed finishes and materials.

1.07 COORDINATION

A. Verify locations of light fixtures indicated in Drawings and coordinate with other reference data and materials as required prior to installation to ensure locations will not interfere with other work. Verify space above luminaires and confirm non-interference with other equipment, such as ducts, pipes, conduit and cabling, and openings. Alert Architect/Engineer of Record and Board's Representative in writing to non-standard modifications required for compliance with the Contract Documents and for installation to coordinate with ceiling system before proceeding with the work.
B. Verify dimensions. Where discrepancies are found within the Contract Documents, or additional information is required, immediately contact Architect/Engineer of Record for clarifications and additional information.
C. Coordinate installation of lighting system with other trades to prevent delays in the work and to ensure the lighting fixtures and supports will not be damaged by subsequent construction operations
D. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
E. Coordinate the placement of luminaires (and luminaire suspensions systems) with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

F. Coordinate the placement of exit signs with soffits, changes in ceiling heights, furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
G. Coordinate installation of lighting fixtures indicated to extend in continuous, wall to wall installation. Provide field, or established, dimensions to luminaire manufacturer in sufficient time so not to cause delays in the work.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 EXTRA MATERIALS:

A. See Section 01 60 00 - Product Requirements, for additional provisions.
B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage an identified with labels describing contents. Provide a manifest of all extra materials provided.
C. Extra Lenses and Louvers: Ten (10) percent of total quantity installed for each type, but not less than one (1) of each type.
    1. Extra LED Modules: One (1) for every hundred (100) of each type and rating installed. Furnish as least two (2) of each type.
    2. Extra Lamps: Ten (10) percent of total quantity installed for each type, but not less than two (2) of each type.
    3. Extra Drivers: One (1) percent of total quantity installed for each type, but not less than one (1) of each type.
    4. Battery and Charger Data: One (1) for each emergency lighting unit.
    5. Globes and Guards: One (1) for every twenty (20) (5 percent) of each type and rating installed, but not less than one (1) of each type.

1.10 WARRANTY

A. Special Warranty: Submit a written warranty, beginning from date of Preliminary Acceptance, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Failures shall include, but not be limited to, deterioration of metal finishes, failure of LED modules, or failure of LED drivers. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components. The first year of warranty labor shall be provided by the contractor. The second through fifth (2-5) years of warranty labor shall be covered by the manufacturer
    1. Warranty Period for LED Luminaires, including LED modules, LED boards, chips, and drivers:: Five (5) years from date of Preliminary Acceptance.
    2. Warranty Period for Metal Finishes: Five (5) years from date of Preliminary Acceptance.
B. Special Warranty for Emergency Lighting Batteries: Submit a written warranty, beginning from date of Preliminary Acceptance, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components. The first year of warranty labor shall be provided by the contractor. The second through fifth (2-5) years of warranty labor shall be covered by the manufacturer.
    1. Warranty Period for Emergency Lighting Unit Batteries: Five (5) years from date of Preliminary Acceptance. Full warranty shall apply for first year, and prorated warranty for the remaining four (4)years.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Provide for proper recycling or disposal of existing lamps and ballasts removed from the site in accordance with EPA and State of Illinois regulations.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Manufacturers - Accessories: Subject to compliance with requirements, provide products by one of the manufacturers listed within the luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Product Description: Provide complete luminaire assemblies with features, options and accessories as scheduled and required for complete assembly, whether specified or not.

B. Provide fixtures constructed, wired, and installed in compliance with appropriate UL standards and applicable codes. Provide fixtures that are listed by UL for the applications and locations where they are shown. Provide all products with UL label.

1. Provide products that are listed and labeled as complying with UL 1598, where applicable. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Verify and provide luminaires that are appropriate for the mounting conditions and in accordance with the City of Chicago Electrical Code.

D. All fixture components must operate within the temperature limits of their design .

E. Provide products that are listed and labeled as complying with UL 1598, where applicable. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Provide products complying with Federal Energy Management Program (FEMP) requirements.

H. Unless otherwise indicated, provide complete luminaires including LED modules, LED boards, drivers, reflectors, lenses, housings and other components required to position, energize and protect the light source and distribute the light.

I. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

J. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

K. Provide specification grade products only.

L. Luminaire Coatings and Finishes:

1. Luminaire surfaces, components, trim, and housing shall be factory pre-treated, rustproof, primed and otherwise prepared to inhibit rust and corrosion. Exposed luminaire surfaces shall be factory pre-treated, primed and finish coated with a suitable rust and corrosion inhibiting product.
2. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   a. White Surfaces: 85 percent.
   b. Specular Surfaces: 83 percent.
   c. Diffusing Specular Surfaces: 75 percent.
   d. Laminated Silver Metallized Film: 90 percent.
3. Luminaries shall receive manufacturer's standard finish, unless otherwise indicated. Color shall be as indicated or, if not indicated, as selected by Architect/Engineer of Record from manufacturer's standard range.
4. Exposed finish shall be free of streaks, runs, holidays, stains, blisters, and similar defects.
5. Metal Parts: Free of burrs and sharp corners and edges.
6. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

M. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless otherwise is indicated.
      b. UV stabilized.
   2. Glass globes, diffusers and lenses shall be fabricated from annealed crystal glass, or tempered glass, unless otherwise indicated.
   3. Destaticize all panels at the factory prior to shipping.

N. Louvers:
   1. Provide louvers or baffles fabricated from aluminum reflector sheet free of marks including mars and indentations caused by fabrication and assembly techniques. No rivets, springs, or other hardware shall be visible after installation. Plastic louvers are not permitted.
   2. Provide non-iridescent type louvers for fixtures.
   3. Provide louvers and baffles that are polished, buffed, and anodized.

O. Reflectors and Trims:
   1. Attach non-permanently affixed reflectors to housing by means of safety chains or spring clips, to prevent reflectors from falling. No part of the clip or chain shall be visible after installation, when viewed from any angle up to 45 degrees from horizontal.
   2. Aluminum Reflectors:
      a. Provide reflectors and reflecting cones fabricated from aluminum reflector sheet free of marks including spinning lines, mars, and indentations caused by fabrication and assembly techniques. No rivets, springs, or other hardware shall be visible after installation. Provide only reflectors free from blemishes, scratches, or indentations.
      b. Provide reflectors that are polished, buffed, and anodized.
      c. Provide non-iridescent type louvers for fixtures.
      d. Provide polished self-flanged trim cones, color finish shall match that of the cone.
   3. Painted Reflectors: Completely formed before application of primer and paint. Minimum of 87 percent reflectance white.

P. Recessed Luminaires:
   1. Ceiling Compatibility: Comply with NEMA LE 4.
   2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
   3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

Q. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
   4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts "label indicating their specific performance characteristics, tested and reported in accordance with the requirements of the most current version of IES LM-79.
   5. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA -C78.377.
   6. LEDs shall be binned within a maximum 3-step MacAdam Ellipse.
   7. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.

R. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

S. Fixture Support Components: Comply with Section 26 05 29 - Hangers and Supports for Electrical Systems.
   1. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish shall be the same as the fixture.
   2. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish shall be the same as the fixture.
   3. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
   4. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord and locking-type plug.

T. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position.

U. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging. Free of burrs and sharp corners and edges.

2.03 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101and the Chicago Electrical Code, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
   1. Sealed maintenance-free nickel cadmium unless otherwise indicated.
   2. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Charger: Fully automatic, solid-state type with sealed transfer relay.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low-voltage disconnect to prevent battery damage from deep discharge.

G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

H. Provide units with integral time delay to maintain emergency illumination for 15 minutes after restoration of normal power source.

I. Accessories:
   1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
   2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   3. Provide compatible accessory wire guards.
      a. Heavy-chrome-plated wire guard protects lamp heads or fixtures.
      b. Provide wire guard at gymnasium, gym/cafeteria/assembly area, cafeteria, locker rooms, weight rooms, and in other locations as indicated.
   4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 EXIT SIGNS

A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101and the Chicago Electrical Code for sign colors, visibility, luminance, and lettering size, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single- or double-face as indicated or as required for installed location.

2. Directional Arrows: As indicated or as required for installed location.
3. AOR Face: Provide Area of Rescue style face where required per plans.
4. Colors: red letters on white background.

B. Self-Powered Exit Signs:
1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
2. Battery: Sealed, maintenance-free, nickel cadmium unless otherwise indicated.
3. Charger: Fully automatic, solid-state, constant current type with integral sealed transfer relay.
4. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
5. Provide low-voltage disconnect to prevent battery damage from deep discharge.
6. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
7. Low Battery Disconnect: Provide a device and/or related circuitry that shall automatically disconnect the battery and protect it from deep/over discharge.
8. Shall consume 5 watts of AC power, or less, per face under normal operating conditions.

C. AC-Powered Exit Signs
1. Lamps for AC Operation: LED's, 70,000 hours minimum rated lamp life.
2. Shall consume 5 watts of AC power, or less, per face under normal operating conditions.

D. Accessories:
1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

E. Accessories:
1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

2.05 DRIVERS

A. Manufacturers:
1. Advance
2. Cree
3. EldoLED
4. Enlighted
5. General Electric Company/GE Lighting: www.gelighting.com/#sle.
6. Lutron Electronics Company, Inc; www.lutron.com/#sle.
7. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
8. Philips Lighting North America Corporation; www.usa.lighting.philips.com/#sle.
9. Thomas Research Products
10. Manufacturer Limitations: Where possible, for each type of luminaire provide drivers produced by a single manufacturer.
11. Where a specific manufacturer or model of driver is indicated elsewhere, such as in the luminaire schedule or on the drawings, substitutions for that specific driver are not permitted unless explicitly indicated.

B. Drivers - General Requirements:

1. Electronic Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
2. Drivers and power supplies shall be provided in accordance with the requirements of ANSI C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI C82.77.
3. Drivers shall have internal surge protection to protect each fixture. Each fixture shall be capable of being readily disconnected from the circuit.
4. Provide UL listed and labeled drivers. Provide drivers with temperature ratings appropriate to the installation.
5. Fixtures intended to be dimmed shall have dimming capable drivers and be compatible with the specified dimmer controls.

C. LED Drivers - Specific Requirements:
1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fixtures intended to be dimmed shall have dimming driver fully compatible with the dimming controls to be installed.
3. LED drivers shall be factory provided by the respective luminaire manufacturers, and shall be suitable for their intended use, to operate the designated LED modules listed in the Luminaire Schedule, and as specified herein, to their full light output.
4. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
5. Provide identical drivers within each luminaire type.
6. Provide complete connection to LED type luminaires through both integrally installed and remote electronic drivers.
7. Drivers shall be totally enclosed within a metallic enclosure, and shall be provided with integral leads color coded per ANSI Standards or with poke-in style wire retaining connectors.
8. Surge Tolerance: Capable of withstanding characteristic surges, 10,000 aic minimum.
9. Remote Drivers:
   a. Remote drivers are specifically not shown on the drawings. Contractor shall install remote drivers in a readily accessible, dry, indoor, concealed location, in accordance with the manufacturer's instructions.
   b. Provide ventilated metal enclosures for remote drivers furnished as loose equipment. All wiring to/from remote drivers and their associated LED luminaires shall be installed in conduit.
   c. Metal Enclosures shall be Chicago Plenum Rated
   d. Verify and comply with remote distance limitations specified by the luminaire/driver manufacturer.

2.06 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2 inch size, factory finished to match luminaire or field-painted as directed.
B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4 inch size, field-painted as directed.
C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

D. Lenses:
1. Source Limitations: Fixture lenses shall be provided by the light fixture manufacturer.

2. Construct acrylic lenses, diffusers, covers, and globes of 100 percent virgin acrylic injection-molded plastic complying with ASTM D788. Polystyrene lenses are not acceptable.
3. All plastic shall be highly resistant to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation.
4. Destaticize all panels at the factory prior to shipping.
5. Lens Patterns:
   a. Pattern 12 Lens: Pattern 12 lens shall be not less than 0.125-inch thick (overall panel thickness), with inverted conical prisms, in straight flat-sided prism shape, configured on 45-degree axis layout across the entire panel.
   b. Pattern 19 Lens: Pattern 19 lens shall be not less than 0.156-inch thick (overall panel thickness), with inverted conical prisms, in straight flat-sided prism shape, configured on parallel/perpendicular 90-degree axis layout across the entire panel. Provide pattern 19 lenses in kitchens, serveries, locker rooms, and toilet rooms.

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 29 - Hangers and Supports for Electrical Systems for channel-supports.
B. Single-Stem Hangers: 1/2-inchsteel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.0808-inch (12 gage) minimum diameter.
D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that lighting fixture back-boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with City of Chicago Electrical Code.
C. Verify that suitable support frames are installed where required.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring lighting fixture back-boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from lighting fixture back-boxes.
C. Removal of Existing Luminaires: Disconnect and remove abandoned luminaires, including lamps and accessories, and luminaires indicated to be removed. Remove abandoned wiring in accordance with requirements of authorities having jurisdiction.
D. Removal and Reinstallation of Existing Luminaires: Carefully remove luminaires from existing locations and store as required for new luminaires. Reinstall luminaires as indicated and as specified.
   1. Prior to reinstallation, luminaires shall be cleaned and repaired, including installation of new wiring, ballast(s) and lamps; replacement of broken, damaged, or faulty lamp sockets; replacement of broken or damaged lenses; replacement of faulty or nonfunctioning lamps; and damp cleaning of lens and interior of luminaires.
E. Existing Luminaires to Remain: Clean existing luminaires, lamps and accessories, indicated to remain. Make repairs to existing luminaires as required to make fully functional, including installation of new wiring, ballast(s) and lamps, and to aesthetically match newly installed luminaires of same type in same space, if any.
F. Extend existing installation using materials and methods specified.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of luminaires provided under this section.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install products in accordance with manufacturer's instructions.
D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
E. Provide required support and attachment in accordance with Section 26 05 29.
F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
G. Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.
H. Suspended Ceiling Mounted Luminaires:
    1. Do not use ceiling tiles to bear weight of luminaires.
    2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
    3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
    4. Secure pendant-mounted luminaires to building structure.
    5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
    6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
    7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
I. Recessed Luminaires:
    1. Install trims tight to mounting surface with no visible light leakage.
    2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
    3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
    4. Support for Luminaires in Lay-in/Accessible Ceilings: Use grid as a support element.
        a. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6-inchesfrom lighting fixture corners.
        b. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
        c. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
        d. Install at least two (2) independent support rods or wires from structure above to the light fixture housing. Supports shall be installed on opposite (diagonal) corners. Wires or rods shall be capable of supporting, without failure, a load equal to three times the weight of the light fixture.
J. Suspended Luminaires:
    1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
    2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
    3. Install canopies tight to mounting surface.
    4. Suspended Lighting Fixture Support:
        a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
        b. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
        c. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

K. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
L. Install accessories furnished with each luminaire.
M. Bond products and metal accessories to branch circuit equipment grounding conductor.
N. Emergency Lighting Units:
    1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
    2. Install lock-on device on branch circuit breaker serving units.
O. Exit Signs:
    1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
    2. Install lock-on device on branch circuit breaker serving units.
P. Identify luminaires connected to emergency power system and install labels with panel and circuit numbers on concealed junction and outlet boxes in accordance with Section 26 05 53 - Identification for Electrical Systems.
Q. Install lamps in each luminaire.
    1. Provide all lamps needed for all fixtures, including replacements for extinguished or defective lamps, until Final Acceptance. Replace lamps used in fixtures during construction prior to Final Acceptance.
    2. Install lamps according to manufacturer's instructions.
R. Adjust aimable lighting fixtures as required to provide required light intensities.
S. Adjust aimable heads of emergency lighting units as required to provide required light intensities along egress paths.
T. Connections:
    1. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
    2. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to their manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.
U. Lenses, Louvers and Reflectors:
    1. Exercise particular care when installing fixtures and lamps in fixtures with specular reflector material to prevent smudging or damaging the reflector surface. Wear clean gloves as recommended by the fixture manufacturer.
    2. Do not install removable reflectors, louvers, diffusers, and decorative elements of lighting fixtures until completion of wet work, plastering, painting and general cleanup in the area of the fixtures, but not more than three days before date scheduled for inspections that establish date of Preliminary Acceptance.
V. Accessibility: Install equipment such as junction and pull boxes, fixture housings, transformers, remote drivers, switches and controls, and other apparatus that requires occasional maintenance to be accessible and appropriate for mounting and ceiling conditions.
W. Install fixtures in mechanical areas after ductwork and piping installation. Locate and mount fixtures as indicated on Drawings unless mechanical equipment prohibits or makes it impractical to do so. In such cases, chain or wall mount fixtures so that serviceable equipment is illuminated.
X. Locate recessed ceiling luminaires as indicated on Drawings. Mount fixtures at heights and locations indicated. Where heights are not indicated or conflicts exist, coordinate final locations with Architect/Engineer of Record.

Y. In mechanical fan housings, locate fixtures so as not to interfere with belts, filters, and similar items.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each product for damage and defects.
C. Operate each luminaire after installation and connection to verify proper operation.
D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply. Verify transfer from normal power to emergency power and retransfer to normal. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly. Note and record the following:
   1. Duration of supply.
   2. Low battery voltage shutdown.
   3. Normal transfer to battery source and retransfer to normal.
   4. Low supply voltage transfer.
E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Architect/Engineer of Record.

3.05 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 - Identification for Electrical Systems.

3.06 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect/Engineer of Record. Secure locking fittings in place.
B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect/Engineer of Record or authority having jurisdiction.
C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect/Engineer of Record or authority having jurisdiction.
D. After system checkout and adjustment, operate the system for the review of the Board and Architect/Engineer of Record. Make adjustments or modifications as required by the Board or Architect/Engineer of Record.

3.07 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.08 CLOSEOUT ACTIVITIES

A. See Section 01 78 23.1 - Closeout Submittals, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Training: Perform on-site training of Board's personnel on operation, adjustment, and maintenance of interior lighting. Training shall last a minimum of 4 hours and at the end of the session, the Board's maintenance personnel shall be thoroughly instructed in the proper operation of the system.
D. Demonstration: Demonstrate proper operation of luminaires to Architect/Engineer of Record, and correct deficiencies or make adjustments as directed.
E. Just prior to Preliminary Acceptance, replace all lamps that have failed.

3.09 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 51 00 (MEP)
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.
B. Exit signs.
C. Drivers.
D. Lamps.
E. Accessories.

1.02 REFERENCE STANDARDS

A. ANSI C78.379 - Classification of the Beam Patterns of Reflector Lamps 2015.
B. ANSI C82.1 - American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts 2004 (R2015).
C. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements 2017.
D. ANSI C82.77 - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment 2002.
E. ANSI C82.SSL1 - SSL Drivers Current.
F. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
G. ASTM D788 - Standard Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds 2016.
H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
I. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
J. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments 2017.
K. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information 2002 (Reaffirmed 2008).
L. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products 2008.
M. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules 2015, with Errata (2017).
N. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
O. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems 2006.
P. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
Q. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts 2016.
R. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012.
S. NEMA LE 5 - Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires 2001.
T. NEMA LE 5A - Procedure for Determining Luminaire Efficacy Ratings for Commercial, Non-Residential Downlight Luminaires 1999.
U. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
V. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
W. UL 844 - Luminaires for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.
X. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.
Y. UL 1598 - Luminaires Current Edition, Including All Revisions.

Z. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.03 SYSTEM DESCRIPTION

A. The interior lighting system shall include all lighting fixtures, LED modules, switches, mounting, wiring, control equipment, and accessories required for complete system, whether or not they are indicated or specified, as indicated in the Drawings and as specified.

B. The luminaire schedules in the Drawings indicate manufacturer, fixture design, appearance and performance desired.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Provide separate submittal product data/shop drawings for each fixture type clearly indicating the fixture type designation used in the Drawings and all pertinent options and accessories. Do not group similar fixture types together on a single cut sheet. Submittals that do not indicate option data where multiple selections exist will be returned without being reviewed.

C. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. For custom, non-standard, and continuous row / length luminaires. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
   a. Include estimated useful life, calculated based on IES LM-80 test data.
   b. Include IES LM-79 test report upon request.
2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
3. LED Drivers: Include information as to input watts. Indicate mounting distance limitation and standard wire sizes for remote drivers, indicate dimming type and range.
4. LED modules: per luminaire tag, including life, lumen output, correlated color temperature (CC), color rendering index (CRI) and energy-efficiency data.
5. Remote Drivers: Indicate mounting distance limitation and standard wire sizes for remote drivers/transformers.
6. Efficiency Data: Provide both lumen performance efficiency and luminaire efficiency rating (LER).
7. Special Warranty: Provide documentation of compliance with special warranties as part of the product data.

E. Certification of Compatibility: Submit a written statement, signed by the Contractor, Installer, and Controls Manufacturers, certifying the power supplies and drivers, automatic lighting control devices, including occupancy sensors and daylight harvesting controls, and related components being supplied for the Project are compatible equipment. Statement shall include that system components do not compromise the proper operation, or the design criterion, of the supplied power supplies, drivers, and automatic control devices.

F. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
   1. Include DOE "Lighting Facts" Information
   2. Include DLC listing status.
   3. Include Efficacy information.

G. Field quality control reports (by contractor).

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Operation and Maintenance Manuals: Provide a collection of manufacturer recommended maintenance practices for each lighting fixture type. Including the following:
   1. Tools required.
   2. Acceptable cleaners and recommended cleaning practices.
   3. Replacement parts list.
   4. Dates of installation.
   5. Replacement parts order information.
   6. LED module and driver re-ordering information and replacement schedule.
   7. Contact information for manufacturer's service department or qualified service agencies.
   8. Submittal data.
   9. Operation data.
   10. Intended operation narrative.
   11. Disposal information.

J. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components within thirty (30) days of date of Preliminary Acceptance.

K. Re-Commissioning Data: Submit manual containing all information required for re-commissioning of the installations.
   1. Submit two (2) copies of manual within thirty (30) days of date of Preliminary Acceptance.
   2. Submit re-commissioning manuals in heavy-duty, 3-ring binders. Submit manuals in accordance with Section 01 78 00 - Closeout Submittals.

1.05 QUALITY ASSURANCE

A. Comply with City of Chicago Building Code.

B. Comply with EPA, State of Illinois, and City of Chicago regulations for proper recycling or disposal of existing lamps and ballasts removed from the Site.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the ANSI/IEEE 802.7 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Commissioning: When required for the Project, Contractor shall assign representative(s) with expertise and authority to act on its behalf. The representative(s) shall perform commissioning activities including, but not limited to, the following:
   1. Review submittals relative to interior lighting systems being commissioned.

G. Sample Installations: Before installing lighting fixtures, install sample installations for each type of light fixture indicated or required by Architect/Engineer of Record or Board's Representative. Sample installations shall be used to verify selections made on submittals and to demonstrate aesthetic affects and qualities of materials and workmanship. Install sample installations to comply with the following requirements, using materials indicated for the completed work:

1. Each sample installation shall include not less than two (2) light fixtures.
   a. Where light fixtures are indicated to be installed in a continuous row, sample installation shall include all fixtures in the row.
2. Install each sample installation in the location indicated or as directed by Architect/Engineer of Record.
3. Each sample installation shall include all accessories and components necessary for a complete installation.
4. Obtain Architect/Engineer of Record's approval of sample installations before proceeding with installation of lighting fixtures.
5. Maintain sample installations during installation in an undisturbed condition as a standard for judging the completed work.
6. Approved sample installations may become part of the completed work if undisturbed at time of Preliminary Acceptance.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.
C. Protect luminaires, lamps, and accessories during transit, delivery, storage, and handling to prevent damage.
D. Deliver luminaires to the Site factory-assembled and wired to the greatest extent possible and in accordance with approved submittals.
E. Store luminaires and accessories in accordance with manufacturer's instructions in a clean, dry location, protected from weather and away from dust generating construction activities. As required, cover materials with tarpaulin or polyethylene sheeting in a manner that allows air circulation and prevents condensation beneath the covering.
F. Keep handling on site to a minimum. Exercise particular care to avoid damage to exposed finishes and materials.

1.07 COORDINATION

A. Verify locations of light fixtures indicated in Drawings and coordinate with other reference data and materials as required prior to installation to ensure locations will not interfere with other work. Verify space above luminaires and confirm non-interference with other equipment, such as ducts, pipes, conduit and cabling, and openings. Alert Architect/Engineer of Record and Board's Representative in writing to non-standard modifications required for compliance with the Contract Documents and for installation to coordinate with ceiling system before proceeding with the work.
B. Verify dimensions. Where discrepancies are found within the Contract Documents, or additional information is required, immediately contact Architect/Engineer of Record for clarifications and additional information.
C. Coordinate installation of lighting system with other trades to prevent delays in the work and to ensure the lighting fixtures and supports will not be damaged by subsequent construction operations
D. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
E. Coordinate the placement of luminaires (and luminaire suspensions systems) with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
F. Coordinate the placement of exit signs with soffits, changes in ceiling heights, furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.

G. Coordinate installation of lighting fixtures indicated to extend in continuous, wall to wall installation. Provide field, or established, dimensions to luminaire manufacturer in sufficient time so not to cause delays in the work.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 EXTRA MATERIALS:

A. See Section 01 60 00 - Product Requirements, for additional provisions.

B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage an identified with labels describing contents. Provide a manifest of all extra materials provided.

C. Extra Lenses and Louvers: Ten (10) percent of total quantity installed for each type, but not less than one (1) of each type.

1. Extra LED Modules: One (1) for every hundred (100) of each type and rating installed. Furnish as least two (2) of each type.
2. Extra Drivers: One (1) percent of total quantity installed for each type, but not less than one (1) of each type.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Special Warranty: Submit a written warranty, beginning from date of Preliminary Acceptance, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Failures shall include, but not be limited to, deterioration of metal finishes, failure of LED modules, or failure of LED drivers. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components. The first year of warranty labor shall be provided by the contractor. The second through fifth (2-5) years of warranty labor shall be covered by the manufacturer

1. Warranty Period for LED Luminaires, including LED modules, LED boards, chips, and drivers:: Five (5) years from date of Preliminary Acceptance.
2. Warranty Period for Metal Finishes: Five (5) years from date of Preliminary Acceptance.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Provide for proper recycling or disposal of existing lamps and ballasts removed from the site in accordance with EPA and State of Illinois regulations in accordance with Section 02 86 13 Hazardous and Universal Waste Management.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Manufacturers - Accessories: Subject to compliance with requirements, provide products by one of the manufacturers listed within the luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Product Description: Provide complete luminaire assemblies with features, options and accessories as scheduled and required for complete assembly, whether specified or not.

B. Provide fixtures constructed, wired, and installed in compliance with appropriate UL standards and applicable codes. Provide fixtures that are listed by UL for the applications and locations where they are shown. Provide all products with UL label.

1. Provide products that are listed and labeled as complying with UL 1598, where applicable. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Verify and provide luminaires that are appropriate for the mounting conditions and in accordance with the City of Chicago Electrical Code.

D. All fixture components must operate within the temperature limits of their design .
E. Provide products that are listed and labeled as complying with UL 1598, where applicable. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
F. Provide products listed, classified, and labeled as suitable for the purpose intended.
G. Provide products complying with Federal Energy Management Program (FEMP) requirements.
H. Unless otherwise indicated, provide complete luminaires including LED modules, LED boards, drivers, reflectors, lenses, housings and other components required to position, energize and protect the light source and distribute the light.
I. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
J. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
K. Provide specification grade products only.
L. Luminaire Coatings and Finishes:
    1. Luminaire surfaces, components, trim, and housing shall be factory pre-treated, rustproof, primed and otherwise prepared to inhibit rust and corrosion. Exposed luminaire surfaces shall be factory pre-treated, primed and finish coated with a suitable rust and corrosion inhibiting product.
    2. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
        a. White Surfaces: 85 percent.
        b. Specular Surfaces: 83 percent.
        c. Diffusing Specular Surfaces: 75 percent.
        d. Laminated Silver Metallized Film: 90 percent.
    3. Luminaries shall receive manufacturer's standard finish, unless otherwise indicated. Color shall be as indicated or, if not indicated, as selected by Architect/Engineer of Record from manufacturer's standard range.
    4. Exposed finish shall be free of streaks, runs, holidays, stains, blisters, and similar defects.
    5. Metal Parts: Free of burrs and sharp corners and edges.
    6. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
M. Diffusers and Globes:
    1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
        a. Lens Thickness: At least 0.125 inch minimum unless otherwise is indicated.
        b. UV stabilized.
    2. Glass globes, diffusers and lenses shall be fabricated from annealed crystal glass, or tempered glass, unless otherwise indicated.
    3. Destaticize all panels at the factory prior to shipping.
N. Louvers:
    1. Provide louvers or baffles fabricated from aluminum reflector sheet free of marks including mars and indentations caused by fabrication and assembly techniques. No rivets, springs, or other hardware shall be visible after installation. Plastic louvers are not permitted.
    2. Provide non-iridescent type louvers for fixtures.
    3. Provide louvers and baffles that are polished, buffed, and anodized.
O. Reflectors and Trims:

1. Attach non-permanently affixed reflectors to housing by means of safety chains or spring clips, to prevent reflectors from falling. No part of the clip or chain shall be visible after installation, when viewed from any angle up to 45 degrees from horizontal.
2. Aluminum Reflectors:
   a. Provide reflectors and reflecting cones fabricated from aluminum reflector sheet free of marks including spinning lines, mars, and indentations caused by fabrication and assembly techniques. No rivets, springs, or other hardware shall be visible after installation. Provide only reflectors free from blemishes, scratches, or indentations.
   b. Provide reflectors that are polished, buffed, and anodized.
   c. Provide non-iridescent type louvers for fixtures.
   d. Provide polished self-flanged trim cones, color finish shall match that of the cone.
3. Painted Reflectors: Completely formed before application of primer and paint. Minimum of 87 percent reflectance white.

P. Recessed Luminaires:
1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

Q. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts "label indicating their specific performance characteristics, tested and reported in accordance with the requirements of the most current version of IES LM-79.
5. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA -C78.377.
6. LEDs shall be binned within a maximum 3-step MacAdam Ellipse.
7. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.

R. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

S. Fixture Support Components: Comply with Section 26 05 29 - Hangers and Supports for Electrical Systems.
1. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish shall be the same as the fixture.
2. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish shall be the same as the fixture.
3. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
4. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord and locking-type plug.

T. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position.

U. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging. Free of burrs and sharp corners and edges.

2.03 EXIT SIGNS

A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101and the Chicago Electrical Code for sign colors, visibility, luminance, and lettering size, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single- or double-face as indicated or as required for installed location.
   2. Directional Arrows: As indicated or as required for installed location.
   3. AOR Face: Provide Area of Rescue style face where required per plans.
   4. Colors: red letters on white background.

B. Self-Powered Exit Signs:
   1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
   2. Battery: Sealed, maintenance-free, nickel cadmium unless otherwise indicated.
   3. Charger: Fully automatic, solid-state, constant current type with integral sealed transfer relay.
   4. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
   5. Provide low-voltage disconnect to prevent battery damage from deep discharge.
   6. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
   7. Low Battery Disconnect: Provide a device and/or related circuitry that shall automatically disconnect the battery and protect it from deep/over discharge.
   8. Shall consume 5 watts of AC power, or less, per face under normal operating conditions.

C. AC-Powered Exit Signs
   1. Lamps for AC Operation: LED's, 70,000 hours minimum rated lamp life.
   2. Shall consume 5 watts of AC power, or less, per face under normal operating conditions.

D. Accessories:
   1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   2. Provide compatible accessory wire guards where indicated.

E. Accessories:
   1. Provide compatible accessory high-impact polycarbonate vandal shields where indicated.
   2. Provide compatible accessory wire guards where indicated.

2.04 DRIVERS

A. Manufacturers:
   1. Advance
   2. Cree
   3. EldoLED
   4. Enlighted
   5. General Electric Company/GE Lighting: www.gelighting.com/#sle.
   6. Lutron Electronics Company, Inc; www.lutron.com/#sle.
   7. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
   8. Philips Lighting North America Corporation; www.usa.lighting.philips.com/#sle.
   9. Thomas Research Products
   10. Manufacturer Limitations: Where possible, for each type of luminaire provide drivers produced by a single manufacturer.

11. Where a specific manufacturer or model of driver is indicated elsewhere, such as in the luminaire schedule or on the drawings, substitutions for that specific driver are not permitted unless explicitly indicated.

B. Drivers - General Requirements:
1. Electronic Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
2. Drivers and power supplies shall be provided in accordance with the requirements of ANSI C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI C82.77.
3. Drivers shall have internal surge protection to protect each fixture. Each fixture shall be capable of being readily disconnected from the circuit.
4. Provide UL listed and labeled drivers. Provide drivers with temperature ratings appropriate to the installation.
5. Fixtures intended to be dimmed shall have dimming capable drivers and be compatible with the specified dimmer controls.

C. LED Drivers - Specific Requirements:
1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fixtures intended to be dimmed shall have dimming driver fully compatible with the dimming controls to be installed.
3. LED drivers shall be factory provided by the respective luminaire manufacturers, and shall be suitable for their intended use, to operate the designated LED modules listed in the Luminaire Schedule, and as specified herein, to their full light output.
4. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
5. Provide identical drivers within each luminaire type.
6. Provide complete connection to LED type luminaires through both integrally installed and remote electronic drivers.
7. Drivers shall be totally enclosed within a metallic enclosure, and shall be provided with integral leads color coded per ANSI Standards or with poke-in style wire retaining connectors.
8. Surge Tolerance: Capable of withstanding characteristic surges, 10,000 aic minimum.
9. Remote Drivers:
    a. Remote drivers are specifically not shown on the drawings. Contractor shall install remote drivers in a readily accessible, dry, indoor, concealed location, in accordance with the manufacturer's instructions.
    b. Provide ventilated metal enclosures for remote drivers furnished as loose equipment. All wiring to/from remote drivers and their associated LED luminaires shall be installed in conduit.
    c. Metal Enclosures shall be Chicago Plenum Rated
    d. Verify and comply with remote distance limitations specified by the luminaire/driver manufacturer.

2.05 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2 inch size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4 inch size, field-painted as directed.

C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

D. Lenses:
   1. Source Limitations: Fixture lenses shall be provided by the light fixture manufacturer.
   2. Construct acrylic lenses, diffusers, covers, and globes of 100 percent virgin acrylic injection-molded plastic complying with ASTM D788. Polystyrene lenses are not acceptable.
   3. All plastic shall be highly resistant to yellowing and other changes due to aging, exposure to heat and ultraviolet radiation.
   4. Destaticize all panels at the factory prior to shipping.
   5. Lens Patterns:
      a. Pattern 12 Lens: Pattern 12 lens shall be not less than 0.125-inch thick (overall panel thickness), with inverted conical prisms, in straight flat-sided prism shape, configured on 45-degree axis layout across the entire panel.
      b. Pattern 19 Lens: Pattern 19 lens shall be not less than 0.156-inch thick (overall panel thickness), with inverted conical prisms, in straight flat-sided prism shape, configured on parallel/perpendicular 90-degree axis layout across the entire panel. Provide pattern 19 lenses in kitchens, serveries, locker rooms, and toilet rooms.

2.06 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 29 - Hangers and Supports for Electrical Systems for channel-supports.
B. Single-Stem Hangers: 1/2-inchsteel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.0808-inch (12 gage) minimum diameter.
D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that lighting fixture back-boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with City of Chicago Electrical Code.
C. Verify that suitable support frames are installed where required.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring lighting fixture back-boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from lighting fixture back-boxes.
C. Removal of Existing Luminaires: Disconnect and remove abandoned luminaires, including lamps and accessories, and luminaires indicated to be removed. Remove abandoned wiring in accordance with requirements of authorities having jurisdiction.
D. Removal and Reinstallation of Existing Luminaires: Carefully remove luminaires from existing locations and store as required for new luminaires. Reinstall luminaires as indicated and as specified.
   1. Prior to reinstallation, luminaires shall be cleaned and repaired, including installation of new wiring, ballast(s) and lamps; replacement of broken, damaged, or faulty lamp sockets; replacement of broken or damaged lenses; replacement of faulty or nonfunctioning lamps; and damp cleaning of lens and interior of luminaires.
E. Existing Luminaires to Remain: Clean existing luminaires, lamps and accessories, indicated to remain. Make repairs to existing luminaires as required to make fully functional, including installation of new wiring, ballast(s) and lamps, and to aesthetically match newly installed luminaires of same type in same space, if any.

F. Extend existing installation using materials and methods specified.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems as required for installation of luminaires provided under this section.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install products in accordance with manufacturer's instructions.
D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
E. Provide required support and attachment in accordance with Section 26 05 29.
F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
G. Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.
H. Suspended Ceiling Mounted Luminaires:
    1. Do not use ceiling tiles to bear weight of luminaires.
    2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
    3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
    4. Secure pendant-mounted luminaires to building structure.
    5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
    6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
    7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
I. Recessed Luminaires:
    1. Install trims tight to mounting surface with no visible light leakage.
    2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
    3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
    4. Support for Luminaires in Lay-in/Accessible Ceilings: Use grid as a support element.
        a. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6-inchesfrom lighting fixture corners.
        b. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
        c. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
        d. Install at least two (2) independent support rods or wires from structure above to the light fixture housing. Supports shall be installed on opposite (diagonal) corners. Wires or rods shall be capable of supporting, without failure, a load equal to three times the weight of the light fixture.
J. Suspended Luminaires:
    1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
    2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
    3. Install canopies tight to mounting surface.
    4. Suspended Lighting Fixture Support:
        a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
        b. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

c. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

K. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

L. Install accessories furnished with each luminaire.

M. Bond products and metal accessories to branch circuit equipment grounding conductor.

N. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
2. Install lock-on device on branch circuit breaker serving units.

O. Identify luminaires connected to emergency power system and install labels with panel and circuit numbers on concealed junction and outlet boxes in accordance with Section 26 05 53 - Identification for Electrical Systems.

P. Install lamps in each luminaire.
1. Provide all lamps needed for all fixtures, including replacements for extinguished or defective lamps, until Final Acceptance. Replace lamps used in fixtures during construction prior to Final Acceptance.
2. Install lamps according to manufacturer's instructions.

Q. Adjust aimable lighting fixtures as required to provide required light intensities.

R. Connections:
1. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to their manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

S. Lenses, Louvers and Reflectors:
1. Exercise particular care when installing fixtures and lamps in fixtures with specular reflector material to prevent smudging or damaging the reflector surface. Wear clean gloves as recommended by the fixture manufacturer.
2. Do not install removable reflectors, louvers, diffusers, and decorative elements of lighting fixtures until completion of wet work, plastering, painting and general cleanup in the area of the fixtures, but not more than three days before date scheduled for inspections that establish date of Preliminary Acceptance.

T. Accessibility: Install equipment such as junction and pull boxes, fixture housings, transformers, remote drivers, switches and controls, and other apparatus that requires occasional maintenance to be accessible and appropriate for mounting and ceiling conditions.

U. Install fixtures in mechanical areas after ductwork and piping installation. Locate and mount fixtures as indicated on Drawings unless mechanical equipment prohibits or makes it impractical to do so. In such cases, chain or wall mount fixtures so that serviceable equipment is illuminated.

V. Locate recessed ceiling luminaires as indicated on Drawings. Mount fixtures at heights and locations indicated. Where heights are not indicated or conflicts exist, coordinate final locations with Architect/Engineer of Record.

W. In mechanical fan housings, locate fixtures so as not to interfere with belts, filters, and similar items.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply. Verify transfer from normal power to emergency power and retransfer to normal. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly. Note and record the following:
   1. Duration of supply.
   2. Low battery voltage shutdown.
   3. Normal transfer to battery source and retransfer to normal.
   4. Low supply voltage transfer.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Architect/Engineer of Record.

3.05 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 - Identification for Electrical Systems.

3.06 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect/Engineer of Record. Secure locking fittings in place.

B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect/Engineer of Record or authority having jurisdiction.

C. After system checkout and adjustment, operate the system for the review of the Board and Architect/Engineer of Record. Make adjustments or modifications as required by the Board or Architect/Engineer of Record.

3.07 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.08 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Training: Perform on-site training of Board's personnel on operation, adjustment, and maintenance of interior lighting. Training shall last a minimum of 4 hours and at the end of the session, the Board's maintenance personnel shall be thoroughly instructed in the proper operation of the system.

D. Demonstration: Demonstrate proper operation of luminaires to Architect/Engineer of Record, and correct deficiencies or make adjustments as directed.

E. Just prior to Preliminary Acceptance, replace all lamps that have failed.

3.09 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 56 00 (LNK)
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.
B. Drivers
C. Poles and accessories.
D. Luminaire accessories.

1.02 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
B. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signal 2013 (Revised 2019).
C. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements 2017.
D. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing 2010.
E. ANSI C136.41 - For Roadway and Area Lighting Equipment— Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver 2013.
F. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube 2010e1.
G. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.
H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.
I. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 2013 (Corrigendum 2019).
J. IEEE C2 - National Electrical Safety Code 2017.
K. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products 2008.
L. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules 2015, with Errata (2017).
M. IES RP-8 - Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting 2018.
N. IES TM-15 - Technical Memorandum: Luminaire Classification System for Outdoor Luminaires 2020.
O. NAAMM AMP 500-06 - Metal Finishes Manual 2006.
P. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
Q. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems 2006.
R. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.
S. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012.
T. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control Current Edition, Including All Revisions.
U. UL 1598 - Luminaires Current Edition, Including All Revisions.
V. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

1.03 SYSTEM DESCRIPTION

A. The exterior lighting system shall include all lighting fixtures, LED modules, switches, mounting, wiring, control equipment, and accessories, whether or not they are indicated or specified, required for a complete system, as indicated in the Drawings and as specified.
B. The luminaire schedules in the Drawings indicate manufacturer, fixture design, appearance and performance desired.

1.04 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
B. Live Load: Single load of 500 lbs, distributed as stated in AASHTO LTS-4.
C. Ice Load: Load of 3 lbs/sq. ft. applied as stated in AASHTO LTS-4.
D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
    1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 110 mph.
    2. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Include plans, elevations, sections, details, and attachments to other work.
    2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include details that cannot be adequately represented to the satisfaction of the Architect/Engineer of Record in Product Data.
    3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
    4. Wiring Diagrams: For power, signal, and control wiring.
    5. Photometric data, certified by the manufacturer in accordance with the recommended practices of the IES.
    6. Quantity and type of LED modules.
C. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Provide separate submittal product data/shop drawings for each fixture type clearly indicating the fixture type designation used in the Drawings and all pertinent options and accessories. Do not group similar fixture types together on a single cut sheet. Submittals that do not indicate option selection where multiple selections exist will be returned without review. Include data on features, accessories, finishes, and the following:
    1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
    2. Details of attaching luminaires and accessories.
    3. Details of installation and construction.
    4. Luminaire materials such as finish and color information.
    5. Photoelectric relays.
    6. LED Drivers: Include information as to input watts. Indicate mounting distance limitation and standard wire sizes for remote drivers.Indicate control type and range.
    7. LED modules, per luminaire tag, including life,
    lumen output, correlated color temperature (CCT), color rendering index (CRI) and energy-efficiency data.
    8. Materials, dimensions, accessories and finishes of poles.
    9. Photometric data based on laboratory tests of each luminaire type, complete with indicated LED modules, drivers, and accessories.
    10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
    11. Pole and support structure anchor bolt information.
    12. Manufactured pole foundations, if any.
D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a State of Illinois Registered Structural Engineer.
E. Field Quality Control Reports.

1. Include test report indicating measured illumination levels.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals. Include manufacturers' recommended maintenance practices for each fixture type including, but not limited to, the following:
1. Tools required.
2. Acceptable cleaners and recommended cleaning practices.
3. Replacement parts list.
4. Manufacturer service department contact information/Qualified Service Agencies.
5. Submittal data.
6. Operation data.
7. Intended operation narrative.

H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes. Submit record drawings of the actual installation within thirty (30) days of date of Preliminary Acceptance.

I. Re-Commissioning Data: Submit manual containing all information required for re-commissioning of the installations.
1. Submit two (2) copies of manual within thirty (30) days of date of Preliminary Acceptance.
2. Submit re-commissioning manuals in heavy-duty, 3-ring binders.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide a manifest of all extra materials provided.
1. LED Modules: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.
3. Drivers: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
4. Globes and Guards: One (1) for every twenty (20) of each type and rating installed. Furnish at least one (1) of each type.

1.07 QUALITY ASSURANCE

A. Comply with the City of Chicago Building Code.

B. Comply with EPA, State of Illinois, and City of Chicago regulations for proper recycling or disposal of existing lamps and ballasts removed from the Site.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the ANSI/IEEE 802.7 by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

G. Solid State Lighting/Luminaires:
1. Luminous flux, luminaire efficiency and chromaticity shall be tested, measured and reported in accordance with the most current versions of IES LM-79 and IES LM-80.

2. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA-C78.377.
3. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1, and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.
4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts "label indicating their specific performance characteristics, tested and reported in accordance with the requirements of the most current version of IES LM-79.

H. Commissioning: When required for the Project, Contractor shall assign representative(s) with expertise and authority to act on its behalf. The representative(s) shall perform commissioning activities including, but not limited to, the following:
1. Review submittals relative to exterior lighting systems being commissioned.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.
B. Store poles on decay-resistant-treated skids at least 12-inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Handle poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4-inch deep. Do not apply tools to section of pole to be installed below ground line.
D. Retain factory-applied pole wrappings on metal poles until right before pole installation.
E. Deliver exterior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers or equivalent.
F. Handle exterior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures; replace and return damaged units to equipment manufacturer.
G. Store lighting fixtures in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

1.09 COORDINATION

A. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
B. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
C. Verify locations of light fixtures indicated in Drawings and coordinate with other reference data and materials as required prior to installation to ensure locations will not interfere with underground utilities or openings. Alert Architect/Engineer of Record and Board's Representative in writing to non-standard modifications required for compliance with the Contract Documents prior to proceeding with the work.
D. Where discrepancies are found within the Contract Documents, or additional information is required, immediately contact Architect/Engineer of Record for clarifications and additional information.
E. Coordinate installation of lighting system with other trades to prevent delays in the work and to ensure the lighting fixtures and supports will not be damaged by subsequent construction operations.

1.10 WARRANTY

A. Special Warranty: Submit a written warranty, beginning from date of Preliminary Acceptance, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within the specified warranty period. Damage due to lightning, hail, vandalism, abuse, or unauthorized repairs or alterations shall be excluded from special warranty coverage.

Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components.

1. Warranty Period for LED Luminaires, including LED Modules, LED boards, chips, and Drivers: Five (5) years from date of Preliminary Acceptance.
2. Warranty Period for Metal Corrosion: Five (5) years from date of Preliminary Acceptance.
3. Warranty Period for Color Retention: Five (5) years from date of Preliminary Acceptance.
4. Warranty Period for Fuses: Two (2) years from date of Preliminary Acceptance.
5. Warranty Period for Poles: Three (3) years from date of Preliminary Acceptance. Warranty shall include pole finish.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Provide for proper recycling or disposal of existing lamps and ballasts removed from the site in accordance with EPA and State of Illinois regulations in accordance with Section 02 86 13 Hazardous and Universal Waste Management.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Manufacturers:
   1. Products: Subject to compliance with requirements indicated and the design criteria specified in the Luminaire Schedule, provide one (1) of the products specified in the Luminaire Schedule.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.
   1. Fixtures that are aimed upward shall be listed and labeled for installation in wet locations in that position.

D. Provide products complying with Federal Energy Management Program (FEMP) requirements.

E. Unless otherwise indicated, provide complete luminaires including LED modules, LED boards, drivers, reflectors, lenses, housings and other components required to position, energize and protect the light source and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc. Components, including nuts, bolts, rivets, springs, and similar parts, to be made from corrosion resistant materials.

H. Provide luminaires listed and labeled as suitable for wet locations and outdoor service unless otherwise indicated. Provide IP ratings required by fixture schedule, in compliance with IEC 60529.

I. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
   4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts "label indicating their specific performance characteristics, tested and reported in accordance with the requirements of the most current version of IES LM-79.
   5. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA -C78.377.
   6. LEDs shall be binned within a maximum 3-step MacAdam Ellipse.

7. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1 and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.

J. Provide anodized aluminum for aluminum parts of exterior fixtures that are not specified as requiring a painted finish.

K. Lateral Light Distribution Patterns: Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for luminaires. Comply with IES TM-15.

L. Metal Parts: Free of burrs and sharp corners and edges.

M. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

N. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

O. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit maintenance. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.

P. Exposed Hardware: Stainless steel.

Q. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

R. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

S. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

T. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

U. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
   1. Where luminaire products are not indicated to be field painted and are not indicated to match the finish process and color of pole or support materials, provide the following:
      a. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
         1) Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
         2) Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

V. Factory-Applied Labels: Comply with UL 1598. Include recommended LED modules and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when fixture assemblies are in place.
   1. Label shall include the following LED module and driver characteristics:
      a. "USES ONLY" and include specific LED module type.
      b. CCT and CRI for all luminaires.

W. Emergency Power: Provide emergency LED power pack with back box matching housing finish where indicated or, if not indicated, where required by Architect/Engineer of Record, or Board's Representative.

2.02 BALLASTS AND DRIVERS

A. Drivers - General Requirements:
   1. LED drivers shall be factory provided by the respective luminaire manufacturers, and shall be suitable for their intended use, to operate the designated LED modules listed in the Luminaire Schedule, and as specified herein, to their full light output.
   2. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
   3. Provide complete connection to LED-type luminaries through both integrally installed and remote electronic drivers.
   4. Shall be totally enclosed within a metallic enclosure, and shall be provided with integral leads color coded per ANSI C82.11, or with poke-in style wire retaining connectors.
   5. Provide identical drivers within each luminaire type.
   6. Provide UL listed and labeled drivers. Provide drivers with temperature ratings appropriate to the installation.
   7. Surge Tolerance: Capable of withstanding characteristic surges, 10,000 aic minimum.
   8. Fixtures intended to be dimmed shall have dimming driver compatible with the specified dimmer controls.
   9. Remote Drivers:
      a. Remove drivers are specifically not indicated in Drawings. Install remove drivers in a readily accessible, dry, indoor, concealed location in accordance with the manufacturer's written instructions. If an indoor location is not within wiring distance limitations, an above grade, exterior enclosure rated as NEMA 3R or 4X is allowable. Enclosures shall be lockable, with a piano hinge design.
      b. Provide ventilated metal enclosures for remove drivers furnished as loose equipment. All wiring related to remove drivers and the related LED luminaries shall be installed in conduit.
      c. Verify and comply with the remote distance limitations specified by the luminaire/driver manufacturer.

2.03 POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
B. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
C. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.
F. Concrete Pole Foundations: Cast in place, not less than 24-inches in diameter, and extending above and below grade as indicated in Drawings. Install with anchor bolts to match pole-base flange. Provide raceways, grounding electrodes, and other electric work relating to the pole foundations. Refer to Section 03 30 00 - Cast-in-Place Concrete for concrete, reinforcement, and formwork.
G. Poles shall be provided with handhole, anchor bolt covers, and grounding lug.

2.04 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B429/B429M, Alloy 6063-T6 with access handhole in pole wall.
   1. Shape and Size: Per Luminaire Schedule.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Handhole: Provide handhole opening, nominal 3-inches by 5-inches, at approximately 18-inches above pole base, complete with weathertight cover and securing fastener.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, and then bolted together with stainless-steel bolts. Fabricated with span and rise as indicated in Drawings.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole.

F. Aluminum Finish: Comply with NAAMM AMP 500-06 for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

2.05 POLE ACCESSORIES

A. Duplex Receptacle: Where indicated, provide a 120V, 20A receptacle in a weatherproof assembly complying with Section 26 27 23 - Indoor Service Poles for ground-fault circuit-interrupter type.
   1. Recessed, 12 inches above finished grade.
   2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
   3. With cord opening.
   4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Fusing: Provide in-line fuses at handhole in each pole for each light fixture. Shall be UL listed and labeled, single pole, 600VAC, breakaway style, in-line fuse holders, designed for field installation onto pole supported luminaires. Provide complete with fuses, sized to the specific load.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

2.06 INTEGRAL PHOTOELECTRONIC CONTROLS

A. Integral, Luminaire Installed, Photocell:
   1. Where indicated, provide a photo-electronic device designed, built, and tested to provide automatic on/off control of individual luminaire, from dusk to dawn, based on ambient light level.
   2. Controls shall be UL 773A listed and fabricated to meet or exceed requirements of ANSI C136.10 or ANSI C136.41 , with integral relay contacts rated not less than 1000VA to a total load at not less than 300VAC.
   3. Provide controls with integral time delay feature to prevent false operation after momentary light flashes or light blockages.

4. Controls shall be manufactured, or provided, by luminaire manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Verify that field measurements are as indicated.
D. Verify that lighting fixture back-boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with ANSI/IEEE 802.7.
E. Verify that suitable support frames are installed where required.
F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

3.02 PREPARATION

A. Provide extension rings to bring lighting fixture back-boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.
C. Demolition: Disconnect and remove luminaires, lamps, and accessories as indicated or, if not indicated, as directed by Architect/Engineer of Record. Disconnect and remove abandoned luminaires, lamps, and accessories. Remove from Site and dispose of legally.
D. Existing Installations: Extend existing installation using materials and methods specified.
E. Existing Fixtures to Remain or be Reinstalled: Clean and repair existing luminaires to remain and those indicated to be removed and reinstalled.

3.03 INSTALLATION

A. Coordinate locations of lighting fixture back-boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install products in accordance with manufacturer's instructions.
D. Install luminaires in accordance with NECA/IESNA 501.
E. Provide required support and attachment in accordance with Section 26 05 29.
F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
    1. Where fixtures protrude from the wall surface, provide additional structural support within the wall framing to accommodate the extra moment force created by the fixture
H. Pole-Mounted Luminaires:
    1. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
    2. Maintain the following minimum clearances:
        a. Comply with IEEE C2.
        b. Comply with utility company requirements.
            1) Fire Hydrants and Storm Drainage Piping: 60 inches.
            2) Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
        c. Trees:
            1) Less than 4-inch caliper: 15 feet.
            2) Greater than 4-inch caliper: Locate outside dripline.
    3. Foundation-Mounted Poles:
        a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 03 30 00 - Cast-in-Place Concrete.
            1) Install anchor bolts plumb per template furnished by pole manufacturer.
            2) Position conduits to enter pole shaft.
        b. Install foundations plumb.

1) Exposed concrete surfaces of bases for all light poles and light fixtures shall be free of voids.

c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
1) Use anchor bolts and nuts selected for the application and approved by manufacturer.
2) Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
3) Install base covers, unless otherwise indicated.
4) Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

d. Tighten anchor bolt nuts to manufacturer's recommended torque.
e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
f. Install anchor base covers or anchor bolt covers as indicated.
g. Remove all rough edges from exposed surfaces. Leave exposed surfaces smooth.
h. Remove all exposed forming materials.

4. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
5. Embedded Poles: Install poles plumb as indicated.
6. Grounding:
a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
b. Provide supplementary ground rod electrode as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems at each pole bonded to grounding system as indicated.
7. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
8. Install non-breakaway in-line fuse holders and fuses complying with Section 26 28 13 - Fuses in pole handhole or transformer base for each ungrounded conductor.
9. Install weather resistant GFI duplex receptacle with weatherproof cover as specified in Section 26 27 26 - Wiring Devices in designated poles.

I. Install accessories furnished with each luminaire.
J. Ground metal poles and support structures according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
1. Install a minimum of a 3/4-inch diameter by 8-foot copper grounding electrode for each pole, unless otherwise indicated, and installed as indicated in Drawings.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

K. Raise and set poles using web fabric slings (not chain or cable).
L. Installation of Individual Ground-Mounted Luminaires: Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00.

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
B. Steel Conduits: Comply with Section 26 05 33.13 - Conduit for Electrical Systems. In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a fifty (50) percent overlap.

3.05 RACEWAYS AND BOXES

A. Plastic conduit shall be used where indicated in Drawings, in unpaved areas and lawn areas. The conduit shall be Schedule 40, UL Listed, polyvinyl chloride conduit, and not less than 1-1/2 inches in diameter.
B. Galvanized rigid conduit shall be used under buildings, within five feet of entrances to buildings, in pole foundations, under paved areas and walkways, and within 18-inches, horizontally, of exterior junction boxes.
C. Provide pull line in empty conduit and duct.
D. Comply with the additional requirements of Section 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.

3.06 IDENTIFICATION

A. Provide vinyl tagging with panel source and circuit number on wiring at handhole in each pole and at each exterior box.
B. Identify each exterior box with 1-1/2 inch high black letters and numbers on yellow weatherproof, pressure-sensitive adhesive vinyl on the covers. Labels shall be Brady #1530.
C. Comply with the additional requirements of Section 26 05 53 - Identification for Electrical Systems.

3.07 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each product for damage and defects.
C. Operate each luminaire after installation and connection to verify proper operation.
D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Architect/Engineer of Record.
E. Measure illumination levels at night with calibrated meters to verify compliance with performance requirements. Record test results in written report to be included with submittals.

3.08 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Board. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources. Secure locking fittings in place.
B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect/Engineer of Record.

3.09 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.10 CLOSEOUT ACTIVITIES

B. See Section 01 79 00.1 - Demonstration and Training, for additional requirements.
C. Inspect each installed fixture for damage. Replace damaged fixtures and components.
D. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
    1. Verify operation of photoelectric controls.
E. Replace fixtures that show evidence of corrosion during project warranty period.
F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with requirements.
G. Training: Perform on-site training of Board's personnel on operation, adjustment, and maintenance of exterior lighting. Training shall last a minimum of 4 hours and at the end of

the session, the Board's maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.11 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.12 COMMISSIONING AND DEMONSTRATION

A. After system checkout and adjustment, the contractor shall operate the system for the review of Architect/Engineer of Record and Board's Representative, and shall make all adjustments and modifications as required by Architect/Engineer of Record and Board's Representative.

END OF SECTION

SECTION 00 01 02

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END OF SECTION 00 01 02

SECTION 27 05 03 (LNK)

COMMUNICATIONS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Communications system design requirements.
   1. Section covers general requirements for communications structured cabling systems used as signal pathways for voice and high-speed data transmission. Communications hardware and equipment furnished shall conform to the requirements of this specification and the particular application specifications.

B. Installer Qualifications

C. Special Warranty.

1.02 DEFINITIONS

A. ACE: Administrative Concentrator Enclosure.

B. BICSI: Building Industry Consulting Service International.

C. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 5 to 1000 MHz.

D. Carrier: An RF signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band.

E. Cat 6 PP: Category 6 Patch Panel (Are installed in Equipment Racks/Enclosures).

F. CATV: Community Antenna Television; a communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.

G. CCTV: Closed circuit television.

H. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

I. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

J. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

K. CXP: RG6 Coax Patch Panel (Are installed in Equipment Racks).

L. dB: Decibel.

M. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log 10(V1/V2) where V1 is the measurement of voltage at a point having identical impedance to V2 (0.001 V across 75 ohms).

N. Device Port: is the location on the patch panel, faceplate or product where the label is located.

O. EMI: Electromagnetic interference.

P. ESD: Electrostatic discharge.

Q. FOPP: Fiber Optic Patch Panel.

R. GPS: Global Positioning System.

S. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points.

T. ICC: Intercom Control Cabinet. The ICC may also be referred to as the Intercom Headend.

U. IDC: Insulation displacement connector.

V. IDF: Intermediate Distribution Frame.

W. ITS: Office of Information and Technology Services.

X. Jack / Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates, these outlets are typically inserted in a faceplate.

Y. Ladder Rack: A fabricated structure consisting of two longitudinal side rails (stringers) connected by individual transverse members (rungs).

Z. LAN: Local area network.

AA. ALCE: Lab (computer, library, or science) concentrator enclosure.

BB. AMDF: Main Distribution Frame.

CC. AMMTV: Media Management Television.

DD. AModulator: An active device that modulates a baseband audio and video source onto an NTSC 6 MHz wide channel. This device shall employ a custom SAW filter to provide true vestigial sideband selectivity with built-in FCC group delay pre-distortion. This will allow for adjacent channel operation without any interference. This device shall also comply with FCC Docket 21006.

EE. AMUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

FF. ANIST: National Institute of Science and Technology.

GG. AOutlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

HH. APATHWAY: A pathway is typically a conduit that requires labeling so that IT can understand where the conduit begins and ends.

II. APC: Personal computer.

JJ. APORT: A port is an end of line location on a patch panel, faceplate or switch.

KK. AQCE: Quad (Four) Classroom Concentrator Enclosure.

LL. ARCDD: Registered Communications Distribution Designer.

MM. ARF: Radio frequency.

NN. ASCE: Shared Concentrator Enclosure.

OO. ATBB: Telecommunication Bonding Backbone.

PP. ATCE: Three Classroom Concentrator Enclosure.

QQ. ATGB: Telecommunication Ground Bus Bar.

RR. ATMGB: Telecommunication Main Ground Bus Bar.

SS. AUser Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the 75-ohm terminals on device plates.

TT. AUTC: Universal time coordinated. The precisely measured time at zero degrees longitude; used as a worldwide standard for time synchronization.

UU. AUTP: Unshielded Twisted Pair.

VV. AVU: Volume unit.

WW. AW: Workstation which is a location / faceplate where cables are terminated.

XX. AWAP: Wireless Access Point.

YY. AZone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

B. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2017.

C. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling; 2006.

D. NFPA 70 - National Electrical Code; 2017.

E. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.

F. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

G. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate layout and installation of communications equipment with Board's Representative, telecommunications and LAN equipment, and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
a. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and the Board to exchange information and agree on details of equipment arrangements and installation interfaces.
b. Record agreements reached in meetings and distribute them to other participants.
c. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
d. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
2. Coordinate communications outlet/connector locations with location of power receptacles at each work area.
3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details.
1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Preinstallation Meeting.
2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
a. Require attendance by all affected installers including but not limited to
1) Contractor's Superintendent
2) Installer
3) Manufacturer/Fabricator Representative
4) Other affected Subcontractors
5) Architect/Engineer of Record
6) Board’s Representative
3. Record minutes and distribute copies within 5 days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

1.05 SUBMITTALS

A. General:
1. Reviews of submittals are to establish general conformance to design intent and does not waive contract requirements. Contractor is responsible for dimensions, quantities, mounting accessories, methods of construction, and compliance with the Contract Documents.
2. Provide separate submittal product data/shop drawings for each fixture, device, and equipment type clearly indicating the type designation per the Contract Documents and all pertinent options and accessories. Do not group similar fixture types together on a single cut sheet. Submittals which do not indicate option data where multiple selections exist will be returned without being reviewed.

B. Refer to “Submittals” article of each Division 27 Section for requirements specific to the Section.

C. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

D. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

E. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

F. Evidence of qualifications for installer.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A company having at least five (5) years' experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
      a. If personnel of Contractor are not BICSI-trained and –certified, Contractor to submit with bid all necessary credentials and certificates of training for personnel staff for evaluation and determination by CPS ITS Sr. Infrastructure Manager that said credentials and certificates are equal to BICSI standards. The project shall be staffed at all times by Installers and Technicians who, in the role of lead crafts persons, will be able to provide leadership and technical resources for the remaining crafts persons on the project.
   2. Supervisors and installers factory certified by manufacturers of products to be installed.
      a. Shall be certified by the manufacturing company(-ies) in all aspects of installation and testing of the products described within the telecommunications systems specifications. Specifically, those manufacturer(s) whose components constitute a component of the structured cabling system(s) installed as part of the voice and data transport systems. Said certification is to be such that the Contractor is able to offer and fully comply with the requirements to provide the Board with an extended warranty as defined in “System Warranty and Application Assurance” Article of this Section.

B. Installer Supervision:
   1. The selected Contractor shall provide a Project Manager to act as a single point of contact for all activities performed under this Section. The Project Manager shall be a Registered Communications Distribution Designer (RCDD). The RCDD shall have a minimum of 3 years' experience in design and installation. The designer must have sufficient experience in this type project(s) as to be able to lend adequate technical support to the field forces during installation, during the warranty period and during any extended warranty periods or maintenance contracts. The Contractor must attach a resume of the responsible designer to the Contractor's response for evaluation.
   2. The Project Manager, or designee thereof, shall be required to attend project meetings as required until project closeout/signoff.
   3. Should the Project Manager assigned to this project change during the installation, the new Project Manager assigned must meet all qualifications stated in this Section, and must also submit a resume for review by the Board.
   4. If, in the opinion of the Board, the Project Manager does not possess adequate qualifications to support the project, the Board reserves the right to require the Contractor to assign a designer whom, in the Board's opinion, possesses the necessary skills and experience required of this project.

C. Materials and equipment shall be the standard product of a manufacturer regularly engaged in the production of the required type of material or equipment for at least five (5) years (unless specifically exempted by the Board) and shall be the manufacturer's latest design with published properties.

D. Source Limitations: Equipment and materials of the same general type shall be of the same manufacturer throughout the project to provide uniform appearance, operation and maintenance.

E. Equipment and materials shall be without blemish or defect.

F. Comply with 2019 City of Chicago Building Code.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

H. Comply with NFPA 70 for abandoned cabling.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Do not deliver or install equipment frames and ladder rack until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

C. Receive, handle, and store communications system items and materials at the project site. Materials and items shall be placed so that they are protected from damage and deterioration.

D. Stage materials in a secure area of the project site until installation.

1.08 SYSTEM WARRANTY AND APPLICATION ASSURANCE

A. General Warranty: The warranty specified in this Article shall not deprive the Board of other rights the Board may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under other requirements of the Contract Documents.

B. The Contractor shall guarantee at the time of the bid that all telecommunications equipment, cabling and components meet or exceed specifications.

C. Special Warranty: Provide to the Board an Extended System and Application Assurance Warranty covering product and installation defects for all passive manufactured components of the structured cabling system(s) installed as part of the voice and data transport systems. Passive components are defined as those exhibiting no gain or contributing no energy. Warrant to the Board the following:
1. The passive products that comprise the telecommunications structured cabling system will be free from manufacturing defects in material or workmanship under normal and proper use.
2. All approved passive cabling products that comprise the structured cabling system exceed the specification standards and will conform to the performance specifications of the associated product data sheet in effect at the time the product is utilized.
3. The installation will meet, if not exceed, the requirements and the standards for cabling configurations specified in these standards.
4. The Special Warranty shall provide an application assurance guaranteeing structured cabling system shall be capable of running a minimum of Gigabit Ethernet (1000Mbs) in the horizontal channel, and 10-Gigabit Ethernet (10,000Mbs) in the backbone.

5. The Special Warranty shall be applicable to the original site of installation. Under the warranty, the manufacturer will either repair or replace the defective product itself at the manufacturer's cost, or the manufacturer will pay an authorized reseller for the cost to repair or replace any such defective product on behalf of the manufacturer.
6. Transfer manufacturer's warranties to the Board in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve Contractor of these obligations.
7. Special Warranty shall be held by the product manufacturer(s).

D. Special Warranty Period: 25 years from date of acceptance.

PART 2 - PRODUCTS

2.01 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
1. Comply with TIA-568 (SET) (cabling) and TIA-569-D (pathways), latest editions (commercial standards).
2. Provide fixed cables and pathways that comply with City of Chicago Electrical Code and TIA-607-C and are UL listed or third party independent testing laboratory certified.
3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
1. Locate main distribution frame as indicated on the drawings.

C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
1. Locate intermediate distribution frames as indicated on the drawings.

D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

PART 3 - EXECUTION

3.01 COMMUNICATIONS DEMOLITION

A. For a renovation project in an existing building, demo and remove back to source, all abandoned communications wiring serving communications outlets and devices within the area of work. Coordinate work to not disrupt communications services to areas outside the project's area of work as may be served by components and communications infrastructure located within the project's area of work.

B. Remove and dispose of termination devices, panels, housings, outlets, mounting frames, cable supports, wire management, etc. abandoned as a result of demolition work, except where indicated for re-use and except where remove of said components would disrupt communication infrastructure and communications systems service to areas outside project's area of work.

C. Coordinate any disruption to existing communications systems service with CPS ITS Sr. Infrastructure Manager, and provide at least fourteen days advance notice to CPS ITS prior to disruption.

D. Removal of all existing electronic equipment shall be coordinated, with at least fourteen days advance notice, with CPS ITS Sr. Infrastructure Manager. All existing electronic equipment shall be turned over to CPS ITS Sr. Infrastructure Manager, and shall not be disposed by Contractor.

3.02 INSTALLATION - GENERAL

A. The drawings for work under Division 27 Sections related to communication systems are diagrammatic and are intended to convey the scope of work and indicate the general arrangement of outlets, equipment, termination hardware, fixtures and other work included in the Contract.

B. Location of items required by the drawings or specifications not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site and shall be subject to the approval of the Board.

C. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points.
1. Where headroom or space conditions appear inadequate, the Board shall be notified before proceeding with installation.
2. Minor rerouting and changes in location shall be made at no additional cost to the Board.
3. Coordinate the mounting heights of communications equipment and raceways to clear the opening heights of doors and the heights of equipment which needs to be removed and replaced.
4. As necessary, adjust elevations of rack-mounted termination hardware and horizontal wire management panels so as to compensate for rack unit sizes of actual hardware used, as compared to hardware rack unit sizes depicted in Contract Drawings.

D. Perform all work with skilled mechanics of the particular trade involved in a neat and workmanlike manner.

E. Perform all work in cooperation and coordination with other trades and schedule.

F. Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, routes for conduit, and also furnish information and shop drawings necessary to permit trades affected to install their work properly and without delay.

G. Where there is evidence that work of one trade will interfere with the work of other trades, all trades shall assist in working out space allocations to make satisfactory adjustments and shall be prepared to submit and revise coordinated shop drawings.

H. With the approval of the Board and without additional cost to the Board, make minor modifications in the work as required by structural interferences, by interferences with work of other trades or for proper execution of the work.

I. Work installed before coordinating with other trades so as to cause interference with the work of such other trades shall be changed to correct such condition without additional cost to the Board and as directed by the Board.

J. Minor changes in the locations of outlets, fixtures and equipment shall be made prior to rough in at the direction of the Board and at no additional cost to the Board.

K. Contractor shall cooperate with other trades and coordinate work so that conflicts with other work are eliminated.

L. Equipment shall be installed with adequate space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring shall be provided without moving other equipment which is to be installed or which is in place. Contractor shall verify measurements. Discrepancies shall be brought to the Board's attention for interpretation.

M. Determine temporary openings in the buildings that will be required for the admission of apparatus furnished under this Division, and notify the Board accordingly. In the event of failure to give sufficient notice in time to arrange for these openings during construction, assume all costs of providing such openings thereafter.

N. Location of communication outlets and raceway pathways are approximate and exact locations shall be determined on site.

O. Contractor shall refer to contract documents for details, reflected ceiling plans, and large scale drawings.

P. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569-D (pathways), TIA-607-C (grounding and bonding), NECA/BICSI 568, City of Chicago Electrical Code, and SYSTEM DESIGN as specified in PART 2.

Q. Comply with Communication Service Provider requirements.

R. Grounding and Bonding: Perform in accordance with TIA-607-C and City of Chicago Electrical Code.

3.03 EXAMINATION OF PATHWAYS

A. Examine pathway elements intended for cables.
   1. Verify proposed routes of pathways. Check raceways, ladder racks, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements.
   2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
   3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
   1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
   2. Do not over-cinch or crush cables.

3. Do not exceed manufacturer's recommended cable pull tension.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
2. At Outlets - Copper: 12 inches.
3. At Outlets - Optical Fiber: 39 inches.

C. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569 for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.05 FIRESTOPPING

A. Utilize an approved firestop assembly to seal all cable and raceway penetrations of fire-rated floor and wall assemblies. Assembly must achieve the same smoke/fire-resistance rating as the floor or wall being penetrated.

B. Comply with requirements in Section 07 84 00 - Firestopping.

C. Comply with TIA-569-D, Annex A, "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-C.

C. Coordinate location of communications grounding bus bar to minimize the length of bonding conductors.

D. Bond metallic equipment to the communications grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION

A. Comply with requirements in Section 27 05 53 - Identification for Communication Systems.

3.08 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit communications systems installation, including all pathway elements and supports necessary for same. Perform cutting by skilled mechanics of trades involved. Perform work so as to not impair structural stability of building construction and systems.

B. Conduits passing through roofs or other surfaces exposed to weather shall be properly flashed as specified in roofing and waterproofing Sections. This flashing work shall be part of this Division of work.

C. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new firestopping where existing firestopping has been disturbed during the course of install. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.09 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 09 91 05 - Renovation Painting.
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 TEMPORARY UTILITIES

A. Comply with requirements of Division 01 regarding furnishing of temporary communications services for use during construction of the Project.

3.11 CLEANING

A. On completion of installation inspect exposed finishes. Remove burrs, dirt, paint spots, and construction debris. Repair damaged finish(es), including chips, scratches, and abrasions.

B. All equipment, hardware and finishes shall be cleaned prior to final acceptance. Unless otherwise indicated, clean shall mean free of dust, dirt, mud, debris, oil, grease, residues, and contamination.

C. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion. Protect

conduit and wireway openings against the entrance of foreign matter by means of plugs or caps. Cover fixtures, materials, equipment and devices furnished or installed under this Section or otherwise protect against damage, both before and after installation. Hardware, materials, equipment, or devices damaged prior to final acceptance of the work shall be restored to their original condition or replaced.

D. During the course of communications installation work, provide for on-going proper disposal of all debris, including but not limited to: equipment packaging and shipping materials, shipping pallets, empty cable reels/boxes, cable cuttings, etc. The Contractor shall, at all times, keep the site free from accumulations of waste material or rubbish caused by its employees or work. Remove all crates, cartons, and other waste materials or trash from the working areas at the end of each working day. Flammable waste material must be removed from the working areas at the time of generation. All rubbish and debris, combustible or not, shall be discarded in covered metal containers daily and removed from the premises at least weekly and legally disposed of.

3.12 COMMISSIONING AND DEMONSTRATION

A. Comply with requirements in Section 27 08 00 - Commissioning of Communications for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

END OF SECTION 27 05 03

SECTION 27 05 53 (LNK)

IDENTIFICATION FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Communications identification.
   1. Cabling identification products.
      a. Print Pockets.
      b. Asset Tags.
   2. Communications systems identification(s) methods and schemes.
      a. Labeling Hierarchy.
      b. Cable Identification.
      c. MDF/IDF Room Identification.
      d. Pathway and Space Identification.
      e. Equipment Identification.
      f. Concentrator Enclosure Identification.
      g. Concentrator Enclosure Warning Sign.
      h. Fiber, Data, Voice, Coax, and HDMI Cable Identification.
      i. Termination Location Identification.
      j. Conduit Pathway Identification.
      k. Identification of Communications Grounding and Bonding System Components.
      l. Cable Schedule.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

B. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2017.

C. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Rev A, 2015.

D. TIA-606-B - Administration Standard for Telecommunications Infrastructure; Rev B, 2012 (with Addenda; 2015).

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of product identified.

C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts

and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. System Labeling Schedules: Electronic copy of proposed labeling schedules and identification plates, in software and format selected by the Board.
2. Cabling administration drawings and printouts.
3. Provide one copy to CPS ITS Sr. Infrastructure Manager for review and approval.

D. Evidence of qualifications for installer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Comply with requirements of Section 27 05 03 - Communications General Requirements for installer qualifications as noted in “Quality Assurance” Article.

B. Electrical Components, Devices, and Accessories: Listed, classified, and labeled as defined in City of Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

C. Comply with City of Chicago Building Code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for delivery, storage and handling.

1.07 WARRANTY

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance.

PART 2 - PRODUCTS

2.01 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Brady Corporation
2. Brother Printer
3. 3M
4. Panduit Corporation

B. Cable markers for the actual cables - shall be self-adhesive, self-laminating mechanically printed with a clear protective laminating over wrap or protective heat-shrink tubing. These cable markers shall be placed directly on the cable within 10-inches of both ends of the cable.

C. Labels for the faceplates, patch panels or devices where cables terminate - the label shall be self-adhesive and shall be from one of the four manufacturers above. The label shall be white in color with Ariel font, no smaller than 9 point.

D. Hard tag shall be metal or hard plastic and shall be attached to the device with a cable tie. The hard tag can be embossed, engraved or an adhesive label can be placed on the hard tag. Cut the excess end of the cable tie off and dispose of it in the trash.

E. The contractor shall utilize women's clear nail polish on all labels where there is a possibility of the label falling off the faceplate or device that it is adhered to.

F. Comply with TIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.02 PRINT POCKETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Milbank Mfg. Company, part no. A-LPPOCKET
2. Hoffman, a Pentair Company, part no. ADP1

B. Adhesive-backed pocket mounted to any enclosure flat surface. Thermoplastic pockets in dark gray color with cutaway areas for inspection of contents.

2.03 ASSET TAGS

A. Manufacturers: Asset tags are provided by the CPS Office of Information and Technology Services. Contact ITS and coordinate information and quantity requirements with the ITS Sr. Infrastructure Engineer for the project.

B. When equipment is deployed in the school, the Asset Tag numbers must be recorded along with equipment and school information, including:
1. School Name and Unit Number
2. Equipment Manufacturer
3. Equipment Model Number
4. Equipment Serial Number
5. Physical Location of the equipment within the school: Room number if possible, otherwise a description of the room's location and use that will allow Board personnel unfamiliar with the school to find the equipment easily (for example, "2nd floor south Janitor's closet next to the gym" would be acceptable)

C. All information described above must be delivered to the Board Representative in either Microsoft Excel or in a text file using comma separated values, (.csv) format as well as paper copies where the Board requires.

PART 3 - EXECUTION

3.01 COMMUNICATIONS DEMOLITION

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for demolition of communications systems.

3.02 EXAMINATION

A. Verify that surfaces are clean before installing labels. When in doubt wipe with alcohol swab prior to applying label.

B. Install labeling in accordance with label manufacturers' instructions and requirements related to preparation of surface area.

3.03 LABELING HIERARCHY

A. Labeling is in a **"From - To"**- hierarchy with the greater significance room being the **"From"** and the less significance room being the **"To"**.

B. When labeling communications cabling and pathways, always begin the labeling scheme with the room or location of greater significance. Ex: MDF, IDF, Concentrator Enclosure designation.

C. Consult with CPS ITS Sr. Infrastructure Manager for clarifications regarding application of hierarchy to the project. Hierarchy relationships that must be adhered to include, but are not limited to:
   1. Cabling and/or pathways between the MDF and any IDFs must list the MDF first.
   2. Cabling and/or pathways between the MDF and concentrator enclosures must list the MDF first.
   3. Cabling and/or pathways between an IDF and concentrator enclosures must list the IDF first.
   4. Cabling and/or pathways between a concentrator enclosure and the faceplate port (including WAP) must list the concentrator enclosures first.

D. Labeling must be exactly the same on both ends of the conduit, cable, and faceplate port.

E. Labeling for all communications infrastructure elements shall be consistent across the installation. Coordinate with requirements for labels and identification defined in Contract Drawings.

3.04 CABLE IDENTIFICATION

A. Cable labels shall be installed on the cable within 4-inches of each end of the cable, and in addition where cable is accessible in junction or pull boxes. The label on the cable shall match exactly what the label is on the patch panel port and the workstation faceplate.

B. Identification within Connector Fields in MDF, IDFs, and concentrator enclosures: Label each connector and each discrete unit of cable-terminating and connecting hardware.

3.05 MDF/IDF ROOM IDENTIFICATION

A. On the exterior and interior face of the door to the MDF and for each IDF, provide a vitreous enameled metal sign or rigid polyethylene, red on white, reading "MDF" or "IDF" respectively.

B. On each interior wall of the MDF and each IDF, provide a vitreous enameled metal sign or plastic sign, red on white, reading "MDF Room (or "IDF Room" respectively) No Storage Permitted." Signs shall be mounted at clearly visible locations within the rooms or on the inside of doors where wall space within the room is not available.

3.06 PATHWAY AND SPACE IDENTIFICATION

A. Label each conduit coming into the MDF or IDF utilizing one of the following methods:
   1. Write legibly with a permanent marker (wide Sharpie) on each conduit near the end of the conduit or at a location that is easily read.
   2. Provide 3/4 inch wide, embossed label with the designations in 5/16-inches high letters.
   3. Conduits that home run from one location (room, roof, outside) shall list the location and orientation within space (north, east, south or west walls).
   4. When multiple conduits terminated in a junction box and one conduit comes into the MDF or IDF, label the conduit and cover plate of the junction box (of consolidated junction box) with the same number.

B. Minimum of two (2) labels, one at each end of the conduit pathway and any exposed points (i.e. Screw cover boxes, pull points, etc.).

C. Exposed conduit raceways do not need to be labeled unless transitioning into or out of an inaccessible space.

D. Telecommunication Systems Conduits: Green and yellow - blue or green conduits (TO BE CONFIRMED BY CPS ITS)

3.07 EQUIPMENT IDENTIFICATION

A. Label each Patch Panel (Fiber and Copper) with a 3/4-inch adhesive label; letters will be 5/16-inches high. Label shall reference the numerical designation and equipment designation. Labels shall be placed on the front and rear of equipment adjacent to the top left hand side of the equipment at the rack. Label shall not cover any existing labels, asset tags, or vents.

B. It is the responsibility of the Architect/Engineer of Record and the Contractor to verify requirements regarding and pertaining to the ITS Asset tags type and installation procedures.

3.08 CONCENTRATOR ENCLOSURE IDENTIFICATION

A. Coordinate concentrator enclosure type with Contract Drawings. Utilize the following identification scheme to label each type of concentrator enclosures where (room #) is the room in which the CE is located:
1. Administrative Concentrator: “ACE-(room#)”.
2. Library or Lab Concentrator: “LCE-(room#)”.
3. Quad Classroom Enclosure: “QCE-(room#)”.

3.09 CONCENTRATOR ENCLOSURE WARNING SIGN

A. On the exterior of each concentrator enclosure door, provide the following:
1. White label with red core laminated phenolic nameplate with 3/8-inch lettering etched through the outer covering, reading “DO NOT OBSTRUCT”. Sign size shall be 5 inches high by 7 inches wide.
2. White label with red core laminated phenolic nameplate with 3/8-inch lettering etched through the outer covering, reading the room number that the concentrator is located in. The label shall be installed in the upper right corner of the enclosure.
3. Contractor’s business information must not be placed on the sign.
4. Each concentrator shall be labeled with the type of concentrator and the room number on the top right side of the enclosure with a 3/4-inch adhesive label; letters will be 5/16-inches high white background with black lettering. Example: QCE-215.

3.10 FIBER, DATA, VOICE, COAX, AND HDMI CABLE IDENTIFICATION

A. Each Fiber Optic cable, Copper Category cable, Coax and HDMI cable shall be labeled within four (4) inches of termination, and at all accessible points in concentrators, manholes, hand holes, and pull boxes. Labels shall be self-sticking wire markers as defined in Part 2.

B. Each cable shall be assigned a unique identification number and shall be recorded on a cable schedule showing the identification number and what the purpose of the cable is for.

C. The basis of labeling cables and conduits is to always state **"From - To"** on each of the cables and then, in addition, give the cable or conduit a sequential unique identification number.

D. Connecting the cable to end hardware - or - ports in a patch panel or ports in a faceplate shall be identified using the following system:
1. Room numbers shall be utilized to depict the **"From - To"**. The contractor shall use these room numbers (when available) to state where the cable is **"From"** and where it is

going **"To"**. The MDF room shall always be stated first and the end location room number shall always follow then a unique identification number. If there is no room number assigned to the MDF or IDF, the MDF or IDF designation shall be all that is required.

2. From the MDF or IDF room cables are home run to individual rooms within the building.
3. Within the individual rooms cables are terminated in Concentrators Enclosures and/or faceplates ports.
4. The types of cables that are home run from the MDF or IDF to the room are:
   a. High pair count Cable (25 pair)
   b. RG 6 Coaxial Cable (MMTV)
   c. Fiber Optical Cable
   d. Category 5e Cable (Voice) - The individual voice cables do not terminate in the enclosure, but use the enclosure as a pass thru from jack location to MDF or IDF.

E. HDMI cables between Teacher Station and Overhead Projector shall be labeled:
1. Teacher Station end of HDMI cable shall be labeled "To Overhead Projector."
2. Projector end of HDMI cable shall be labeled "To Teacher Station."

F. HDMI cables between Teacher Station and Smartboard / Short Throw Projector shall be labeled:
1. Teacher Station end of HDMI cable shall be labeled "To Smartboard."
2. Projector end of HDMI cable shall be labeled "To Teacher Station."

3.11 TERMINATION LOCATION

A. The Category 5e cables that are home run from the MDF or IDF to the individual faceplate within a room are used for telephone. Voice cables shall have a 'V' designation before the unique number. Labeling Example: MDF-115-V01.

B. Future Category 5e cables from 24/25pr voice riser backbone in concentrator enclosure to the individual faceplate within a room are used for future telephone and fax used. Voice cables shall have a 'V' designation before the unique number. Labeling Example: QCE115-115-V01.

C. The High pair count cables (25 pair) that are home run from the MDF or IDFto the room concentrator is terminated on a wall mount 110 block in the MDF or IDF and then terminated on a rack mount 110 block in the concentrator. Because space is limited on the 110 block the contractor shall place a brother label around the 25 pair cable itself. The label has to be in clear view and not behind other cables. As an example, from the MDF or IDF to the QCE the label on the cable shall read "QCE115-115-V02. The in the QCE the label would read 115-V02.

D. The Fiber Optic Cables (6 strand) are home run from the MDF or IDF to the concentrator is terminated on both ends in a rack mount Fiber Optic Patch Panel. Labeling Example: MDF-115-01.

E. The RG6 Coax cables are home run from the MDF or IDF to the individual faceplate within each room. Labeling Example: MDF-115-01.

F. The Category 6 cables for data shall be terminated on a patch panel in closest Concentrator Enclosure. If data is near MDF or IDF, then can be terminated on patch panel in rack. Data cables shall have a 'D' designation before the unique number. Labeling Example: QCE115-115-D01. The first number "D01" shall begin at the teacher's station, and then proceed around the room in a clockwise rotation with increasing numbers, D02, D03 and so forth. If there is no teacher station in the room the numbering will begin at the door and continue clockwise around the room.

G. The Category 6 cables for WAP shall be terminated on a patch panel in closest Concentrator Enclosure. If WAP is near MDF or IDF, then can be terminated on patch panel in rack. WAP cables shall have a 'WAP' designation before the unique number. Labeling Example: QCE115-115-WAP1. WAP cables located in a hallway/corridor shall have a 'H' designation after the room number. Labeling Example: QCE215-200H-WAP1.

H. The Category 6 cables for IP CCTV cameras shall be terminated on a patch panel in closest Concentrator Enclosure. If camera is near MDF or IDF, then can be terminated on patch panel in rack. Data cables shall have a 'C' designation before the unique number. Labeling Example: QCE115-115-C01.

I. Administration of the individual jack locations will be used for local tracking or tracing of the patch panel termination points. At Intercom Admin station jack, faceplate shall be labeled 'INTERCOM 1' in a sequential number scheme. At the other end of the Intercom 1 station, the patch panel shall be labeled 'IC1'.

J. Aiphone system shall be labeled at the master station faceplate, door station and patch panel. At Aiphone master station jack, faceplate shall be labeled 'AIPHONE 1' in a sequential number scheme. At the doors, the Aiphone jack shall be labeled AI-D#, with the appropriate door designation number. At the patch panel, master station connection shall be labeled 'AI-M1' and door connections shall be labeled 'AI-D#'.

K. In classrooms, the sequential unique numbering scheme shall begin at the teacher station and continue in a clockwise rotation around room. In all other rooms, the sequential unique numbering scheme shall begin at the main door and continue in a clockwise rotation around room, then ceiling, then floor.

3.12 CONDUIT PATHWAY IDENTIFICATION

A. Conduit labels shall be made adhesive and a minimum of ¾ inch wide, embossed with the designations in 5/16-inch high letters (numbers placed in 2 locations for all spaces and on all pathways at both ends) and legibly written with a permanent marker.

B. Minimum of two (2) labels, one at each end of the pathway and any exposed points (i.e., screw cover boxes, pull points, etc.).

C. Exposed raceways do not need to be labeled unless transitioning into or out of an inaccessible space. When necessary, raceway designation will be (RW).

D. All conduit pathways shall be identified with a sequential numbering to designate locations for the origin and the end of the pathway.

E. Conduit Pathways labels shall follow the hierarchy.

F. Each conduit shall have a **"From - To"** room number with an individual unique number for the conduit. The origin of the conduit shall always be listed first. Examples:
   1. Conduit leaving MDF and ending at classroom concentrator 232:
      a. Conduit label shall read "MDF-QCE232"
      b. Room of Primary Significance = MDF (Main Distribution Frame) - Room of Primary Significance = QCE232 Quad Classroom Enclosure Room 232).
   2. Telecommunications service entrance from the main service entrance to the MDF:
      a. Conduit label shall read "MDF-TCN"
      b. Room of Primary Significance = MDF (Main Distribution Frame) - Conduit Identification = TCN (Telecommunications service entrance).

G. When multiple rooms of secondary significance are combined together (Branched off) within the same common conduit, leaving the room of significance, each label will be attached to the common conduit and Identified on a spreadsheet in the enclosure pockets and the MDF binder. Example:
   1. MDF-SCE256
   2. MDF-TCE254

H. When multiple conduits are extended from the MDF to a common location, a distinction is to be made between the conduits. Example:
   1. Two conduits from MDF to the Telecommunications Service Entrance:
      a. Conduit label shall read "MDF-TCN-CN1 (2)
      b. Room of Primary Significance = MDF (Main Distribution Frame) - Conduit Identification = TCN (Telecommunications service entrance) - Conduit Identification = CN1 (Conduit # 1).
   2. If going from MDF room to room number 115 and there are 3 different conduits going from the MDF to room 115 the labels shall read:
      a. MDF-115-01
      b. MDF-115-02
      c. MDF-115-03

I. For ALL clarifications on Media and Equipment administration, contact the Office of Information & Technology Services (ITS).

3.13 IDENTIFICATION OF COMMUNICATIONS GROUNDING AND BONDING SYSTEM COMPONENTS

A. Tags shall be adhesive, 3/4-inch wide and be embossed with the designations in 5/16-inch high black letters and numbers on white or clear background.

B. Utilize the following abbreviations to label each type of component:
   1. Telecommunications Main Grounding Bus bar: TMGB
   2. Telecommunications Grounding Bus bar: TGB
   3. Telecommunications Bonding Backbone : TBB
   4. Equipment Bonding Conductors: EBC
   5. Telecommunications Bonding Conductors to the main electrical service equipment: TBC

3.14 CABLE SCHEDULE

A. Concentrator Enclosures: Provide a type written directory of concentrator enclosure types and room numbers. Data port ID numbers and voice port ID numbers shall be identified with the hierarchy listed. Provide information on 8 ½ by 11 inch paper placed in a print pocket on the inside of the door of the concentrator, vertical centerline of doors (do not cover vents) and MDF binder.

B. IDF Post in prominent location in in each IDF. List incoming and outgoing cables and their designations, origins, and destinations. Provide information on 8 ½ by 11 inch paper. Provide in protective print pocket installed on interior door of and each IDF. Furnish an electronic copy of final comprehensive schedules for Project.

C. Provide photographs of the completed concentrator enclosures with all active and passive components included with the typewritten directories of the concentrator's. Photographs shall be included with documents in the concentrator print pockets and also in a three ring binder at the MDF.

D. E911 Compliance: Contractor to provide CPS ITS with an electronic copy of floor plans to include all voice jacks with their respective jack numbers indicated. VISIO is the desired format to be used.

3.15 CLEANING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for cleaning.

3.16 COMMISSIONING AND DEMONSTRATION

A. Comply with requirements in Section 27 05 03 - Communications General Requirements for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

END OF SECTION 27 05 53

SECTION 27 05 53.01 (LNK)

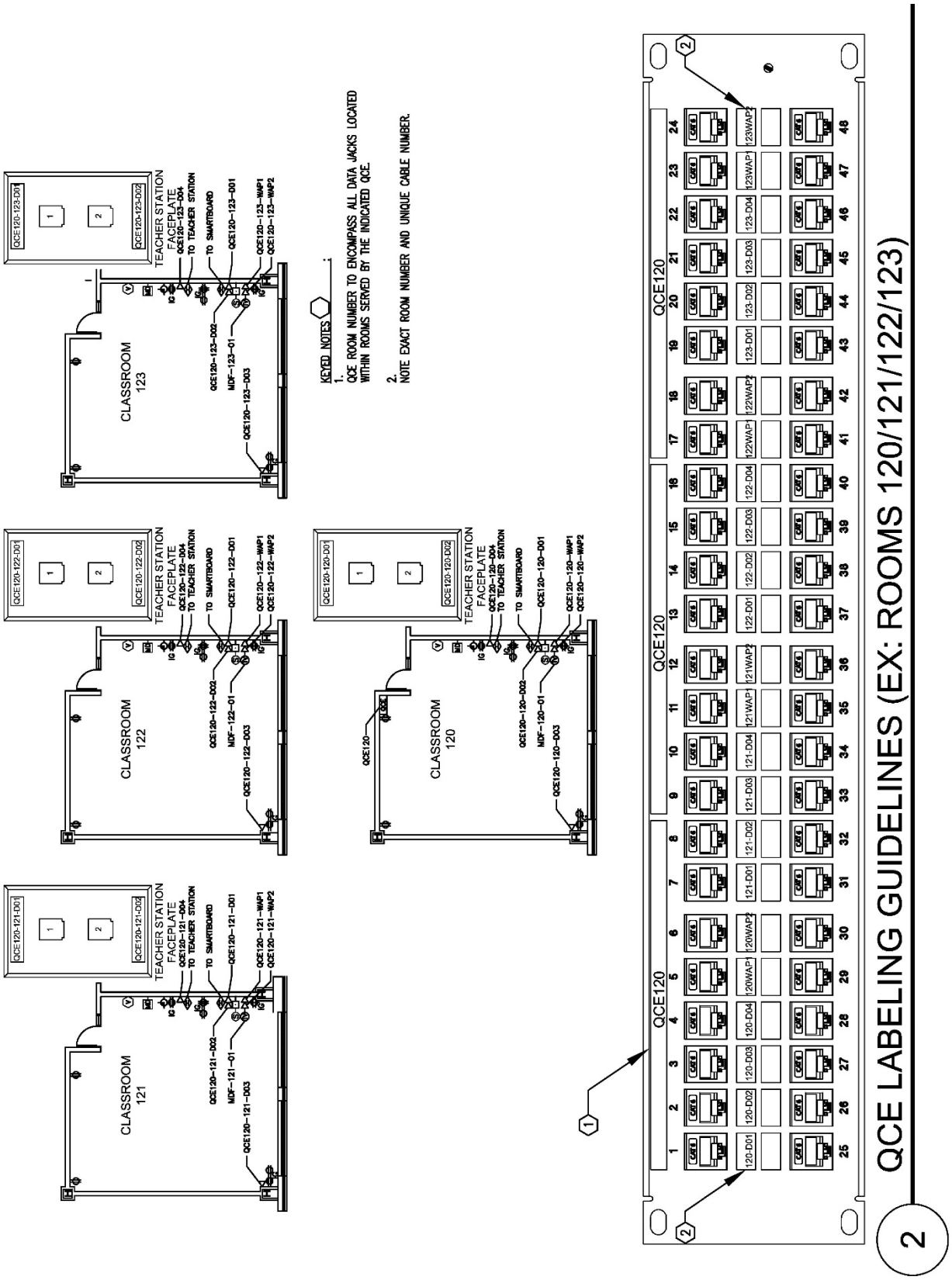
CABLE AND CONDUIT LABELING GUIDELINES

Cables and Conduits

From	To	Fiber Optic Cable	Copper High Pair Count	Conduit	Data Cat 6	Voice Cat 5e	TV Coax	WAP Cat 6	CCTV Cat 6	Projector HDMI
MDF	IDF	MDF-IDF-01	MDF-IDF-01							
MDF	Roof			MDF-ROOF-01						
MDF	Concentrator	MDF-QCE115	MDF-QCE115	MDF-QCE115						
IDF	Concentrator	IDF-QCE115	IDF-QCE115	IDF-QCE115						
MDF	Workstation					MDF-115-V01	MDF115-01			
Concentrator	Workstation/ Device				QCE115-115-D01	QCE115-115-V01		QCE115-115-WAP1	QCE115-115-C01	
Teacher Station	Overhead Projector									TO OVERHEAD PROJECTOR
										TO TEACHER STATION
Teacher Station	Smartboard/ Short-Throw Projector									TO SMARTBOARD
										TO TEACHER STATION

Labeling Notes

1. ASSUME THAT THE CLASSROOM ROOM NUMBER IS 115 AND THERE IS A QCE IN THE ROOM.
2. IF THERE ARE TWO CONDUITS GOING TO THE ROOF, THE SECOND CABLE WOULD BE LABELED 'MDF-ROOF-02'.
3. IF THERE ARE MORE THAN ONE FIBER OPTIC CABLES GOING FROM THE MDF TO THE IDF, THEN THE SECOND CABLE SHALL BE LABELED 'MDF-IDF-02'.
4. IF THERE ARE MORE THAN ONE COPPER HIGH PAIR COUNT CABLES GOING FROM THE MDF TO THE IDF, THEN THE SECOND CABLE SHALL BE LABELED 'MDF-IDF-02'.
5. THE SECOND DATA CAT 6 CABLE WITHIN A ROOM SHALL HAVE THE DESIGNATION -D02, THIRD DATA SHALL BE LABELED -D03 AND SO FORTH.
6. IF THERE ARE MORE THAN ONE WAP WITHIN A ROOM, THE SECOND WAP SHALL BE LABELED -WAP2 AND SO FORTH.
7. VOICE JACKS FROM 25 PAIR 110 RACK MOUNTED IN CONCENTRATOR ENCLOSURES SHALL BE LABELED 'QCE115-115-V01'.



END OF SECTION

SECTION 27 08 00 (LNK)

COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Section defines the tests and checks that shall be made on all communications hardware and wiring to ensure compliance with the requirements of the Contract Documents.

B. Commissioning of communications.
1. Performance tests for UTP and fiber optic structured cabling.
2. Preparation of test and inspection reports.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

B. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2017.

C. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling; 2006.

D. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard. (consists of 3 Parts, listed below); Rev C, 2012, and latest addenda.

E. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Rev A, 2015.

F. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Rev C, 2015.

G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.

H. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Rev C, 2009 (with Addenda; 2016).

I. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Rev C, 2008 (with Addenda; 2011).

J. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

K. TIA-606-B - Administration Standard for Telecommunications Infrastructure; Rev B, 2012 (with Addenda; 2015).

L. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
2. Coordinate activities and cooperate with others on the Project to ensure that communications systems are installed and fully tested in a timely basis to permit installation of Board Authorized Representation's installed communications equipment and connections.
3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
5. Conduct tests and present test results to the Architect/Engineer of Record, the Construction Manager, and the CPS Office of Information & Technology Services (ITS).
6. Final payment will not be issued until complete testing and compliant test results of all equipment, cabling, and connectivity is determined and submitted.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of product.

B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Board.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:
a. Cross-connects.
b. Patch panels.
c. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Evidence of qualifications for installer.

D. Field Test Reports.

E. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. Record actual locations of outlet boxes and distribution frames.
2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify distribution frames and equipment rooms by room number on contract drawings.

F. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Comply with requirements of Section 27 05 03 - Communications General Requirements for installer qualifications as noted in "Quality Assurance" Article.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

C. Comply with City of Chicago Building Code.

D. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

E. Grounding: Comply with TIA-607-C.

1.07 WARRANTY

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PHOTOGRAPHS

A. Provide photographs of the completed MDF or IDF(s), and concentrator enclosures with all active and passive components installed, including the typewritten directories of the concentrator enclosures and the MDF or IDF(s).
1. Each photograph shall each be imprinted with a Date/Time stamp.
2. Photographs shall be minimum 3.5” x 5” in size.

B. Photographs shall be included with documents at the concentrator enclosure locations and also in a full three ring binder located in the MDF or IDF(s) respectively for future reference

3.02 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:
1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568.
2. Visually confirm Category 6 marking of outlets, outlet/connectors, and patch panels for horizontal UTP cabling for Data/Wireless, Kronos and MMTV applications.
3. Visually confirm Category 5e marking of outlets, outlet/connectors, termination blocks and patch panels for horizontal UTP cabling voice and 25-pair Category 5e backbone applications.
4. Visually confirm Category 3 marking of copper backbone UTP cables for indoor voice backbone applications.
5. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
6. Inspect cable terminations for color coded labels of proper type.

C. Copper UTP Cable Tests:
1. Copper UTP Test Instruments:
a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568. Perform tests with a tester that complies with performance requirements in "Test

Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for permanent link test configuration.

b. For horizontal UTP cable certification tests, use a Level III tester.

2. Copper Backbone UTP Cable Tests:
   a. Test copper backbone UTP cabling for DC loop resistance, shorts, opens, intermittent faults, polarity between conductors, and for insertion loss (attenuation). Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
3. UTP Performance Tests:
   a. Test permanent link for each outlet. Perform the following tests according to TIA/EIA-568:
      1) Wire map.
      2) Length (physical vs. electrical, and length requirements).
      3) Insertion loss.
      4) Near-end crosstalk (NEXT) loss.
      5) Power sum near-end crosstalk (PSNEXT) loss.
      6) Equal-level far-end crosstalk (ELFEXT).
      7) Power sum equal-level far-end crosstalk (PSELFEXT).
      8) Return loss.
      9) Propagation delay.
      10) 1Delay skew.
   b. Testing for Category 6 horizontal UTP must additionally report values for attenuation-to-crosstalk ratio (ACR), and power sum attenuation-to-crosstalk ratio (PSACR).
   c. A star (“*”) passing shall not be considered acceptable.

D. Optical Fiber Cable Tests:
1. Optical Fiber Test Instruments:
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
2. Optical Time Domain Reflectometry Tests: After terminating optical fiber cables, one individual fiber from each backbone cable installed shall be tested using an optical time domain reflectometer (OTDR). Perform OTDR testing in accordance with manufacturer’s recommended test procedures. Test to determine the installed length, continuity, and OTDR-based attenuation measurement. Provide test report identifying backbone cable identification and indicating corresponding values from tests.
3. Link End-to-End Attenuation Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568.
   a. Multimode backbone link measurements: Test at 850 or 1300 nm in both directions according to TIA-526-14-A, Method B, One Reference Jumper.
   b. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568.
   c. These readings must not be higher than the "Optimal Attenuation Loss (OAL)". The OAL will be calculated using the manufacturer's factory certified test results, (db/km) adjusted for the actual installed lengths (dBs) plus the manufacturer's best published attenuation losses for the connector on this project and/or splice installed on this project (0.25dB for Connectors and 0.10dB for splices).
   d. Link End-to-End Attenuation Test reports shall include:
      1) Cable identification and Strand numbers.
      2) The OAL value for each link.
      3) The theoretical maximum attenuation value, per TIA/EIA-568, for each link.
      4) Tested values for attenuation.

E. HDMI Cable Test - Conduct approved cable tests on all HDMI cables and provide written results to Board. All HDMI cables should meet or exceed industry standards for HDMI cable performance (based on the HDMI Specification Version the specified installed cable is rated to). At a minimum the report shall contain picture confirmation of connectivity between all endpoints of the HDMI or CAt6/HDMI locations.

F. Document data for each measurement. Data for submittals shall be transferred from the instrument to the computer, saved as CSV files to a CD, DVD, or portable drive and submitted.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections. Correct failures and retest to demonstrate compliance; otherwise, remove and replace with new components and retest to demonstration compliance with requirements.

H. Prepare test and inspection reports.

3.03 FIRESTOPPING

A. Inspect and verify all fire stopped locations comply with:
1. Requirements in Section 07 84 00 - Firestopping.
2. Comply with TIA-569-D, Annex A, "Firestopping."
3. Comply with BICSI TDMM, "Firestopping Systems" Article.

B. Correct any deficiencies.

3.04 GROUNDING

A. Inspect and verify all grounding and bonding has been installing according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter, and complies with TIA-607-C.

B. Verify all floor-mounted racks, overhead ladder rack and concentrator enclosures are bonded to communications bus bar.

3.05 IDENTIFICATION

A. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for **IDFs,** concentrator enclosures, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Furnish electronic record of all drawings, in software and format selected by the Board.

3.06 DEMONSTRATION

A. Train Board designated maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Schedule training with at least seven days' notice.

3.07 CLEANING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for cleaning.

END OF SECTION 27 08 00

SECTION 27 13 13 (LNK)

COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Copper cable and terminations.
   1. Copper UTP cabling for backbone applications.
   2. Cable connecting hardware, termination panels, and cross-connects for copper UTP backbone cabling.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. 7 CFR PART 1755 - Telecommunications Policies on Specifications. Acceptable Materials and Standard Contract Forms; 2016.

B. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

C. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2018.

D. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Revision E, 2005.

E. ICEA S-84-608 - Telecommunications Cable Filled, Polyolfin Insulated, Copper Conductor Technical Requirements; 2017.

F. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; 2012.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

H. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling; 2006.

I. NFPA 70 - National Electrical Code; 2017.

J. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard. (consists of 3 Parts, listed below); Rev C, 2012, and latest addenda.

K. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.

L. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Rev C, 2009 (with Addenda; 2016).

M. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

N. TIA-606-B - Administration Standard for Telecommunications Infrastructure; Rev B, 2012 (with Addenda; 2015).

O. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

P. UL 1666 - Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Edition 5, 2007.

Q. UL 444 - Communications Cables; Current Edition, Including All Revisions.

R. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
2. Coordinate layout and installation of pathways for communications backbone cabling with location of communications rooms, enclosures, site entrances, etc. and termination frames and hardware therein.
3. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
4. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of product.

B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Board.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:
   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Evidence of qualifications for installer.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.
1. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Comply with requirements of Section 27 05 03 - Communications General Requirements for installer qualifications as noted in “Quality Assurance” Article.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Comply with City of Chicago Building Code.

E. Grounding: Comply with TIA-607-C.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for delivery, storage and handling of materials provided under this Section.

B. Test cables upon receipt at Project site.
1. Test each pair of UTP cable for open and short circuits.

1.08 WARRANTY

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Connecting Blocks: One of each type.

PART 2 - PRODUCTS

2.01 SYSTEM DESIGN

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
1. Comply with TIA-568 (SET) (cabling) and TIA-569-D (pathways), latest editions (commercial standards).
2. Comply with Communications Service Provider requirements.
3. Provide fixed cables and pathways that comply with City of Chicago Building Code and TIA-607-C and are UL listed or third party independent testing laboratory certified.

4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

2.02 COPPER CABLE AND TERMINATIONS

A. Copper Backbone Cable:
1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568-C.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
2. Cable Type: TIA-568-C.2 Category 3 UTP (unshielded twisted pair); No.24 AWG.
3. Cable Capacity: Quantity of pairs as indicated on drawings.
4. Cable Applications:
   a. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.

B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

2.03 INDOOR CATEGORY 3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Berk-Tek; a Nexans company; www.nexans.us.
2. General Cable Technologies Corporation; www.generalcable.com.
3. Mohawk; a Division of Belden CDT; www.mohawk-cable.com.
4. Superior Essex Inc.; www.spsx.com.

B. Description:
1. Conductors: No. 24 AWG, 100-ohm, solid annealed copper; Pair size as indicated in Contract Drawings.
2. Insulation: Polyolefin or flame-retardant semi-rigid PVC, color coded in accordance with telephone industry standards.
3. Core Assembly: Cables 25-pairs and less assemble pairs in a single group. Cables larger than 25-pairs arrange pairs in 25-pair units with color-coded unit binders.
4. Jacket: Flame-retardant PVC.
5. Jacket Markings: Include manufacturer’s identification, pair count, AWG, product identification at 2-foot intervals along cable jacket.
6. Comply with ICEA S-90-661 and TIA/EIA-568, Category 3.
7. Listed: Type CMR complying with UL 1666.
8. Cable Jacket Color: Gray, Natural, or White.

2.04 OUTSIDE-PLANT UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. General Cable Technologies Corporation; www.generalcable.com.
2. Superior Essex, Inc.; www.spsx.com.
3. Or Equal.

B. Backbone OSP Foam Skin Filled Copper Cable: Permits extension of telecommunication services in a multi-building environment, extending from the main cross-connect to the intermediate cross-connect in each building being served.

1. Conductors: No. 24 AWG, 100-ohm, solid annealed copper; Pair size as indicated in Contract Drawings.
2. Insulation: Dual insulated conductors with inner layer of foamed polyolefin covered by an outer solid, colored polyolefin skin. Color coded in accordance with telephone industry standards.
3. Core Assembly: Cables 25-pairs and less assemble pairs in a single group. Cables larger than 25-pairs arrange pairs in 25-pair units with color-coded unit binders.
4. Filling Compound: Entire core assembly completed filled with ETPR compound, completely filling interstices between the pairs and under the core wrap.
5. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally.
6. Shielding: Corrugated, copolymer coated 8-mil aluminum tape applied longitudinally with an overlap. Shield interfaces to be flooded.
7. Jacket: Black, linear low-density polyethylene.
8. Jacket Markings: Include manufacturer's identification, pair count, AWG, product identification at 2-foot intervals along cable jacket.
9. Comply with ICEA S-84-608 and 7 CFR PART 1755 (PE-89).

2.05 INDOOR 25-PAIR CATEGORY 5E UTP CABLE

A. Manufacturers of Cable: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Belden IBDN Plus; www.belden.com.
2. Berk-Tek; a Nexans company; www.nexans.us.
3. General Cable Technologies Corporation; www.generalcable.com.
4. Mohawk; a Division of Belden CDT; www.mohawk-cable.com.
5. Superior Essex Inc.; www.spsx.com.
6. Uniprise PowerSUM61 Series/Commscope; www.commscope.com.

B. Cable Description: 100-ohm, 25-pair UTP, minimum No.24AWG, with all pairs grouped in a single bundle, covered with a thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568 for performance specifications.
3. Comply with TIA-568-C.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and City of Chicago Electrical Code for the following types:
   a. Communications, Riser Rated: Type CMR, complying with UL 1666.
   b. Jacket color: Gray.

2.06 BACKBONE UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Belden IBDN Plus; www.belden.com.
2. Commscope; www.commscope.com.
3. Hubbell Inc., Hubbell Premise Wiring; www.-hubbell-premise.com.
4. Leviton Manufacturing Co., Inc., Leviton Voice & Data Division; www.leviton.com.
5. Ortronics / Legrand Inc.; www.legrand.us.
6. Panduit Corporation; www.panduit.com.

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, Category 5e. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Wire to TIA/EIA T568B pin configuration.

C. 110A Termination Block: 110-style frame assembly, with legs, used for termination of all horizontal UTP cabling for voice communications.

1. Be constructed of flame-retardant thermoplastic, with strips for terminating a series of individual four-pair cable conductors, with legs for offset mounting.
2. Have access openings for rear to front cable routing to the point of termination.
3. Accommodate termination of wire sizes: Solid No.22-26 AWG.
4. Size: Standard 100-pair or 300-pair footprint, as indicated in Contract Drawings.
5. Capacity: Adjust quantity of blocks based on number of cables to be terminated plus 25 percent spare.
6. Field-terminate, to facilitate future cross- and/or inter-connections, as follows:
   a. For indoor and outside plant copper backbone multi-pair cables, utilize C5 clips terminated over all pairs.
   b. For 25-pair Category 5e UTP backbone cables, utilize C4 clips terminated over pairs 1 - 20 and one C5 clip terminated over pairs 21 - 25.
7. Be equipment with designations strip kits for administrative labeling system:
   a. Designation strips (labels).
   b. Plastic holders (brackets for labels).
8. UL Listed per UL 1863.
9. Concentrator Enclosure: Provide Rack Mounted 5e 110-Style Wiring Block: 24/25 Category 5e pair termination panel Leviton Part Number 010-41DR2-100.

D. 110A Jumper Trough: 110-system trough, with mounting legs, for management of cross-connect jumper pairs routed between 110 termination blocks.
1. Be constructed of flame-retardant thermoplastic.
2. Have access openings to permit cable routing between points of termination.
3. Width: To match 110 Termination Block.
4. Provide above and below each 110 Termination Block. Provide with mounting legs.

E. Patch Panel: Modular panel housing multiple-numbered units with integral front 8-position RJ45 modular opening and rear IDC-type connectors for each port, used for permanent termination of pair groups of installed cables.
1. Number of Ports: 24.
2. Capacity: Provide quantity of panels sufficient for number of cables to be terminated.
3. Mounting: Rack-mount, complying with EIA/ECA-310 standard for 19 inch width.
4. Identification: Permanently imprinted sequentially numbered identification of ports, and clear space above ports for an administrative labeling system to accommodate machine-labeled identification of individual jack ports.
5. Horizontal cable termination on rear of panel. Provide incoming cable strain relief and routing guides on back of panel.
6. Color: Black.
7. Terminations of the 25-pair cable at the patch panel shall begin with port number one (1) and continue through port six (6):
   a. Terminate binder group in 4 pair increments, in sequence, at ports 1 through 6. Wrap 25th pair around cable jacket and reserve for future use.

F. 66 Connecting Block: 50-pair termination block used for legacy termination of copper UTP cabling for voice communications.
1. Be constructed of flame-retardant thermoplastic.
2. 25-pair x 2 sided block (66M1-50), capable of terminating up to 50 cable pairs.
3. Terminates No.22 - 26 AWG solid insulated cable.
4. Provided with fanning strips for management for backbone cabling pairs and cross-connect jumper wires.
5. Provided with S89B stand-off bracket.
6. Provided with bridging clips for cross-connection of cable pairs.
7. Be equipment with hinged snap-on cover providing for administrative labeling system:
   a. Designation insert (label).

2.07 HINGED COVER (INTERIOR MOUNTING OF LABEL)PATHWAYS

A. General Requirements: Comply with TIA-569-D.

B. Cable Support: NRTL labeled, designed to prevent degradation of cable performance and pinch points that could damage cable. Use to train and manage communications cabling routed on plywood backboard.
1. Lacing bars, spools, and D-rings.

C. Ladder Rack Runway: Comply with requirements of Section 27 11 16 - Communications Cabinets, Racks, and Enclosures.
1. Used for routing of communications cabling within MDF.

D. Conduit and Boxes: Comply with requirements in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems and 26 05 33.23 - Surface Raceways for Electrical Systems. Flexible metal conduit shall not be used.

2.08 GROUNDING

A. Comply with requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems for grounding conductors and connectors.

B. Comply with TIA-607-C.

2.09 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569-D (pathways), TIA-607-C (grounding and bonding), NECA/BICSI 568, City of Chicago Electrical Code, and SYSTEM DESIGN as specified in PART 2.

B. Comply with Communication Service Provider requirements.

C. Grounding and Bonding: Perform in accordance with TIA-607-C and City of Chicago Building Code.

D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00 - Firestopping.

3.02 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by telecommunications service provider.P

B. Install underground pathways complying with recommendations in TIA-569-D, "Entrance Facilities" Article.
1. Install [underground][buried][aerial] entrance pathway complying with requirements in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.

3.03 WIRING METHODS AND INSTALLATION OF PATHWAYS

A. Wiring Method: Install cables in raceways dedicated to copper backbone cabling. Conceal raceway except in unfinished spaces.
   1. Comply with requirements for raceways and boxes and their installation specified in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.
   2. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop per requirements of this Section. Provide and use lacing bars and distribution spools.

C. Wiring within MDF: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop per requirements of this Section. Utilize overhead ladder rack runway for cable routing within room(s). Provide and use lacing bars and distribution spools for wire routing and management on plywood backboard.

D. Comply with requirements for ladder rack runway, cabinets, and racks specified in Section 27 11 16 - Communications Cabinets, Racks, and Enclosures. Drawings indicate general arrangement of pathways and fittings.

3.04 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA/EIA-568.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Install 110-style IDC termination hardware unless otherwise indicated.
   4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   5. Cables may not be spliced. Secure and support cables not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Do not over-cinch or crush cables.
   6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than 4X cable diameter. Install lacing bars and distribution spools.
   8. Hook and loop (Velcro)-style cable ties shall be used to bundle and secure exposed cables in the concentrator enclosures and MDF/IDF rooms. Use of plastic cable ties is not permitted.
   9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   10. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
   11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions, and do not exceed manufacturer’s recommended cable pull tension.
   12. When installing in conduit, use only lubricant approved by cable manufacturer and do not chafe or damage outer jacket.
   13. Service Loops: Provide the following minimum extra length of cable, dressed and routed neatly:

a. At MDF frames: 60 inches, neatly installed in vertical wire manager or accommodated by additional routing around overhead ladder rack runway.
b. At Concentrator Enclosures - Terminated Cables: 24 inches, neatly secured inside housing.

C. UTP Cable Installation:
1. Comply with TIA-568-C.2.
2. Maintain pair twists as close as possible to point of termination, but do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Concentrator Enclosures: No cabling is to be routed down through the center area of the enclosure so as to inhibit the installation of network electronics.
4. MDF: Install and route cabling on overhead ladder rack runway and within horizontal and vertical cable guides to terminating hardware.
5. Terminate backbone cables, using T568B pinout configuration, to termination hardware as follows:
a. Indoor Category 3 UTP and OSP UTP cables: to 110 termination block(s) at each end, mounted to plywood backboard.
1) For indoor and outside plant copper backbone multi-pair cables, utilize C5 clips terminated over all pairs.
b. Indoor Category 5e UTP cables - IDF:to 110 termination block(s), mounted to plywood backboard.
1) For 25-pair Category 5e UTP backbone cables, utilize C4 clips terminated over pairs 1 - 20 and one C5 clip terminated over pairs 21 - 25.
c. Indoor Category 5e UTP cables - Concentrator Enclosures: to rack-mounted Category 5e patch panel. Terminate binder group in 4 pair increments, in sequence, at ports 1 through 6. Wrap 25th pair around cable jacket and reserve for future use.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources: Comply with requirements of Section 27 05 03 - Communications General Requirements.

3.05 FIRESTOPPING

A. Comply with requirements in Section 07 84 00 - Firestopping.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING

A. Comply with TIA-607-C.

B. Bond metallic cable shields to the communications grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

C. Bond metallic equipment to the communications grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION

A. Comply with requirements in Section 27 05 53 - Identification for Communication Systems.

3.08 CLEANING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for cleaning.

3.09 COMMISSIONING AND DEMONSTRATION

A. Comply with requirements in Section 27 08 00 - Commissioning of Communications for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

END OF SECTION 27 13 13

SECTION 27 13 23 (LNK)

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Optical Fiber Backbone Cabling.
   1. 50/125-micrometer, optical fiber cabling.

B. Fiber optic cable interconnecting devices.
   1. Cable connecting hardware, termination panels, and cross-connects.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

B. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2018.

C. ICEA S-104-696 - Indoor-Outdoor Optical Fiber Cable; 2013.

D. ICEA S-83-596 - Indoor Optical Fiber Cables; 2016.

E. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling; 2006.

F. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces; 2015.

G. NFPA 70 - National Electrical Code; 2017.

H. TIA/EIA-604-12 - FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ; 2000.

I. TIA-455-204 - FOTP-204 Measurement of Bandwidth on Multimode Fiber; 2013.

J. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Rev A, 1988 (R2012).

K. TIA-455-220 - FOTP-220 Differential Mode Delay Measurement of Multimode Fiber in the Time Domain; 2003.

L. TIA-492AAAC-B - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association; 2009.

M. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.

N. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Rev C, 2008 (with Addenda; 2011).

O. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

P. TIA-598-D - Optical Fiber Cable Color Coding; Rev D, 2014.

Q. TIA-604-2 - FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST; 2004.

R. TIA-604-3 - FOCIS 3 Fiber Optic Connector Intermateability Standard- Type SC and SC-APC; 2004.

S. TIA-606-B - Administration Standard for Telecommunications Infrastructure; Rev B, 2012 (with Addenda; 2015).

T. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

U. UL 1666 - Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Edition 5, 2007.

V. UL 444 - Communications Cables; Current Edition, Including All Revisions.

W. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of product.

B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:
   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Evidence of qualifications for installer.

D. Source quality-control reports.

E. Field Test Reports.

F. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
1. Record actual locations of outlet boxes and distribution frames.
2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
3. Identify all splices and connectors.
4. Identify distribution frames and equipment rooms by room number on contract drawings.

G. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Comply with requirements of Section 27 05 03 - Communications General Requirements Article "Quality Assurance," paragraph "Installer Qualifications."

B. Regulatory Requirements:
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, by UL or another qualified testing agency, acceptable to the authorities having jurisdiction, and marked for intended location and application.
2. Comply with the City of Chicago Building Code.

C. Grounding: Comply with TIA-607-C.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for delivery, storage and handling of materials.

B. Immediately upon receipt of fiber optic cables at Project site, test cables for continuity end to end. Use optical fiber flashlight or optical loss test set.

1.08 WARRANTY

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance.

PART 2 - PRODUCTS

2.01 SYSTEM DESIGN

A. Optical fiber backbone cabling system shall provide interconnections between the IDF, and Concentrator Enclosures in the telecommunications cabling system infrastructure. Cabling system consists of backbone cables, intermediate, mechanical terminations, and patch cords or jumpers used for backbone-to-equipment connections.

B. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.

1. Comply with TIA-568 (SET) (cabling) and TIA-569-D (pathways), latest editions (commercial standards).
2. Provide fixed cables and pathways that comply with City of Chicago Electrical Code and TIA-607-C and are UL listed or third party independent testing laboratory certified.
3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

2.02 CROSS LISTING OF OPTIC FIBER MANUFACTURERS

A. Cross listed solution products shall be selected and installed so as to provide the Board with warranty complying with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance. Manufacturers of Optical Fiber Backbone Cable and Manufacturers of Optical Fiber Connecting Hardware and Patch Cords must be selected and utilized together on project as follows:
1. Belden Fiber Express Cable Product Solution; www.belden.com.
2. Berk-Tek with Leviton solution; www.nexans.us.
3. Commscope/Uniprise LaserCore solution; www.commscope.com.
4. Corning Optical Communications; www.corning.com.
5. General Cable Technologies Corp. with Panduit Corp.: PanGen Plus10GBE solution; www.generalcable.com.
6. Mohawk with Hubbell Premise Wiring: SureBit SureLight solution; www.mohawk-cable.com.
7. Superior Essex Inc. with Ortronics Voice & Data: solutions; www.spsx.com.
8. Tyco Electronics/AMP Netconnect: XG System solution; www.te.com.

2.03 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Backbone Cable:
1. Manufacturers: Subject to compliance with requirements of this Section, provide products by one of the following manufacturers:
   a. Belden Fiber Express Cable Product Solution; www.belden.com.
   b. Berk-Tek; a Nexans company, GIGAlite10(EB) series; www.nexans.us.
   c. Uniprise LaserCore solution; www.commscope.com.
   d. Corning Optical Communications; www.corning.com.
   e. General Cable Technologies Corporation, Nextgen G10X (Type BI/BE) series; www.generalcable.com.
   f. Mohawk; a Division of Belden CDT, AdvanceLite Grade 5 series; www.mohawk-cable.com.
   g. Superior Essex Inc., TeraGAIN 10G series; www.spsx.com.
   h. Tyco Electronics/AMP Netconnect; Tyco International Ltd., XG System series; www.te.com.

B. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568-C.3, TIA-598-D, ICEA S-83-596 and listed as complying with UL 444 and UL 1651, and City of Chicago Electrical Code for the following types:
1. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
2. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

C. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC-B.
1. Comply with IEEE 802.3ae standard for 10 GB Ethernet transmission at 850nm window.
2. Cable Capacity: Quantity of fibers as indicated on drawings.

D. Cable Applications:
1. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.

2. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.

E. Cable Jacket:
1. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua (unless otherwise indicated).
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-568-C.3.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Product(s):
1. Indoor 10G/150M Multimode Fiber-Optic Cable: 50/125-micrometer, laser-optimized multimode optical fiber, capable of 10-Gigabit Ethernet transmission up to 492 feet (150 meters), for use in indoor-applications only.
   a. Strand Count: 6 (IDF to enclosures), and 12 MDF to IDF.
   b. Maximum Attenuation: 3.00 dB/km at 850 nm; 1.0dB/km at 1300 nm.
   c. Minimum OFL Bandwidth: 700 MHz-km at 850 nm; 500 MHz-km at 1300 nm, as characterized by OFL (overfill launch) measurement per TIA-455-204.
   d. Cable shall meet or exceed the OM3 standard.
2. Indoor 10G/300M Multimode Fiber-Optic Cable: 50/125-micrometer, laser-optimized multimode optical fiber, optimized for VCSEL-based transmission of 10-Gigabit Ethernet up to 984 feet (300 meters), for use in indoor-applications only.
   a. Strand Count: 6 (IDF to enclosures), and 12 MDF to IDF.
   b. Maximum Attenuation: 3.0 dB/km at 850 nm; 1.0dB/km at 1300 nm.
   c. Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm; 500 MHz-km at 1300 nm, as characterized by DMD measurement per TIA-455-220.
   d. Cable shall meet or exceed the OM3 standard.
3. Indoor-Outdoor 10G/300M Multimode Fiber-Optic Cable: 50/125-micrometer, laser-optimized multimode optical fiber, optimized for transmission of 10-Gigabit Ethernet up to 984 feet, with riser-rated jacket permitting cable to run from the outside plant environment to a building's first cross-connect point without a transition at the building entrance.
   a. Strand Count: 12 (MDF to IDF).
   b. Loose tube design, utilizing a dry water-blocking agent in the interstices between and/or around 250-micron fiber strands and tube(s), fitted with 900-micron buffer fan-out kit at termination.
   c. Maximum Attenuation: 3.0 dB/km at 850 nm; 1.0dB/km at 1300 nm.
   d. Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm; 500 MHz-km at 1300 nm, as characterized by DMD measurement per TIA-455-220.
   e. Comply with ICEA S-104-696 for mechanical properties.
   f. Cable Jacket Color: Aqua.

G. Fiber Optic Interconnecting Devices:
1. Manufacturers: Subject to compliance with requirements of this Section, provide products by one of the following manufacturers:
   a. Belden Fiber Express Product; www.belden.com.
   b. Corning Optical Communications; www.corning.com.
   c. Hubbell Inc., Hubbell Premise Wiring; www.hubbell-premise.com.
   d. Leviton Manufacturing Co., Inc., Leviton Voice & Data Division; www.leviton.com.
   e. Ortronics / Legrand, Inc.; www.legrand.us.
   f. Panduit Corporation; www.panduit.com.
   g. Tyco Electronics/TE Netconnect; Tyco International Ltd.; www.te.com.
   h. Uniprise; www.commscope.com.
2. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA-604-2, TIA-604-3, and TIA/EIA-604-12. Comply with TIA-568-C.3.
3. Fiber Optic Termination Housing: Rack-mounted, with multi-numbered, duplex connector insert adapter panels holding fiber optic strand connectors.

a. General: Housing shall be modular in design with management clips that provide slack storage to comply with optical fiber bend radius and the recommended slack storage length, and be equipped with pullout tray for front access to fiber terminations and rear of adapter panels. Housing shall have:
   1) Administrative labeling system for identification of individual fiber ports.
   2) Anchor points and strain relief for entry of optical cable into the unit.
   3) Recessed adapter panel face, with front-mounted door that is secured with a keyed cylinder lock, clasp, or tab insert.
b. Size - Concentrator Enclosures: One (1) rack unit high; sized to accommodate a total of two (2) adapter panels.
c. Size - MDF: Three (3) rack units high; sized to accommodate at least six (6) adapter panels.
d. Adapter Panels: Housing to be fitted out with adapter panels, each able to accommodate six (6) duplex LC-style quick-connect couplers (12 strands total), with blank adapter panels at all unused housing panel slots. Provide in quantity required to accommodate quantity of fiber optic cables served by housing.

4. Fiber Patch Cords: Board to provide all patch cords, information below is for reference only.
   a. Patch cords shall be factory-made, dual-fiber design, from the same manufacturer and consistent with components and performance level of cross-listed solutions indicated.
   b. Specification of fiber optic patch cord shall match fiber optical backbone served by cord.
      1) Multimode, including 10 Gigabit Ethernet transmission requirements for laser-optimized 50/125 micrometer multimode fiber optic cabling.
   c. Connectorization: Type LC to Type LC.
   d. Jacket Color: Aqua.
   e. Quantity: Provide two (2) patch cords for each optical fiber backbone cable installed on Project, as follows:
      1) One (1) in 1-meter length.
      2) One (1) in 2-meter length.
5. Optical Cable Connectors:
   a. Field-terminated, quick-connect, simplex and duplex, Type LC connectors.
   b. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
   c. Maximum Attenuation/Insertion Loss: 0.3 dB.
   d. Color: Aqua.

2.04 PATHWAYS

A. General: Comply with TIA-569-D.

B. Cable Support: NRTL labeled, designed to prevent degradation of cable performance and pinch points that could damage cable. Use to train and manage communications cabling routed on backing panel. Include lacing bars, spools, and D-rings.

C. Ladder Rack Runway: Comply with requirements of Section 27 11 16 - Communications Cabinets, Racks, and Enclosures. For routing of communications cabling within MDF.

D. Conduit and Boxes: Comply with requirements in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems. Flexible metal conduit shall not be used.

2.05 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607-C.

2.06 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B.

B. Comply with requirements of Section 27 05 53 - Identification for Communication Systems.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569-D (pathways), TIA-607-C (grounding and bonding), NECA/BICSI 568, City of Chicago Electrical Code, and SYSTEM DESIGN as specified in PART 2.

B. Comply with Communication Service Provider requirements.

C. Grounding and Bonding: Perform in accordance with TIA-607-C and City of Chicago Electrical Code.

3.02 WIRING METHODS AND INSTALLATION OF PATHWAYS

A. Wiring Method: Install cables in raceways dedicated to optical fiber backbone cabling. Conceal raceway except in unfinished spaces.
   1. Comply with requirements for raceways and boxes and their installation specified in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.
   2. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop as specified. Provide and use lacing bars and distribution spools.

C. Wiring within IDF: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop as specified. Utilize overhead ladder rack runway for cable routing within room(s).

D. Comply with requirements for ladder rack runway, cabinets, and racks specified in Section 27 11 16 - Communications Cabinets, Racks, and Enclosures. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA-568 (SET).
   2. Comply with BICSI ITSIM, Chapter 6, "Cable Termination Practices."
   3. Hook and loop (Velcro) style cable ties shall be used to bundle and secure exposed cables in the concentrator enclosures and MDF/IDF rooms. Use of plastic cable ties is not permitted. Do not over-cinch or crush cables.
   4. Pulling Cable: Comply with BICSI ITSIM, Chapter 4, "Pulling Cable". Monitor cable pull tensions, and do not exceed manufacturer's recommended cable pull tension.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radius than minimums recommended by manufacturer.

6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than 10 x outside diameter of cable under no load, installed conditions, and not less than 20 x outside diameter of cable during pulling.
7. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated termination housings.
11. Cables may not be spliced. Secure and support cables at intervals not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
12. Service Loops: Provide the following minimum extra length of cable, dressed and routed neatly:
    a. At IDF frames: 60 inches, neatly installed in vertical wire manager or accommodated by additional routing around overhead ladder rack runway.
    b. At Concentrator Enclosures - Terminated Cables: 24 inches, neatly secured inside housing.

C. Fiber Optic Cabling:
1. Comply with TIA-568-C.3.
2. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
3. Support vertical cable at intervals as recommended by manufacturer.
4. Cables shall terminate with LC-type connectors secured in connecting hardware that is rack or enclosure mounted.
5. Concentrator Enclosures: No cabling is to be routed down through the center area of the enclosure so as to inhibit the installation of network electronics.
6. MDF/IDF: Install and route cabling on overhead ladder rack runway and within horizontal and vertical cable guides to terminating hardware.

D. Group connecting hardware for cables into separate logical fields.

3.04 FIRESTOPPING

A. Comply with requirements in Section 07 84 00 - Firestopping.

3.05 IDENTIFICATION

A. Comply with requirements in Section 27 05 53 - Identification for Communication Systems.

3.06 CLEANING

A. Comply with requirements in Section 27 05 03 - Communications General Requirements for cleaning.

3.07 COMMISSIONING AND DEMONSTRATION

A. Comply with requirements in Section 27 08 00 - Commissioning of Communications for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

END OF SECTION 27 13 23

SECTION 27 15 00 (LNK)
DATA COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Copper cable and terminations.
   1. Category 6 and Category 5e horizontal UTP cabling.
   2. Cable connecting hardware, patch panels, patch cords and cross-connects.
   3. HDMI and USB extender cabling.

B. Communications outlets.
   1. Telecommunications outlet/connectors.

C. Communications grounding and bonding.

D. Communications identification.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago, Title 14B, Building Code 2019.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements 2018.

C. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment Revision E, 2005.

D. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements 2012.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling 2006.

G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set 2019.

H. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards 2009, with Addendum (2016).

I. TIA-569-D - Telecommunications Pathways and Spaces 2015d, with Addendum (2016).

J. TIA-606-B - Administration Standard for Telecommunications Infrastructure Rev B, 2012 (with Addenda; 2015).

K. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises 2015c, with Addendum (2017).

L. TIA-968 - Telecommunications Telephone Terminal Equipment Technical Requirements for Connection of Terminal Equipment to the Telephone Network 2016.

M. UL 1666 - Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts Edition 5, 2007.

N. UL 444 - Communications Cables Current Edition, Including All Revisions.

O. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers Current Edition, Including All Revisions.

P. UL 1863 - Communications-Circuit Accessories Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Schedule a pre-installation conference for communications cabling installation with the ITS, Architect/Engineer of Record and Board's Representative.
   2. Coordinate layout and installation of telecommunications pathways and cabling with Board Representative's telecommunications and LAN equipment and service suppliers.
   3. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

4. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
5. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
6. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of product.
B. Shop Drawings: Show compliance with requirements on schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration.
D. Evidence of qualifications for installer.
E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Comply with requirements of Section 27 05 03 - Communications General Requirements for installer qualifications as noted in " Quality Assurance" Article.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in ANSI/IEEE 802.7, by a qualified testing agency, and marked for intended location and application.
C. Comply with City of Chicago Building Code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for delivery, storage and handling.

1.08 WARRANTY

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

A. HORIZONTAL CABLING DESCRIPTION
   1. Horizontal cable and its connecting hardware provide the means of transporting signals between the communications outlet/connector and the horizontal cross-connect located in the Concentrator Enclosure, and the MDF, and/or the IDF. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
      a. Bridged taps and splices shall not be installed in the horizontal cabling.
   2. The maximum allowable horizontal cable length is determined by the communications area serving that link, as follows:

a. For horizontal cabling served from a Concentrator Enclosure, the maximum allowable length is 141 feet.
b. For horizontal cabling served directly from the MDF or from the IDFs, the maximum allowable length is 295 feet.
c. The maximum allowable lengths do not include an allowance for patch cords.
d. HDMI cabling from the teachers faceplate to the overhead projector shall be as short as possible.

B. PERFORMANCE REQUIREMENTS
1. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568 (SET), when tested according to test procedures of this standard.
2. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
a. Comply with TIA-568 (SET) (cabling) and TIA-569-D (pathways), latest editions (commercial standards).
b. Provide fixed cables and pathways that comply with City of Chicago Building Code and TIA-607-C and are UL listed or third party independent testing laboratory certified.
c. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
d. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
3. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS
A. General Requirements: Comply with TIA-569-D.
B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable. Use to train and manage communications cabling routed on plywood backboard.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, and D-rings.
3. Hook and loop (Velcro) cable ties.
C. Ladder Rack Runway: Comply with requirements of Section 27 11 16 - Communications Cabinets, Racks, and Enclosures.
1. Used for routing of communications cabling within MDF and IDFs.
D. Conduit and Boxes: Comply with requirements in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems. Flexible metal conduit shall not be used.

2.03 CATEGORY 6 UTP CABLE AND CONNECTING HARDWARE
A. Category 6 UTP: Manufacturers of Cable: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Belden, Data Twist 4800; www.belden.com.
2. Berk-Tek; a Nexans company, Lanmark-2000 series; www.berktek.us.
3. General Cable Technologies Corporation, GenSPEED 6500 Premium; www.generalcable.com.
4. Hubbell Premise Wiring, Nextspeed C6E Enhanced; www.hubbell.com/hubbellpremisewiring/en
5. Superior Essex Inc., NextGain series; www.spsx.com.
B. Category 6 UTP: Manufacturers of Connecting Hardware and Patch Cords: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Belden, Key Connect Cat6E; www.belden.com.

2. Hubbell Inc., Hubbell Premise Wiring, NEXTSPEED series components; www.hubbell.com/hubbellpremisewiring/en/.
3. Leviton Manufacturing Co., Inc., Leviton Voice & Data Division, Extreme 6+ series components; www.leviton.com.
4. Ortronics Inc., Tech Choice Cat 6 KT2 Series; www.ortronics.com.
5. Panduit Corporation, NetGen Solution; www.panduit.com.

C. Cross-Listing: Cross listed solutions shall be selected and installed so as to provide the Board with warranty complying with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance. Manufacturers of Cable and Manufacturers of Connecting Hardware and Patch Cords must be selected and utilized together on project as follows:
1. Belden with:
   a. Belden Key Connect CAT6E.
2. Berk-Tek with:
   a. Leviton, Extreme 6+ Series.
3. General Cable Technologies Corp. with:
   a. Panduit Corp.: NetGen Solution.
4. Hubbell Premise Wiring with:
   a. Hubbell Premise Wiring NEXTSPEED Solution.
5. Superior Essex Inc. Nextgain 5400 with:
   a. Ortronics Tech Choice Cat 6 KT2 Series.

D. Category 6 UTP: Cable Description: 100-ohm, 4-pair UTP, minimum 23AWG, covered with a thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.2 for performance specifications.
3. Comply with TIA-568-C.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and ANSI/IEEE 802.7 for the following types:
   a. Communications, Riser Rated: Type CMR, complying with UL 1666.
5. Jacket color: Coordinated with system application as follows:
   a. Data/Wireless UTP system: Blue.
   b. Kronos Attendance UTP system: Green.
   c. CCTV system: Purple.
6. Cables shall be suitable for installation in a plenum application.

E. Category 6 UTP: General Requirements for Cable Connecting Hardware:
1. Comply with TIA-568-C.2, Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Wire to TIA/EIA T568B pin configuration.

F. Category 6 UTP: Patch Panel: Modular panel housing multiple-numbered units with integral front 8-position RJ45 modular opening and rear IDC-type connectors for each port, used for permanent termination of pair groups of installed cables.
1. Number of Ports: 48 as indicated in Contract Drawings.
2. Capacity: Provide quantity of panels sufficient for number of cables to be terminated plus 25 percent spare.
3. Mounting: Rack-mount, complying with EIA/ECA-310 standard for 19-inch width.
4. Identification: Permanently imprinted sequentially numbered identification of ports, and clear space above ports for an administrative labeling system to accommodate machine-labeled identification of individual jack ports.
5. Horizontal cable termination on rear of panel. Provide incoming cable strain relief and routing guides on back of panel.

6. Patch Panel ports shall utilize 110 punch down termination on back panel and include retention cap for reach port.
7. Patch Panels shall be constructed of high strength steel with black powder finish.
8. Color: Black.

G. Category 6 UTP: Jacks and Jack Assemblies: Modular, color-coded, non-keyed eight-position modular receptacle units with integral IDC-type terminals.
1. Wiring: Shall have universal termination and color-coded indication for wiring to TIA/EIA T568B pin configuration.
2. Color: Front face of jack shall be colored. Use of a color-coded icon insert on a neutral-color jack shall not be acceptable. Color coordinated with system application as follows:
a. Data/Wireless UTP system: Orange.
b. Kronos Attendance UTP system: Green.
c. CCTV system: Purple.
3. Jack Modules shall comply with TIA-568-C.2.
4. Jack Modules shall be capable of being re-terminated.
5. Jack Modules shall be available in non-keyed format.
6. Reference Contract Drawings for typical arrangement of jacks at work area faceplate.

H. Category 6 UTP: Patch Cords: Factory-made, four-pair cables terminated with eight-position modular plug at each end. Board to provide all patch cords, information below is for reference only.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance.
a. Patch cords shall have latch guards to protect against snagging.
b. Jack Modules shall comply with TIA-568-C.2.
2. Patch Cord plug modules shall comply with TIA-968 requirements. Patch cords shall be of same manufacturer and consistent with components and performance level of cross-listed solutions indicated in this Article.
3. Color: Coordinate with UTP cable color per system application:
a. Data/Wireless UTP system: Blue.
b. Kronos Attendance UTP system: Green.
4. Quantity to be Board provided:
a. Work Area: Provide one (1) 6-ft patch cord for each Category 6 UTP outlet installed per system application.
b. Equipment End:
1) Data Racks:
(a) Provide one (1) 5-ft patch cord for one-half (fifty-percent) of the total number of Category 6 UTP outlets installed per system application.
(b) Provide one (1) 7-ft patch cord for one-half (fifty-percent) of the total number of Category 6 UTP outlets installed per system application.
2) Concentrator Enclosures:
(a) Provide one (1) 1-ft patch cord for each Category 6 UTP outlets installed per system application.

2.04 CATEGORY 5E UTP CABLE AND CONNECTING HARDWARE

A. Category 5e UTP: Manufacturers of Cable: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Belden, DataTwist 1200; www.belden.com.
2. Berk-Tek; a Nexans company, LANmark-350 series; www.berktek.us.
3. General Cable Technologies Corporation, GenSPEED 5500 series; www.generalcable.com.
4. Hubbell Premise Wiring, Category 5e UTP; www.hubbell.com/hubbellpremisewiring/en
5. Superior Essex Inc., Cobra 5e series; www.spsx.com.

B. Category 5e UTP: Manufacturers of Connecting Hardware and Patch Cords: Subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Belden, Key Connect 5e; www.belden.com.
   2. Hubbell Inc., Hubbell Premise Wiring, SPEEDGAIN series components; www.hubbellpremisewiring/en.
   3. Leviton Manufacturing Co., Inc., Leviton Voice & Data Division, GigaMAX 5e+ series components; www.levition.com.
   4. Ortronics Inc., Tech Choice Cat 5e KT2 Series; www.ortronics.com.
   5. Panduit Corporation, NetGen Solution; www.panduit.com.

C. Category 5e UTP: Cross-Listing: Cross listed solutions shall be selected and installed so as to provide the Board with warranty complying with requirements of Section 27 05 03 - Communications General Requirements for system warranty and application assurance. Manufacturers of Cable and Manufacturers of Connecting Hardware and Patch Cords must be selected and utilized together on project as follows:
   1. Belden with:
      a. Belden Giga Key Connect 5e.
   2. Berk-Tek with:
      a. Leviton, GigaMax5e+ Series.
   3. General Cable Technologies Corp. with:
      a. Panduit Corp.: NetGen Solution.
      b. Hubbell Premise SPEEDGAIN Solution.
   4. Hubbell with:
      a. Hubbell Premise SPEEDGAIN solution.
   5. Superior Essex Inc. with:
      a. Ortronics Tech Choice Cat 5e KT2 Series.
   6. TE Connectivity 520 Series.

D. Category 5e UTP: Description: 100-ohm, 4-pair UTP, minimum 24AWG, covered with a thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA-568-C.2 for performance specifications.
   3. Comply with TIA-568-C.2, Category 5e.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and ANSI/IEEE 802.7 for the following types:
   5. Communications, Riser Rated: Type CMR, complying with UL 1666.Jacket color: Coordinated with system application as follows:
      a. Voice UTP system: Yellow.
      b. Intercom/Admin UTP system: Gray.
   6. Cables shall be suitable for installation in a plenum application.

E. Category 5e UTP: General Requirements for Cable Connecting Hardware:
   1. Comply with TIA-568-C.2, Category 5e.
   2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
   3. Wire to TIA/EIA T568B pin configuration.

F. Category 5e UTP: Patch Panel: Modular panel housing multiple-numbered units with integral front 8-position RJ45 modular opening and rear IDC-type connectors for each port, used for permanent termination of pair groups of installed cables.
   1. Number of Ports: 48 as indicated in Contract Drawings.
   2. Capacity: Provide quantity of panels sufficient for number of cables to be terminated plus 25 percent spare.
   3. Mounting: Rack-mount, complying with EIA/ECA-310 standard for 19-inch width.

4. Identification: Permanently imprinted sequentially numbered identification of ports, and clear space above ports for an administrative labeling system to accommodate machine-labeled identification of individual jack ports.
5. Horizontal cable termination on rear of panel. Provide incoming cable strain relief and routing guides on back of panel.
6. Patch Panel ports shall utilize 110 punch down termination on back panel and include retention cap for reach port.
7. Patch Panels shall be constructed of high strength steel with black powder finish.
8. Color: Black.

G. Category 5e UTP: 110A Termination Block: 110-style frame assembly, with legs, used for termination of all horizontal UTP cabling for voice communications.
1. Be constructed of flame-retardant thermoplastic, with strips for terminating a series of individual four-pair cable conductors, with legs for offset mounting.
2. Have access openings for rear to front cable routing to the point of termination.
3. Size: Standard 100-pair or 300-pair footprint.
4. Capacity: Adjust quantity of blocks based on number of cables to be terminated plus 25 percent spare.
5. Field-terminate, utilizing C4 clips terminated over all horizontal pairs so as to facilitate future cross connection and/or inter connection using cross-connect wire.
6. Accommodate termination of wire sizes: Solid No. 22-26 AWG.
7. Listed UL 1863.

H. Category 5e UTP: 110A Jumper Trough: 110-system trough, with mounting legs, for management of cross connect jumper pairs routed between 110 termination blocks.
1. Be constructed of flame-retardant thermoplastic.
2. Have access openings to permit cable routing between points of termination.
3. Width: To match 110 Termination Block.
4. Provide above and below each 110 Termination Block. Provide with mounting legs.
5. Provide finger design to maintain proper bend radius.

I. Category 5e UTP: Jacks and Jack Assemblies: Modular, color-coded, non-keyed eight-position modular receptacle units with integral IDC-type terminals.
1. Wiring: Color-coded indication for wiring to TIA/EIA T568B pin configuration.
2. Color: Front face of jack shall be colored. Use of a color-coded icon insert on a neutral-color jack shall not be acceptable. Color coordinated with system application as follows:
   a. Voice UTP system: White.
   b. Aiphone Master Station: Yellow.
   c. Intercom/Admin UTP system: Grey.
3. Jack Modules shall comply with TIA-568-C.2.
4. Jack Modules shall be capable of being re-terminated.
5. Jack Modules shall be available in non-keyed format.
6. Reference Contract Drawings for typical arrangement of jacks at work area faceplate.

2.05 HDMI AND USB CABLING AND CONNECTING HARDWARE

A. HDMI and USB connectivity from the teacher station to the overhead projector can be accomplished using one or two faceplates on both ends with a Video USB Extender wall plate / Category 6 cable solution. It is acceptable to utilize either solution.

B. The HDMI and USB cable that extends from the teachers station faceplate shall be routed up to the overhead projector faceplate mounted on the teaching wall or in the ceiling. The cable shall be a continuous cable from faceplate to faceplate. The solution is to have a faceplate at both ends of the cable. A Board Authorized Representative shall provide both HDMI and USB patch cables at both the teachers station and the overhead projector.
1. HDMI and USB Video Extender Wall Plate to Wall Plate Solution. A "Source" wall plate is used at the teacher location and a "Display" wall plate is located at the

projector location. Female connectors are on front of each wall plate which are able to accept the HDMI and USB Patch cables.

a. Hubbell HDMI/USB High Definition powered wall plate Video Extender ISFHD4BK to be used with the HDMIDC5V power supply.
b. Note: the Hubbell solution requires an electrical outlet next to both wall plates for power.
    1) As an option to using the external power supplies, the Hubbell USB Charger Receptacle (AVPS15GY) can be used. It must be installed directly next to the HDMI / USB Extender.

2.06 COMMUNICATIONS OUTLETS

A. Outlet Boxes: Comply with Section 26 05 33.16 - Boxes for Electrical Systems.
    1. Outlet boxes shall be 5-inch width, 5-inch height, by 2-7/8 inches deep, fitted with single- or double-gang trim plates to accommodate single- or double-gang communications faceplates as coordinated with Contract Drawings and outlet configuration.
        a. STEEL CITY 5 Square Telecommunication Boxes; www.tnb.com.
B. Wall Plates:
    1. Comply with system design standards and UL 514C.
    2. Accepts modular jacks/inserts.
    3. Two, Four, Six port-connector assemblies mounted in single or multigang faceplate. Coordinate with Contract Drawings.
        a. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 - Wiring Devices.
        b. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 - Wiring Devices.
        c. Coordinate color and finish selection with Architect/Engineer of Record.
        d. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords. Jacks shall snap firmly into faceplate frame and be flush with outer plate surface.
        e. Provide color-matched snap-in blank insets to fill all unused openings.
        f. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.07 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607-C.

2.08 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B.

PART 3 EXECUTION

3.01 COMMUNICATIONS DEMOLITION

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for demolition of communications systems.

3.02 APPLICATION OF MEDIA

A. Horizontal Cabling for CCTV UTP Service: Use Category 6 UTP cable and connecting hardware.
B. Horizontal Cabling for Data and Wireless Service: Use Category 6 UTP cable and connecting hardware.
C. Horizontal Cabling for Kronos Attendance Service: Use Category 6 UTP cable and connecting hardware.
D. Horizontal Cabling for Intercom/Admin Service: Use Category 5e UTP cable and connecting hardware
E. Horizontal Cabling for Voice Service: Use Category 5e UTP cable and connecting hardware.
F. Horizontal Cabling for Aiphone Service: Use Category 5e UTP cable and connecting hardware.

3.03 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569-D (pathways), TIA-607-C (grounding and bonding), NECA/BICSI 568, ANSI/IEEE 802.7, and SYSTEM DESIGN as specified in PART 2.

B. Grounding and Bonding: Perform in accordance with TIA-607-C and ANSI/IEEE 802.7.

3.04 WIRING METHODS AND INSTALLATION OF PATHWAYS

A. Wiring Method: Install cables in raceways. Conceal raceway except in unfinished spaces.

1. Comply with requirements for raceways and boxes and their installation specified in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.
2. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop per requirements of this Section. Provide and use lacing bars and distribution spools.

C. Wiring within MDF and IDFs: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide service loop per requirements of this Section. Utilize overhead ladder rack runway for cable routing within room(s). Provide and use lacing bars and distribution spools for wire routing and management on plywood backboard.

3.05 INSTALLATION OF CABLING

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568 (SET).
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Do not over-cinch or crush cables.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than 4X cable diameter. Install lacing bars and distribution spools.
8. Hook and loop (Velcro)-style cable ties shall be used to bundle and secure exposed cables in the concentrator enclosures and MDF/IDF rooms. Use of plastic cable ties is not permitted.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions, and do not exceed manufacturer’s recommended cable pull tension.
    a. When installing in conduit, use only lubricant approved by cable manufacturer and do not chafe or damage outer jacket.
12. Service Loops: Provide the following minimum extra length of cable, dressed and routed neatly:
    a. At MDF/IDF frames: 60 inches, neatly installed in vertical wire manager or accommodated by additional routing around overhead ladder rack runway.

b. At Concentrator Enclosures - Terminated Cables: 24 inches, neatly looped inside housing
c. At Concentrator Enclosures - Pass-through Cabling: 24 inches, neatly installed inside housing for horizontal UTP cables that pass through enclosure.
d. At Surface Raceway Outlets - Copper: 12 inches, neatly installed in surface raceway channel.

C. UTP Cable Installation:
1. Comply with TIA-568-C.2.
2. Maintain pair twists as close as possible to point of termination, but do not untwist UTP cables more than 1/8 (.125) inch from the point of termination to maintain cable geometry.
3. Concentrator Enclosures: No cabling is to be routed down through the center area of the enclosure so as to inhibit the installation of network electronics.
4. MDF/IDF: Install and route cabling on overhead ladder rack runway and within horizontal and vertical cable guides to terminating hardware.

D. Group connecting hardware for cables into separate logical fields.
E. Separation from EMI Sources: Comply with requirements of Section 27 05 03 - Communications General Requirements.

3.06 FIRESTOPPING
A. Comply with requirements in Section 07 84 00 - Firestopping.
B. Comply with TIA-569-D, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.07 GROUNDING
A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with TIA-607-C.

3.08 IDENTIFICATION
A. Comply with requirements in Section 27 05 53 - Identification for Communication Systems.

3.09 CLEANING
A. Comply with requirements of Division 27 05 03 - Communications General Requirements for cleaning.

3.10 COMMISSIONING AND DEMONSTRATION
Comply with requirements in Section 27 08 00 - Commissioning of Communications for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

END OF SECTION

SECTION 27 53 15 (LNK)

INTERCOM AND PROGRAM EQUIPMENT INTERFACE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Section includes user-programmable, multichannel, microprocessor-switched, centrally controlled, school intercom and program equipment independent of, but capable of interfacing with the IT network and/or telephone equipment.

B. System functional description as detailed in Article.

C. Zoning:
1. Each classroom / office / administrative area / individual hallway /common area/ Link/ gym / cafeteria / auditorium / exterior location shall be defined as a zone.
2. Paging zone outputs shall be provided where paging speakers are located but do not have a call button associated with them (i.e. hallways, common areas, Link).

D. Provide, as part of system, the following number of groups or schedules as indicated per type:
1. Paging Groups: eight (8) groups minimum for elementary school or sixteen (16) groups minimum for high school.
2. Time Groups: eight (8) groups minimum Time Schedules: eight (8) schedules minimum.

E. Bell Schedule Interface:
1. Existing Schools: The intercom system shall have tones that can be sounded through the intercom speakers to provide a bell schedule and shall be able to be interfaced with the existing hardwired 120VAC bells.
a. The interface consists of the Electrical Contractor (EC) identifying the bell circuits inside the existing bell programmer, removing the internal components of the existing bell programmer, installing a low voltage relay for each individual 120-Volt AC bell circuit, wiring the 120-Volt AC bell circuit across the dry contacts of the relay and feeding one side of the dry contact with a 120-Volt AC source (already existing), and bring back to the head end of the new Intercom control circuit for each relay controlling a 120-Volt AC bell circuit. The intercom System can be programmed to track these relays on with the bell schedule that sounds the tones, thus tones and bells ring together. The control circuit for the relays is 24-Volt DC allowing the wiring of the control circuits to be run in a metal raceway.

1.02 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.03 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2019.

B. City of Chicago Electrical Code - National Electrical Code with Chicago Amendments; 2018.

C. EIA SE 101 - Amplifiers for Sound Equipment; 1954.

D. EIA SE 103 - Speakers for Sound Equipment; 1949.

E. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Revision E, 2005.

F. TIA-569-D - Telecommunications Pathways and Spaces; Rev D, 2015.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate layout and installation of ceiling-mounted speaker microphones and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Coordinate on placement of horizontal Category 5e UTP outlets, for voice communications services, with location of School Intercom and Program Equipment.
3. Coordinate all room numbers and paging zones with final signage room numbers.

1.05 SUBMITTALS

A. Shop Drawings: Indicate wiring diagrams and interconnection diagrams.
1. Equipment Details: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.
2. Station-Arrangement Details: Scaled drawings for built-in equipment.
3. Wiring Diagrams: Power, signal, and control wiring. Include the following:
a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.
d. Differentiate between manufacturer-installed and field-installed wiring.
e. Clock System: identify terminals and wiring color-codes to facilitate installation, operation, and maintenance.

B. Product Data: Provide for each item of equipment; show specified ratings, colors, finishes, and physical dimensions.
1. Admin Master Station.
2. Speaker-microphone stations.
3. All-call amplifier.
4. Intercom amplifier.
5. Paging amplifier.
6. Auxiliary components.

C. Qualification Data: For Installer; certificate signed by manufacturer(s) certifying that installer complies with requirements.

D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.

E. Field quality-control test reports and manufacturer(s)' field-visit/inspection report.

F. Operation Data: Operating instructions for school intercom, [master clock,] and program equipment to include in emergency, operation, and maintenance manuals.

G. Maintenance Data: Maintenance and repair instructions for school intercom, [master clock,] and program equipment to include in emergency, operation, and maintenance manuals.

H. In addition to items specified in Sections 01 77 00 - Closeout Procedures and 01 78 00 - Closeout Submittals include the following:
   1. Record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.
   2. Prepare a written record of system programming decisions, implementation methodology, and final results.
   3. Include manufacturer's brochures and parts lists describing the actual materials used in the work, including microprocessor, signal generator, power supplies, and other major components. Assemble manuals for component parts into single binders identified for each system. Manuals shall include the items below and other information recommended by the manufacturer:
      a. Schematic wiring diagrams.
      b. Parts lists.
      c. Troubleshooting guide.
      d. Name and telephone number of factory-authorized service representative within 100 miles of the Project.
      e. Copies of warranties and guarantees.
      f. Provide four (4) quick reference guides for Building Engineer.

I. System Programming: Record of the Board's system programming options decisions, implementation methodology and final results.

J. Field Service Report: Record of factory authorized representative's inspection report of field assembled components and equipment installation, including connections and initial system programming.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project (contact purchasing).

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with City of Chicago Building Code.

D. Comply with UL 50.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Do not install electronic components until major construction work in the area is complete. Do not install in areas where dust or moisture can contaminate the working parts or where finish can be marred by construction work.

B. Stage materials in a secure area of the project site until installation. Materials and items shall be placed so that they are protected from damage and deterioration.

1.08 MAINTENANCE COMPONENTS

A. Provide the following components or spare capacities, as part of the Project, to the Board Representative, or as part of installed system as indicated:
   1. Components to be given to the Board:
      a. One (1) Admin Master Station.
      b. Programming software.

c. Administration software.
2. Components to be included in the installed system:
a. Ten percent spare capacity in:
1) Amplifiers, typical of each type.
2) Zone/Circuit Cards.

1.09 WARRANTY

A. The Contractor shall unconditionally warrant all equipment and systems provided under this Section to be free from defects in materials and workmanship for a period of at least five years parts and one year labor from the date of Preliminary Acceptance of all work of this Section.
1. Warranty service for the equipment shall be provided during normal working hours, Monday through Friday, excluding holidays. Emergency service provided at times other than as stipulated above shall be available from the same source at additional cost. Emergency service response time shall be within four business hours for high school and eight business hours for elementary school.

PART 2 - PRODUCTS

2.01 SYSTEM DESIGN

A. Functional Description of Microprocessor-Switched Intercom System:
1. Station Selection: Capable of the following:
a. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
b. Communicating on a minimum of three voice channels with up to two simultaneous conversations between master stations and one conversation between a master station and a speaker-microphone station.
c. Increasing the number of conversation channels by adding a module in central-control cabinet.
d. Including up to three other station connections in a conference call.
e. Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
f. Overriding any conversation by a designated master station.
g. Displaying selected station/room number.
h. Providing Dial Directory Sheet.
i. Communicating simultaneously with other stations on system by dialing a designated number on a 12-digit keypad.
j. Automatically controlling gain to ensure constant intercom speech level.
k. Controlling the simultaneous distribution of program material to various combinations of speaker-microphone stations or groups over two program channels by using keypad to control sources and distribute programs.
l. Operating and correcting secondary clocks and controlling class-change signals to speakers and bells by using keypad.
m. Emergency Call Operation: Emergency call is initiated when a call-in button is pushed repeatedly. If the call is not answered, system automatically transfers to a user definable emergency sequence.
n. Output Relays: System is to provide eight (8) auxiliary relays, which may be programmed to respond to various programmed functions within the system.
o. User-programmable features include the following:
1) Station calling by room number.
2) Room station call-in priority levels.
3) Clock signal schedule functions.
4) Schedule characteristics of audible signals.
5) Call-in tone characteristic.

2. Interconnection with the Board's networked IT System: IT Network interconnect features to include the following:
    a. Interconnection with the Board's networked IT System: IT Network interconnect features to include the following:
        1) Hard wired connection capability to the CPS WAN network, utilizing the CPS Standards for connectivity.
        2) System shall allow for remote Access by CPS System Administrators through the CPS Data network. System must have a web front end to manage the device in all aspects that is not reliant on any frameworks (Java, activex, etc..) HTML 5 preferred. The Headend should also allow for SNMP monitoring and support Active directory. At a minimum this access should allow CPS the following administrative capabilities:
            a) Schedule - Creation, modification, deletion.
            b) System adjustment for Daylight Savings Time.
            c) Ability to monitor health of system major components.
3. Interconnection with the Board's Private Phone System: Telephone interconnect features include the following:
    a. Direct connection to central office trunk lines with initial system wiring for two (2) trunk lines, using one or two digit number associated with outgoing line for interconnection.
    b. System shall be setup to accept the telephone at security desk as an administrative handset.
    c. Station programming for access to outside trunk lines to be totally unrestricted access.
    d. Call parking allowing paged party to remotely pick-up outside call from any master station, internal or external telephone.
4. Speakers: Free of noise and distortion during operation and when in standby mode.

2.02 EQUIPMENT AND MATERIALS

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.

C. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

D. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

E. Central-Control Cabinet: Comply with EIA/ECA-310. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, program/monitor and other switching and control devices required for conversation channels and control functions.

F. Remote-Control Cabinet: Comply with EIA/ECA-310. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, program/monitor and other switching and control devices required for conversation channels and control functions.

2.03 ADMIN MASTER STATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
    1. Rauland-Borg Corporation; www.rauland.com.

B. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.

C. Volume Control: Regulates incoming-call volume.

D. Tone Annunciation: Momentary audible tone signal announces incoming calls.

E. Speaker Microphone: Hands-free; transmits intercom voice signals when used via a voice-operated switch.
1. Minimum Speaker Sensitivity: EIA SE 103 pressure rating of 40 dB.

F. Reset Control: Cancels call and resets system for next call.

G. Digital Display: 16-digit alphanumeric LCD readout to register up to four 3-digit station numbers.

H. Minimum Quantity to be included in system design: Coordinate with school type as follows:
1. Elementary Schools: Three.

2.04 ALL-CALL AMPLIFIER

A. Manufacturers: Subject to compliance with requirements, provide part numbered products by one of the following manufacturers:
1. Rauland-Borg Corporation; www.rauland.com.

B. Comply with EIA SE 101.

C. Minimum Output Power: 1-W RMS for each station and speaker that can be connected in all-call mode of operation, plus an allowance for future stations.

D. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.

E. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

F. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

G. Output Regulation: Maintains output level within 2 dB from full to no load.

H. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master station, speaker microphone, or handset transmitter.

I. Amplifier Protection: Prevents damage from shorted or open output.

2.05 INTERCOM AMPLIFIER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Rauland-Borg Corporation; www.rauland.com.

B. Comply with EIA SE 101.

C. Minimum Output Power: 15 W and adequate for all functions.

D. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to 1 station connected to output terminals.

E. Minimum Signal-to-Noise Ratio: 50 dB, at rated output.

F. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

G. Output Regulation: Maintains output level within 2 dB from full to no load.

H. Input Sensitivity: Matched to input circuit and providing full-rated output with sound-pressure level of not more than 10 dynes/sq. cm impinging on microphones in master stations, speaker microphones, and handset transmitters.

I. Amplifier Protection: Prevents damage from shorted or open output.

2.06 PAGING AMPLIFIER

A. Subject to compliance with requirements, provide part numbered products by one of the following manufacturers:
1. Rauland-Borg Corporation; www.rauland.com.

B. Comply with EIA SE 101.

C. Input Voltage: 120-Volt AC, 60 Hz.

D. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.

E. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

F. Total Harmonic Distortion: Less than 3 percent at rated output power from 70 to 12,000 Hz.

G. Output Regulation: Less than 2 dB from full to no load.

H. Controls: On/off, input levels, and low-cut filter.

I. Input Sensitivity: Matched to input circuit and providing full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

J. Amplifier Protection: Prevents damage from shorted or open output.

K. Provide a minimum of four (4) 35W outputs to provide for gym, pool, cafeteria, multi-purpose areas, auditorium, etc. or as indicated on Contract Drawings.

L. For common corridor and outside speakers.

2.07 CONE-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Comply with EIA SE 103.

B. Sensitivity: 90 dB SPL (1 watt 1 meter).

C. Frequency Response: Within plus or minus 3 dB from 75 to 15,000 Hz.

D. Minimum Dispersion Angle: 90 degrees.

E. Speaker with Line Matching Transformer:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
a. Rauland-Borg Corp. , part no. USO188.
2. Speaker: 8 inches with ¾-inch voice coil and minimum 4.8 oz. Ceramic magnet.
3. Transformer: Comply with EIA-160, maximum insertion loss of 1 dB, 5 watt power rating 25 volt and 70 volt primary with 8 ohm secondary and at least four level taps.

F. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.03-inch steel and whole assembly rust-proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; and with relief of back pressure.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
a. Flush Ceiling Mount Backboxes:
1) Rauland-Borg Corp., part no. ACC1101.
b. Flush Wall Mount Backboxes:
1) Rauland-Borg Corp., part no. ACC1105.

G. Baffle: For flush speakers, minimum thickness of 0.03-inch steel, with white hybrid epoxy power coat finish.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
a. Round Flush Ceiling Baffle:
1) Rauland-Borg Corp., part no. ACC1000.
b. Square Flush Wall Baffle:
1) Rauland-Borg Corp., part no. ACC1003.

2.08 HORN-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Flush or surface mounted vandal-proof:
a. Rauland-Borg Corp., part no. ACC1105.

B. Comply with EIA SE 103. All-metal, weatherproof construction; complete with universal mounting brackets.

C. Frequency Response: Within plus or minus 3 dB from 300 to 15,000 Hz.

D. Minimum Power Rating of Driver: 15 W, continuous.

E. Minimum Dispersion Angle: 100 degrees.

F. Line Transformer: 25 to 70 volt primary, maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least 6 level taps.

G. The following locations (but not limited to) shall be provided with vandal proof horn type paging speakers:
1. Exterior Speakers.

2.09 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG.

B. Insulation: Thermoplastic, not less than 1/32 inch thick.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
1. Minimum Shielding Coverage on Conductors: 60 percent.

2.10 AUXILIARY COMPONENTS

A. Program Paging 2-Way Speaker, weatherproof for exterior locations.

2.11 PATHWAYS

A. General Requirements: Comply with TIA-569-D.

B. Conduit and Boxes: Comply with requirements in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems. Flexible metal conduit shall not be used.

PART 3 - EXECUTION

3.01 COMMUNICATIONS DEMOLITION

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for demolition of communications systems.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on Contract Drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Notify Architect/Engineer of Record of conditions that would adversely affect installation or subsequent use.

E. Proceed only after unsatisfactory conditions have been corrected. Commencement of work in this section will be an indication of the acceptance of substrate conditions and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

3.03 WIRING METHODS AND INSTALLATION OF PATHWAYS

A. Wiring Method: Install wiring in dedicated raceway system for School Intercom and Program Equipment. Conceal raceways except in unfinished spaces.
1. Comply with requirements for raceways and boxes and their installation specified in Sections 26 05 33.13 - Conduit for Electrical Systems, "26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.
2. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars in cabinets.

3.04 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

C. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other school intercom and program equipment conductors as recommended by equipment manufacturer.

D. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

F. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

G. Comply with requirements of Section 27 05 03 - Communications General Requirements for cutting and patching.

H. Connect wiring according to Section 26 27 26 - Wiring Devices.

I. Provide an audio control relay interface from the ICC to auxiliary audio systems.

3.05 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Provide dedicated No. #12 AWG ground from the MDF Room 204A (Canter) ground bus to the new intercom system headend equipment rack.

3.06 SYSTEM PROGRAMMING

A. Programming: Fully brief Board Representative on available programming options. Record the Board's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections and initial system programming. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. Schedule tests with at least seven days' advance notice of test performance.

2. After installing school intercom and program equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test originating station-to-station, all-call, and page messages at each intercom station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 300 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
   b. Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
   c. Minimum acceptable ratio is 45 dB.
6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 200, 400, 1000, and 2500 Hz into each intercom, paging, and all-call amplifier. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 400, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section "26 05 26 - Grounding and Bonding for Electrical Systems.

C. Retesting: Correct deficiencies and retest. Prepare a written record of tests.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

E. Prepare written test reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.08 ADJUSTING

A. Adjust program functions to meet Board's revised schedule. Revisit site upon Board's request within one year of Substantial Completion and make additional adjustments to program schedule as directed.
   1. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
   2. Occupancy Adjustments: When requested within 12 months (one year) of date of Preliminary Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to site outside normal occupancy hours for this purpose, without additional cost.

3.09 CLEANING

A. Comply with requirements of Section 27 05 03 - Communications General Requirements for cleaning.

3.10 CONTRACTOR STARTUP AND REPORTING

A. System Startup: Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements. Complete installation and startup checks according to manufacturer's written instructions.

B. Demonstration: Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain school intercom and program equipment. Refer to Section 01 79 00 - Demonstration and Training.
   1. Train Board's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.
   2. Review data in maintenance manuals.
   3. Schedule training with the Board's Representative, through the Architect/Engineer of Record, with at least seven days' advance notice.
   4. Training should consist of a minimum of three sessions which are to be scheduled with a minimum of three weeks between sessions. Each training session shall be a minimum of 90 minutes in duration with final scheduling as agreed to by the School Principal.

C. Contractor to provide sign off sheet to Board Representative upon completion.

END OF SECTION 27 53 15

SECTION 28 23 07 (LNK)

DVS SYSTEM - EXISTING SCHOOL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the materials and components, including programming, for a complete Digital Video Surveillance (DVS) System.
   1. Base Bid shall include the following:
      a. Cabling and connections, including fiber-optic cabling.
      b. Equipment mounts and racks.
      c. Interconnections to LAN and WAN networks.
      d. Final adjustments and system check out.
      e. Training of the Board's designated personnel.
      f. Documentation of camera models / serial numbers, locations, connections to LAN switches / ports utilized.
   2. Board provided components include the following:
      a. PoE Switches.
      b. Viewing stations.
      c. Workstation.
      d. Server.

1.02 PRE-AWARD QUALIFYING INFORMATION REQUIREMENTS

A. The following information, as prepared by the submitting Subcontractor, shall be included as attachments to the Bid Form.
   1. Statement of Qualifications: A brief history of the firm and its responsible personnel, including technicians proposed for the project, and a summary of its experience record, describing particular projects of similar scale and scope to the Project, as they pertain to their ability to perform the work required for the project.
   2. Project List: A listing of major projects, similar in scale and scope to the project, completed in the last three (3) years. Include the project addresses and phone numbers of the facility director and Architect/Engineer of Record, if any, responsible for the project.

1.03 DEFINITIONS

A. Refer to Section 27 05 03 - Communications General Requirements for definitions.

1.04 REFERENCE STANDARDS

A. City of Chicago Electrical Code -; 2018.

B. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
   1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the preinstallation meeting.

2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work. Require attendance by all affected installers including but not limited to:
   a. Contractor's Superintendent.
   b. Installer.
   c. Manufacturer/Fabricator Representative.
   d. Other affected Subcontractors.
   e. Architect/Engineer of Record.
   f. Board's Representative.
3. Record minutes and distribute copies within five (5) days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. Submittals shall be simultaneously (concurrently) submitted to the Architect/Engineer of Record and attention CPS Deputy Director Office of School Safety and Security to CPS Department of Procurement 42 W. Madison.

B. Product Data: Provide for each type of product specified. Including detailed manufacturer's specifications, data on features, ratings, dimensions, electrical characteristics, performance and finishes.
1. Provide Server requirements to support video management system software to CPS Office of School Safety and Security (OSSS) and CPS Office of Information Technology.
2. Provide Storage requirements based upon Drawings and Specifications to CPS Office of School Safety and Security (OSSS) and CPS Office of Information Technology.

C. Shop Drawings: For video surveillance system, include plans, elevations, sections, details and attachment to other work.
1. Detail installed features and devices.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Floor plans, prepared at 1/8 inch scale, indicating the following:
   a. Location of all DVS outlets with identification numbers.
   b. System layout, including, but not limited to, routing of conduit and raceways, locations of concentrator boxes, both existing and new, and other components required as part of the complete system.
   c. Riser and Connection diagrams.
   d. Point-to-point raceway routing, identifying number and type of cables in each raceway. Include pull box locations and sizes.
   e. Conduit fill calculations, indicating cross-section area percent fill for each raceway.
   f. Detailed layout drawings of each DVS MDF rack, including front-view details identifying all components, cabling connections, and cable identification numbers.
4. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
5. Programming documentation using manufacturer's programming form and system layout work sheets. Contact CPS Office of School Safety and Security at (773) 553-3001 or (773) 553-5136 for general programming requirements.
   a. Programming submittals must be reviewed and approved by CPS Office of School Safety and Security prior to starting any work.
   b. Programming documentation shall include the following:
      1) Configure Cameras using IP Scheme.
      2) Configure Network Switch.
      3) Load Software.
      4) Install and configure servers and storage.

D. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation.

E. Test Reports:
1. Final test reports for field tests specified in Sections 27 15 00 - Data Communications Horizontal Cabling and 27 13 23 - Communications Optical Fiber Backbone Cabling.
2. Final reports for startup testing and procedures identified in Article "Contractor Startup and Reporting."

F. Operation and Maintenance Data: For surveillance system components and equipment, to include in emergency, operation, and maintenance manuals. Include the following:
1. Programming instructions.
2. Programming disk.
3. Contact information for programming assistance.
4. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Board's name and registered with manufacturer.
1. Special Warranty specified in this section.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five (5) years of documented experience.

B. Installer Qualifications: Award the digital video surveillance system work to a single firm that is specialized in the installation of digital video surveillance systems, who has successfully completed system installations in not less than three (3) projects of similar size and complexity, to the satisfaction of the Architect/Engineer of Record and Board Representative, in the last two (2) years, and whose work has resulted in a record of successful in-service performance. The installer shall be a factory trained OMNICAST Certified level 2; authorized by the manufacturer(s) to install the products and components required for a complete system; employ technicians trained and familiar with Microsoft Networks and Cisco Systems network hardware and software, capable of performing diagnostic testing and servicing of the system components; and maintain a current P.E.R.C. (Permanent Employee Registration Card - Blue) Card through the Illinois Department of Professional Regulation.
1. The installer shall provide telephone response within one hour and on-site service response within eight (8) hours of the initial call, with the system restored within twenty-four (24) hours of the initial call ninety percent (90%) of the time.
2. The installer shall maintain and provide a 24-hour help desk telephone number.

C. Electrical Components, Devices, and Accessories: Listed and labeled as required by the City of Chicago Electrical Code.

D. Pre-Installation Conference: Not less than 14 days prior to starting the DVS system work, coordinate a pre-installation conference at the Project site to comply with requirements in Division 01. Attendees shall include representatives from the CPS Office of School Safety and Security, CPS Office of Information Technology Services, Facilities and Operations, the Architect/Engineer of Record, the Installer, and representatives of other trades whose work must be coordinated with the camera work. Review methods and procedures related to the DVS system installation including, but not limited to, the following:
1. Review construction schedule and verify availability of materials, equipment, installer personnel, and facilities needed to make progress and avoid delays.
2. Review preparatory work and procedures, including roughing-in of electrical and data wiring, to be performed by other trades.

3. Review and confirm locations for cameras, both interior and exterior, and all other devices that are part of the system.
4. Confirm camera platform, camera models, and mounting hardware.
5. Review requirements for MDF room and equipment installation.
6. Review routing of conduit and locations of concentrator boxes.
7. Review required testing, inspections, and certifying procedures and anticipated dates.
8. Review training procedures for the Board's designated personnel and coordinate dates/times for training sessions.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside, protected from weather, in a secure location, elevated above grade, and according to manufacturer's written instructions. Protect materials from construction activity and other potential sources of damage.

1.09 FIELD CONDITIONS

A. Do not deliver or store materials until building is enclosed and mechanical systems are operational and maintaining interior environment in accordance with manufacturer's requirements.

B. Do not install DVS system components exposed to view until after finish work, including painting, is complete.

C. Interruption of Existing Security Service: Do not interrupt security service to facilities occupied by the Board or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
1. Notify Architect/Engineer of Record and Board Authorized Representative no fewer than ten working days in advance of proposed interruption of security service.
2. Do not proceed with interruption of security service without Architect/Engineer of Record and Board Representative's written permission.

1.10 GUARD SERVICES

A. Guard Services shall be provided for 24 hours each day for the duration of the Security system interruption. Security watch personnel shall make rounds on hourly intervals.

B. Existing Security Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing Security equipment "NOT IN SERVICE" until removed from the building.

C. Equipment Removal: After acceptance of new Security system, remove existing disconnected Security equipment, abandoned security panels, devices and exposed conduit, wire mold and wiring. Provide patch and paint to match existing conditions of walls and floors of removed devices areas.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form, executed by the manufacturer and installer, in which the manufacturer agrees to repair or replace components of the digital video surveillance system that develop defects in materials or workmanship within the specified warranty period. Warranty period shall begin on date the system is approved, and noted as complete, by the designated representative of CPS Office of School Safety and Security.

1. Warranty Period for DVS System Components (except cabling/wiring): three (3) years from date of acceptance by CPS Office of School Safety and Security.
2. Warranty Period for System Cabling/Wiring: twenty-five (25) years from date of acceptance by CPS Office of School Safety and Security and ITS.

1.12 EXTRA MATERIALS

A. Deliver extra of the components indicated below, packaged with protective covering and identification labels, to the CPS Office of School Safety and Security. Provide a quantity equal to three percent (3%) of the quantity installed of each item to the CPS Student Safety Center.
   1. Fixed cameras.
   2. Uninterruptible power supplies.

1.13 MAINTENANCE SERVICE

A. Continuing Maintenance Proposal: Beginning at date of acceptance of installation by CPS Office of School Safety and Security, provide a continuing maintenance proposal from the Installer for extended service and maintenance for the DVS system, starting on date initial maintenance service is concluded. Include the following:
   1. Format: The continuing maintenance proposal shall be in the form of a standard 3-year maintenance agreement. The agreement shall clearly outline services, obligations, conditions, and terms for agreement period and future renewal. Include all necessary parts, labor and service equipment. Include the following basic services:
      a. Repair: Repair or replacement of any equipment that fails to perform as initially installed, as specified, or as determined by the manufacturer's performance criteria.
      b. Preventive Maintenance: Semi-annual preventive maintenance on the installed equipment including, but not limited to, cleaning, realignment, inspection, and testing of all devices. The Board shall receive a written report of these inspections that identifies each device's status and, if required, a list of all required repairs or replacements.
      c. Software Maintenance: Installer shall install and configure, at no cost to the Board, any software updates that the manufacturer provides. Any additional software features, upgrades, or enhancements purchased by the Board shall be installed. The cost of Board requested software upgrades shall be outside of this service contract.
      d. Firmware Upgrades: Provide flash, EEPROM or other firmware upgrades as required.
   2. The Installer shall be compensated for any repairs or maintenance provided as a result of abuse, misuse, intentional damage, or accidental damage by either the Board or the Board's personnel, or power fluctuations exceeding specified equipment tolerances.
   3. System defects or failures shall be corrected within four (4) hours on the same business day if the Board makes a service request before 11:00 a.m. or before 12:00 p.m. the next business day if the Board makes the request after 11:00 a.m. If requested by the Board, the Installer shall respond or remain at the site after normal business hours, and the Board shall reimburse the Installer for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours, and double-time rates for Sundays and holidays. The Installer's services shall be performed in a professional manner and remain free from defects for a period of one (1) year.

B. Provide complete terms and conditions of warranty and services.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Scope - Renovation Project:
1. Provide new peripheral devices, including, but not limited to, Video digital encoders, cameras, power supply, mounting hardware, and cabling in areas indicated.
2. Replace only existing security camera system head end equipment with Video Management server, digital encoders. Equipment must function and be compatible with existing peripheral devices including, but not limited to, camera, power supply, mounting hardware and cabling in areas indicated.
3. Replace only existing security camera system peripheral devices including, but not limited to, camera, power supply, and mounting hardware equipment.
4. Replace existing security camera system peripheral devices including, but not limited to, camera, power supply, mounting hardware, cabling equipment, and cabling. Equipment must function and be compatible with existing head end equipment and cables in areas indicated.

2.02 SYSTEM DESIGN

A. General:
1. Installation of the DVS system shall be done under the direct supervision of an experienced technician, certified by the Vendor, who is trained and approved by the manufacturer to install an IP-based video surveillance system, cameras, and supporting equipment, utilizing structured telecommunications cabling infrastructure.
   a. The DVS system shall record and store images so to ensure they are admissible as evidence in a Court of Law.
2. Contractor shall install Board-provided and programmed network electronics (PoE) switches.

B. Review by CPS:
1. CPS Office of School Safety and Security and CPS Office of Information Technology shall receive and review copies of shop drawings, including raceway routing and pull box locations, and programming documentation, including system layout, prior to the start of installation work.
   a. Work related to the DVS system shall not proceed prior to receipt of final review comments from CPS Office of School Safety and Security and CPS Office of Assets Management.

C. Programming:
1. Camera locations and default viewpoints shall be determined and reviewed by CPS Office of School Safety and Security. Adjustments shall be made in the field (on site) as required by CPS (OSSS) and documented as part of the record documents.
   a. If a camera's viewpoint is altered remotely, the camera shall return to its default viewpoint when control is electronically relinquished, or after a predetermined period of inactivity.
2. Coordinate and program IP cameras to be interconnected with surveillance system software graphical user interface head end located in the Campus Services Room via the Campus Local Area Network.
3. Camera Control - Hierarchy: Control of cameras shall be provided to the groups/agencies, in the order of priority, indicated below. If a camera has been accessed by one of the groups/agencies indicated, those lower in the priority list shall not be allowed access until control is relinquished; those higher in the priority list shall be able to override control/access by those lower in the list.
   a. CPS Office of School Safety and Security (OSSS).
   b. CPS Office of Emergency Management and Control (OEMC).

c. Chicago Police Department (CPD).
d. The school (Principal's office, security office, etc.).
e. Other entities, as directed by CPS Office of School Safety and Security.

D. Surge Protection: Protect components from voltage surges entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 00 - Surge Protective Devices.
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 00 - Surge Protective Devices, as recommended by manufacturer for type of line being protected.

E. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.03 SYSTEM SUMMARY

A. Provide and install IP-based video surveillance system, cameras and supporting equipment throughout the facility as shown on the Drawings.

B. Utilize telecommunication structured cabling system as specified in Section 27 15 00 - Data Communications Horizontal Cabling, Section 27 13 23 - Communications Optical Fiber Backbone Cabling, Fiber Optic Connector Intermateability Standards (FOCIS) specifications TIA/EIA-604-2, TIA/EIA-604-3-A, TIA/EIA-604-12, AND COMPLY WITH TIA/EIA-568B-3.

C. Provide software and programming on Board provided and contractor installed network electronic (PoE) switches.

D. Provide Software and programming for Board provided and Contractor Installed Work Stations and Servers.

E. Provide software Licenses quantity as indicated in contract documents.

F. Federation licenses to be applied separately at the Student Safety Center by vendor for remote viewing of all school federated facilities.

G. Provide IP- cameras aiming, programming and interconnection to the CPS Office of School Safety and Security (OSSS) and the Office of Emergency Management and Communication (OEMC) surveillance systems. The remote access feature shall be included in the installation.

H. System required to interface with Intrusion Detection System and all video surveillance system cabling required to be in conduit. Upon alarm of Intrusion Detection system, a notification and live video feed shall be transmitted to the Student Safety Center.

2.04 CAMERAS

A. Interior Fixed and PTZ Camera and Housing:
1. Fixed Camera:
a. General: The camera shall be a fixed, vandal-resistant, megapixel dome camera with HD capability.
b. Basis-of-Design Product:

1) Axis camera models M3045V, P3225LVE, P3364LVE, P3367VE, Q6055E. All cameras provided are to be vandal resistant and exterior versions of specific models used where applicable.

c. Features: Fixed cameras shall include the following features for optimal performance within a school environment:
1) Power-over-Ethernet (PoE) IP Camera: Providing power and data transmission via a single Category 6 cable (up to 295 feet).
2) Vandal-Resistant Dome: IP66 weatherproof hardened enclosure with security screws.
3) Integrated Sensor: 1/2-inch sensor for low light capabilities and sharper imagery.
4) Resolution: Up to 3 Megapixels of resolution for facial identification at 30 feet.
5) Streaming: Multiple streaming (up to eight) at variable resolutions and frame rates.
6) Compression: H.264 compression.

2. PTZ Camera: Provide one of the following:
a. Axis; Q6055 PTZ dome network camera.
b. Axis; Q6045 PTZ.
c. Axis; P5515 PTZ.
d. Axis; P5624-E Mk II PTZ
3. Housing: Vandal-resistant, low profile, mini-dome enclosure, with smoke-colored dome.
4. Mounting: Cameras shall be wall-mounted. Interior 9 feet as a standard. If ceiling is shorter than 9 feet – then mount camera 3 inches below finished ceiling. Exterior Mounting height is 12-15 feet allowing for architectural detail. Variances on this specification require prior written approval from Department of Safety and Security.
a. Ceiling-mounted cameras are allowed only with prior review and approval, in writing, by CPS Office of School Safety and Security.
5. All cameras shall be capable of electronic light control for low light (day /night) conditions. Cameras shall provide color images when sufficient light is present and automatically provide black and white images during low light and night conditions.
6. All cameras shall have the ability to auto back focus.
7. All cameras shall have automatic iris control with manual override.
8. All cameras shall have intelligent video motion detection feature.

B. Exterior Fixed Camera and Housing:
1. Basis-of-Design Product:
a. Axis; P3367-VE.
b. 5 Megapixel.
2. Housing: Vandal-resistant, low profile, mini-dome enclosure, with clear domes.
3. Mounting: Cameras shall be installed with wall-mounted brackets.
4. Features:
a. Provide camera manufactures recommended heating and fan elements.
b. Provide power supply if the camera and/or heater/cooler are not completely powered over PoE, or High PoE.

C. Specialty Fixed Camera:
1. Axis P3225LV. Location/Use: MDF room surveillance.
2. Axis P3225LV, with wide dynamic range. Location/Use: Exits/entrances and extreme lighting conditions.
3. Axis M3045V Location/Use: Well-lit areas.
4. Axis M3045V compact & discreet camera.
5. Axis P3225LVE fixed outdoor rated, with intuitive IR illuminators. Location/Use: Use in areas that have extreme lighting condition.

D. Outdoor IP PTZ Cameras:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the Axis Q6055-E PTZ dome cameras, or one of the following:
   a. Axis; P5624E Mk II PTZ.
   b. Axis; Q6155E PTZ.
2. Camera for License Plate Recognition: Provide AXIS Q1765-LE Network Camera Outdoor-ready, bullet camera with integrated IR, 18x zoom and HDTV 1080p.
   a. Housing: Vandal-resistant, low profile, mini-dome enclosure with clear dome. Exterior enclosures shall have a heater element and sun shields.
   b. Mounting: PTZ cameras shall be installed with corner mounts as required to provide a 270-degree field of view at building corners.
   c. All cameras shall be capable of electronic light control for low light (day /night) conditions. Camera shall provide color images when sufficient light is present and automatically provide black and white images during low light and night conditions.
   d. All cameras shall have automatic iris control with manual override.
   e. All lenses shall be selected based on the application and view angle for maximum coverage as located in the Drawings.
   f. Provide Power-over-Ethernet or High Power-over-Ethernet with significant voltage to power the internal heating and cooling functions.

E. Additional camera models may be specified based on the release of new products or special requirements requested by Safety and Security.

2.05 POWER AND GROUNDING REQUIREMENTS

A. Power Supplies:
1. General: All power supplies shall be UL listed and labeled, recommended by the camera manufacturer, and provided as required to support the cameras shown on the Drawings. Provide rack mounted power supplies in MDF rack locations. Provide wall mount power supplies within 75 feet of exterior cameras if exterior cameras power requirements exceed PoE or High PoE standards.
2. PTZ Cameras: Provide power supply if the camera and/or heater/cooler are not completely powered over PoE, or High PoE. Provide the required gauge wire (according to manufacturer's specifications) for low-voltage power if the camera and/or heater/cooler are not completely powered over PoE, or High PoE.
   a. Provide 120V, single-phase power within 75 feet of all PTZ as required by camera or midspan device specified. Where outdoor cameras are to be mounted in close proximity, as determined by the manufacturer, a combined local power supply for up to four outdoor cameras may be provided.
   b. Power supplies for PTZ cameras shall be installed indoors, in MDF.

B. Uninterruptible Power Supply (UPS):
1. General: Uninterruptible power supplies shall be Contractor provided and installed.
2. Provide uninterruptible power supply(s) with sufficient capacity to power all DVS system head-end components including camera power supplies located in MDF room for a minimum of 15 minutes.
3. Submit test report stating UPS at time of project completion complies with 15 minutes of backup.
4. Contractor shall confirm the final backup power requirements, which shall be based on the number of PoE cameras and equipment installed within the MDF security system rack. UPS shall be supplied for DVS equipment in MDF head end location.
   a. UPS for MDF Server Rack: Rack-mounted UPS. Provide one of the following:
      1) APC; Smart UPS 5000VA (208V or 120V).
      2) Tripp-Lite; SMART5000RT3U (208V or 120V).

C. Surge Protection Devices - Outdoor Cameras:

1. Location: Provide surge protection devices at all outdoor cameras. Protection devices shall be placed either in the MDF Room or easily accessible interior location within 10 feet of exterior camera building penetration. Locations of surge suppression devices shall be document on as built drawings.
2. Mounting: Attachment shall employ a RJ45 jack format for both input and output for video/data, two pairs of 24V power protection and an external grounding screw.
3. Power protection shall be clamped at a maximum of 47 volts AC.
4. Reaction time of the surge protection device shall be in Pico seconds.
5. Basis-of-Design Manufacturer: Ditek DTK-PVPIP, DTK-MRJPOE or integral built in surge protector.

D. Grounding:
1. Provide Telecommunication Rack Grounding Kit.
2. Provide No. 6 AWG copper bonding conductor.
3. Provide one hole compression lugs for bonding conductor terminations.
4. Provide ground from DVS equipment rack to MDF Main Grounding Bus bar.

2.06 HARDWARE

A. Viewing Workstations: Hardware provided and programmed by the Board, installed by Contractor. Software furnished, installed, and programmed by Contractor.
1. Client Station Requirements:
   a. Windows based computer meeting current CPS ITS specifications.
2. Quantity/Locations: Contractor installed, Board provided viewing workstations at locations indicated below:
3. Viewing workstations shall be connected to local data outlet connected to the MDF room.

B. Switches: Hardware provided by the Board, installed by Contractor. Software furnished, installed, and programmed by Contractor.
1. For MDF Security System Rack: Provide 24-port gigabit fiber/PoE/Ethernet switch.

2.07 SOFTWARE AND SERVERS

A. Software:
1. Genetec: The Genetec Security Center (Version to be determined by Safety and Security at point of installation) is the Video Management System software to manage all the cameras, and connections. The base license includes four (4) client/user connections and the quantity of device licenses is determined by the number of camera connections.
2. Archiving: Physically separate server required; all archiving should be done on completely separate machines so not to slow down the directory and gateway functions. There is a maximum of 75 cameras per 25TB archive machine.
3. Additional Federation Server Licenses are a requirement to link each additional school implementation to the CPS (SSC) Student Security Center and the Office of Emergency Management and Communication (OEMC).
4. Required Licenses: Include the following:
   a. Genetec Security Center standard license for installs under 50 cameras; professional license for systems over 50 cameras.
      1) One 75 camera/25TB archive (on directory machine, camera licenses not included).
      2) Gateway - 8 camera connections - 4 client/user connections.
      3) Maps/Procedures - Camera Sequences - Audio Support - Web pack.
      4) Virtual Matrix.
      5) Macros.
      6) Keyboard connection.
      7) Alarm Management Module.

8) Local Archiving.
9) Offline archiving.
10) 1Time Zone Support.

b. Additional Camera Licenses based upon the number of camera connections.

5. Provide latest version of **Genetec** software in use by CPS at time of Bid submittal.
6. The DVS system shall be capable of receiving signals from the Board's intrusion detection system. Software shall have alarm video monitoring and external alarm capabilities.
7. Software requirements:
   a. Operating System: (CPS Preferred Server OS)
      1) Microsoft® Windows Server® 2008 Standard Edition SP2 32-bit/64-bit.
      2) Microsoft® Windows Server® 2008 Enterprise Edition SP2 32-bit/64-bit.
      3) Microsoft® Windows Server® 2008 Standard/Enterprise Edition R2 64-bit.
   b. Databases (CPS Preferred SQL Version): SQL Server 2008 Express/Standard/Enterprise.
   c. Browser (CPS Preferred Browser): Internet Explorer 7(for Web Clients).

B. Server (Gateway Directory) and Archive Server (s) Hardware: Hardware provided by the Board, installed by Contractor. Software furnished, installed, and programmed by Contractor.
1. Network device rack with adequate space for required equipment within an environmentally controlled environment or enclosure. If using a two post rack, center-mount rails must be purchased to properly mount servers and storage arrays.
2. Provide the server hardware environment to support the DVS/Genetec Software Solution.
3. The Storage capacity and configuration shall be scalable based on specific application needs without modification to the base video management software package.
4. All hardware platforms will be capable of mounting in a standard nineteen inch (19-inch) equipment rack and accepting power, network and other standard IT wiring connections.
5. The video management software manufacturer and camera manufacturer shall provide storage requirements per camera based upon calculations. Hardware requirements for the specific recording configuration to be managed by the video management software server. In order to determine the hardware storage requirements that are best suited for the actual application coordinate with the video management software manufacturer.
6. For Storage Hardware Calculations: Provide storage capacity use 3MP (2048 x 1536) resolution with 30% compression, 12 FPS 7am to 6pm and 6 FPS 6PM to 7am, and 30 days retention.
7. Server Hardware shall be packaged from DELL and shall be coordinated with CPS ITS Representative.
8. Recommended Server Specifications:
   a. Genetec Security Center
      1) Basis of Design Product: Dell SI #7971BD Power Edge R530
      2) General Server Features:
         a) The video server shall be integrated into a server-class computing platform ('PC'). The PC shall be available in a rack-mount chassis and shall fit in an EIA-standard 19-inch equipment rack utilizing no more than two units (2U) of rack space.
         b) The server Operating System shall be Microsoft Windows Web Server 2008 R2.
         c) Server shall have front accessible, hot-swap hard-disk trays.
9. Server System Components:
   a. Server shall utilize Dual (two) Intel Xeon Quad-core CPU, 2.4GHz.
   b. Server shall utilize Intel 5500 series chipset.
   c. Server shall have at least 4GB of DDR3 system memory.
   d. Server Storage Controller shall be a PERC H700.
   e. All hard disk components used by the system shall be designed specifically for enterprise storage applications in disk dense environments.
   f. Server hard drives shall be Seagate Constellation ES SATA.

g. Server shall provide between 4tb and 20tb RAID5 of internal storage for video event data.
h. Server shall have two Gigabit network controller ports.
i. Server shall have RS0232C serial port, for communications with pan-tilt-zoom cameras and other auxiliary devices.
j. Server shall have High-Speed USB 2.0 serial ports, for the attachment of external storage, digital I/O and archive devices.

10. Archive Servers: A minimum of one Genetec Gateway Directory Server and one Genetec Archive Server shall be required. The number of servers required will depend on the total number of cameras as well as the camera used. Another determining factor will be the amount of motion. The greater the motion, the greater the use of storage. Below is an example of an Arecont 80 camera implementation, using 3MP (2048 x 1536) resolution, 30% compression, 12 FPS 7am to 6pm and 6 FPS 6PM to 7am, and 30 days retention.
    a. Max throughput of about 308 Mbps or 3.86 Mbps per camera.
    b. Storage:
        1) 26.5 TB for 13 hours overnight.
        2) 44 TB for 11 hours daytime.
        3) 70 TB total Storage required.
11. An additional archive server is required for every 75 additional cameras. Each archive server can leverage a combination of the internal and attached storage.
12. Additional Archive servers may be required to meet the needs of the installation.

2.08 SIGNAL TRANSMISSION COMPONENTS

A. DVS-UTP Cable:
1. General: Provide Category 6 cable. Refer to Section 27 15 00 - Data Communications Horizontal Cabling.
2. All DVS-UTP cables shall meet or exceed the following UL listing:
    a. UL 1690, Data-Processing Cable defining DP-3 or DP-3P listings.
    b. UL 444, Communications Cable.
3. Jacket Color: Purple.

B. DVS Power Cable: For outdoor camera installations only.
1. Provide a power cable with minimum No. 16 AWG 2-conductor, stranded copper conductor construction. Size of cable shall be based on voltage drop and camera requirements. Cable feeds 24 VAC from a local power supply and shall be provided for each outdoor camera.

C. DVS Backbone Cable: Subject to compliance with requirements in Section 27 13 23 - Communications Optical Fiber Backbone Cabling; provide Indoor 10G/150M Multimode Fiber-Optic Cable: 50/125-micrometer, laser-optimized multimode optical fiber, capable of 10-Gigabit Ethernet transmission up to 492 feet. Use for interior applications only.
1. Strand Count: 6 (MDF to enclosures).
2. Minimum OFL Bandwidth: 700 MHz-km at 850 nm; 500 MHz-km at 1300 nm, as characterized by OFL (overfill launch) measurement per EIA/TIA-455-204.
3. Cable shall meet or exceed the OM3 standard.
4. Sheathing Color: Aqua.

D. DVS Backbone Cable: Subject to compliance with requirements in Section 27 13 23 - Communications Optical Fiber Backbone Cabling; provide Indoor 10G/300M Multimode Fiber-Optic Cable: 50/125-micrometer, laser-optimized multimode optical fiber, optimized for VCSEL-based transmission of 10-Gigabit Ethernet up to 984 feet. Use for interior applications only.
1. Strand Count: 6 (MDF to enclosures).
2. Minimum Effective Modal Bandwidth: 2000 MHz-km at 850 nm; 500 MHz-km at 1300 nm, as characterized by DMD measurement per EIA/TIA-455-220.
3. Cable shall meet or exceed the OM3 standard.

4. Sheathing Color: Aqua.

E. DVS UTP Connecting Hardware:
1. DVS Jacks: Category 6.
   a. DVS jacks shall be modular and not a permanent element associated to a faceplate.
   b. DVS Jack Color: Purple.
2. DVS Patch Panels: Category 6.
   a. DVS patch panels in 16, 24, and 32-port configurations shall have 110 IDC conductor terminations and shall be capable of terminating 22 - 24 AWG solid copper conductors without damaging jack.
   b. Patch cable length determined by rack layout.
   c. Provide one patch cord for each information outlet.
   d. Color requirements:
      1) DVS Jacks for insertion into DVS patch panels shall be purple in color.
      2) Mounting Plate: Black with purple RJ45 jacks.
3. DVS Work Area Patch Cords: Category 6.
   a. Patch cords shall be in the configuration of a four (4) pair, unshielded twisted pair design, stranded copper conductor construction.
      1) The patch cord insulation shall be PVC and shall be UL rated as CM or CMR.
      2) All patch cables shall be component compliant to TIA/EIA Category 6 requirements.
      3) All patch cords shall meet or exceed the TIA/EIA-568-B.2.1 worst-case electrical characteristics.
      4) Patch Cord Color: Purple.
   b. Provide 6 foot work area patch cable length.
   c. Provide one patch cord for each information outlet.
   d. Provide one patch cord for each port.

F. DVS Backbone Connecting Hardware, Patch Cords and Optical Cable Connectors:
1. Comply with Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Fiber Optic Termination Housing: Rack-mount, with multi-numbered, duplex connector insert adapter panels holding fiber optic strand connectors.
   a. Optical Fiber Connecting Hardware: Refer to Section 27 13 23 - Communications Optical Fiber Backbone Cabling.
   b. Size - Concentrator Enclosures: (1) rack unit height; sized to accommodate a total of two (2) adapter panels.
   c. Size - MDF: (3) rack units height, sized to accommodate at least six (6) adapter panels.
3. Patch Cords:
   a. Optical Patch Cords: Refer to Section 27 13 23 - Communications Optical Fiber Backbone Cabling.
   b. Patch cords shall be of same manufacturer and jacket color (purple); consistent with components and performance level of cross-listed solutions indicated in this Section.
   c. Specification of fiber optic patch cord to match fiber optical backbone served by cord.
   d. Patch cable length determined by rack layout.
4. Optical Cable Connectors:
   a. Optical Fiber Connecting Hardware: Refer to Section 27 13 23 - Communications Optical Fiber Backbone Cabling.

2.09 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-D.

B. Ladder Rack Runway:
1. Used for routing of communications cabling within MDF room.

C. Conduit and Boxes: Refer to Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems. Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 4 inch square by 2-1/2 inches deep, fitted with single- or double-gang trim plates to accommodate single- or double-gang communications faceplates as coordinated with Contract Drawings and outlet configuration.

PART 3 - EXECUTION

3.01 WIRING METHODS AND INSTALLATION OF PATHWAYS

A. Drawings indicate general arrangement of pathways and fittings.
1. Conduit Installation: Raceways and conduit shall be fully concealed.
a. Where exposed raceways or conduit are proposed, those installations shall be reviewed and approved, in writing, by CPS Office of Safety and Security prior to the start of the work.

B. Connecting to Existing Equipment: Verify that existing security system is operational before making changes or connections.
1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Wiring Method: Install cables in existing dedicated, existing concealed raceways, cut and patch wall/floor or surface mounted raceway for DVS System cabling.
1. Comply with requirements for raceways and boxes and their installation specified in Sections 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.
2. Comply with TIA/EIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
3. Utilize wide sweeping radius bends and elbows.
4. DVS system shall have dedicated conduit raceway system. No other system wiring shall be allowed in the DVS raceway.

D. Wiring within Enclosures: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide Velcro straps - cable ties are not allowed. Provide service loop as required. Provide and use lacing bars and distribution spools.

E. Wiring within MDF: Bundle, lace, and train cables to terminal points without exceeding manufacturer's limitations on bending radii. Provide Velcro straps - cable ties are not allowed. Provide service loop as required. Utilize overhead ladder rack runway for cable routing within room(s).
1. Coordinate installation of dedicated floor-mounted rack for DVS system equipment. Coordinate location adjacent to existing structured cabling floor-mounted racks.

2. Coordinate with Contractor on installation of dedicated wall-mounted rack for DVS system equipment. Coordinate location with CPS Office of School Safety and Security (OSSS) and CPS Office of Information Technology before mounting.
3. Where raceways or conduit are proposed to be exposed, those installations shall be reviewed, and approved in writing, by CPS Office of Safety and Security prior to the start of the work.

3.02 GENERAL INSTALLATION

A. Install all equipment and components in accordance with manufacturer's written instructions, in compliance with NEC, and with recognized industry practices, to ensure that all items comply with specifications and service intended purposes.

B. Record serial numbers of all items furnished that are serialized. Serial numbers to be included in warranty manual.

C. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between indicated termination, tap, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.

D. Terminations: Terminate UTP cables in MDF room on patch panels. Terminate DVS cables at outlets. Leave 12 inches of slack DVS cable at each outlet box and label cable and outlet box cover plate.

E. Labeling:
1. Identify system components, wiring, cabling, and terminals. Subject to compliance with requirements in Section 27 05 53 - Identification for Communication Systems and Division 26 Section 26 05 53 - Identification for Electrical Systems.
2. Power supply and equipment used shall be labeled "Class 2."
3. Outlets: Label cables within outlet boxes.
4. Distribution Racks and Frames: Label each unit and field within that unit.
5. Within Connectors Fields, in MDF Room: Label each connector and each discrete unit of cable-terminating and connecting hardware.
6. Cables, Generally: Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
7. Head End Equipment: Provide labels on the front of the equipment to identify port number, IP address, subnet mask, and gateway and using a professional labeler
8. Provide labeling for all cameras.
9. Utilize label equipment that is professional grade.

F. Cable Schedule: Post in a prominent location in the MDF room. List incoming and outgoing cables and their designations, origins, and destinations. Provide a disc copy of final comprehensive schedules for the project in the software and format selected by the Board.

G. Programming/Configuring Coordinate with CPS Office of School Safety and Security at (773) 553-3001 or (773) 553-5136 for general programming requirements. Use manufacturer's programming form and system layout work sheets provided by CPS.
1. Configure cameras using IP scheme.
2. Configure network switch.
3. Load software.
4. Install and configure servers and storage.
5. All cameras shall be recorded in MDF on Storage Array Servers. All PTZ cameras to be programmed to tour outside areas as required by CPS Office of School Safety and Security. Tour of duty shall be interrupted by any computer loaded with software and shall resume after two minute idle time delay.

6. DVS System shall be connected to CPS's LAN and WAN network through static IP addressing via the administration network side. IP addresses shall be provided by CPS ITS and programmed into the DVS Software Solution by the Contractor. Contractor shall provide the CPS Office of School Safety and Security emergency control center with new IP addresses.

H. Mounting:
1. Camera locations and mountings shall be determined by CPS Office of School Safety and Security.
2. Exterior cameras (both fixed and PTZ) shall be mounted at a second floor level where possible, minimum of 15 feet above finished grade. Wiring and cables must enter the building within 12 inches of mounting location.
3. Interior cameras shall be wall-mounted, 10-inches below finish ceiling.
4. Where back boxes, raceways or conduit are proposed to be exposed, those installations shall be reviewed, and approved in writing, by CPS Office of Safety and Security prior to the start of the work.

I. Sealing of Penetrations: All penetrations for and at wiring, cabling, conduit, raceway, and outlets shall be tightly sealed with elastomeric sealant or firestopping compound, as required, at the completion of the work. No gaps or openings shall remain.
1. Refer to Section 07 92 00 - Joint Sealants for elastomeric sealant.
2. Refer to Section 07 84 00 - Firestopping for firestopping compounds and materials.

3.03 FIELD QUALITY CONTROL

A. Inspect for physical damage and test cable for continuity and shorts. Test cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.

B. Refer to Section 27 08 00 - Commissioning of Communications for DVS-UTP cable testing procedures.

3.04 SYSTEM STARTUP AND REPORTING

A. Installer shall set outdoor PTZ cameras for manual control (medium speed, medium distances). Tours shall not be set. PTZ cameras shall be set to return to home position after 5 minutes of inactivity.

B. Installer shall obtain and program IP addresses as well as all camera alpha descriptors into **Genetec** and supporting documents and verify connectivity to CPS Student Safety Center at (773) 553-3335 and (773) 553-3001, Office of Emergency Management and Communication (OEMC), as well as connectivity on school computers. Identify port number, IP address, subnet mask, and gateway and using a professional labeler, label MDF head end equipment with this information.

3.05 ADJUSTING

A. Make adjustments or corrections for operation of the system. Obtain final approval from CPS Office of School Safety and Security Equipment Technician.

B. Follow the manufacturer's instructions to program the system and provide a copy of programming on CD-ROM disk in format required for downloading.

C. Adjust or replace system devices until all cameras are aimed and focused as directed by CPS Office of School Safety and Security. Installer's technicians shall be available for adjustments for a period of 30 days following acceptance of installation.

3.06 CLEANING

A. On completion of installation inspect exposed finishes. Remove burrs, dirt, paint spots, and construction debris. Repair damaged finish(es), including chips, scratches, and abrasions.

B. All equipment, hardware and finishes shall be cleaned prior to final acceptance. Unless otherwise indicated, clean shall mean free of dust, dirt, mud, debris, oil, grease, residues, and contamination.

C. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Preliminary Acceptance / Substantial Completion. Protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps. Cover fixtures, materials, equipment and devices furnished or installed under this section or otherwise protect against damage, both before and after installation. Hardware, materials, equipment, or devices damaged prior to final acceptance of the work shall be restored to their original condition or replaced.

3.07 COMMISSIONING

A. Refer to Section 27 08 00 - Commissioning of Communications for performance tests, inspections, correction of deficiencies, and preparation of test and inspection reports.

3.08 CLOSEOUT ACTIVITIES

A. General: Training shall be coordinated with CPS Office of School Safety and Security and school Principal, as required, and shall be provided at mutually agreed on times, with not less than 7 days' notice provided prior to each training session. An outline agenda for each training session shall be provided and names of attendees recorded.

B. Provide a minimum of two (2) four hour sessions of technical training for designated CPS Office of School Safety and Security personnel. Training shall include system programming, operation and maintenance procedures, and delivery of required manuals.

C. Provide one four hour training session for the school Principal and designated staff members. Training shall include proper methods of live view, retrieval, utilizing PTZ cameras, bookmarking incidents.

D. Provide a minimum of two (2) hours of refresher technical training sessions for designated CPS Office of School Safety and Security representatives 30 days after the initial training session. Training shall include system programming, operation and maintenance procedures.

E. Provide a minimum of two (2) hours of Operator/User training sessions for designated CPS Office of School Safety and Security representatives. Training shall include system operations programming and configurations.

F. Provide a minimum of two hours of Operator/User training sessions for designated CPS Office of School Safety and Security representatives 30 days after the initial training session. Training shall include system operations programming and configurations.

END OF SECTION 28 23 07

SECTION 33 51 13 (LNK)

NATURAL GAS PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipes, tubes, and fittings.

B. Piping specialties.

C. Joining materials for piping and tubing.

D. Valves.

E. Pressure regulators.

1.02 REFERENCE STANDARDS

A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2007 (Reaffirmed 2016).

B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

C. ASME B1.20.3 - Dryseal Pipe Threads (Inch); 1976.

D. ASME B16.20 - Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed; 2012.

E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

F. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi (Sizes NPS ½ Through NPS 2); 2012.

G. ASME B16.38 - Large Metallic Valves for Gas Distribution Manually Operated, NPS 2 1/2 (DN 65) to NPS 12 (DN 300), 125 psig (8.6 bar) Maximum; 2012.

H. ASME B16.39 - Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300; 2014.

I. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2017.

J. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012, Including July 2013 Errata.

K. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).

M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

O. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2014.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

Q. AWS D10.12M/D10.12 - Guid for Welding Mild Steel Pipe; 2000.

R. ICC (IFGC) - International Fuel Gas Code; 2018.

S. ANFPA 54 - National Fuel Gas Code; 2018.

T. ANFPA 70 - National Electrical Code; 2017.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roofs, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Anodeless Risers and Sweeps: Fittings that can be installed without additional cathodic protection.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Coordinate installation of anchorages for natural-gas systems. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation and to not cause a delay in the Work.
3. Coordinate requirements for access panels and doors for valves and controls installed concealed behind finished surfaces, and for areas requiring routine maintenance. Comply with requirements in Section 08 31 00 - Access Doors and Panels as applicable.

1.05 PERFORMANCE REQUIREMENTS

A. Natural-Gas System Pressure within Buildings: 2-psig or less.

B. Operating Pressure Ratings:
1. Piping and Valves: 100-psig minimum unless otherwise indicated.
2. Service Regulators: 65-psig minimum unless otherwise indicated.
3. Operating Pressure of Service Meter: 5-psig minimum unless otherwise indicated.

1.06 SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.

B. Shop Drawings: Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail locations of anchors, alignment guides, and expansion joints and loops. Include a site plan, on which natural-gas piping is indicated and coordinated with other services and utilities.
   1. Shop Drawing Scale: Not less than 1/4" = 1'-0".

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Installer Qualifications.

E. Reports:
   1. Field quality-control reports.
   2. Startup Reports: Submit reports documenting activities required during startup of gas boosters. Reports shall be submitted within two weeks following completion of startup activities.
   3. Training Reports: Submit reports regarding training of Board's maintenance personnel. Include date(s) of training and list of attendees.

F. Operation and Maintenance Data: For pressure regulators, include data in emergency, operation, and maintenance manuals.

G. Record Drawings: Indicate, at 1/4" = 1'-0" scale, the actual natural-gas piping installation layout and elevations, sections, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer that is experienced in the installation of natural-gas piping of the types required for the Project, and whose work has resulted in a record of successful in-service performance. Installer licensed to perform natural-gas piping installation and maintenance in Chicago, IL.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged gas boosters and are based on the specific system indicated.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME BPVC.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Regulatory Requirements: Natural-gas piping installations shall comply with ICC (IFGC).

1.08 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose flammable liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps throughout shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.09 FIELD CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by the Board or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify the Board no fewer than seven days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Board's written permission.

1.10 WARRANTY

A. Special Warranty: Submit written warranty, executed by the manufacturer and Installer, agreeing to repair or replace components that develop defects in material or workmanship within the specified warranty period.
   1. Warranty Period for Natural-Gas Systems: One year from date of Preliminary Acceptance. or eighteen months from date of shipment, whichever is greater.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers indicated for each component:
   1. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
      a. Conbraco Industries, Inc.; Apollo Div.
      b. Lyall, R. W. & Company, Inc.
      c. McDonald, A. Y. Mfg. Co.
      d. Perfection Corporation; a subsidiary of American Meter Company.
   2. Bronze Plug Valves:
      a. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.
   3. Cast-Iron, Non-lubricated Plug Valves:
      a. McDonald, A. Y. Mfg. Co.
      b. Mueller Co.; Gas Products Div.
      c. Xomox Corporation; a Crane company.
   4. Cast-Iron, Lubricated Plug Valves:
      a. Flowserve.
      b. McDonald, A. Y. Mfg. Co.
      c. Mueller Co.; Gas Products Div.
      d. R&M Energy Systems, a Unit of Robbins & Myers, Inc.
   5. Appliance Pressure Regulators:

a. Eaton Corporation; Controls Div.
b. Harper Wyman Co.
c. Maxitrol Company.
d. SCP, Inc.

6. Dielectric Unions: No preference.
7. Dielectric Flanges: No preference.
8. Mechanical Sleeves: No preference.

2.02 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.03 PIPING SPECIALTIES

A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.04 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural-gas pipe.

B. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.05 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125-psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch diameter and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125-psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Body: Complying with ASTM B584.
1. Ball: Chrome-plated bronze.
2. Stem: Bronze; blowout proof.
3. Seats: Reinforced TFE; blowout proof.
4. Packing: Threaded-body packnut design with adjustable-stem packing.
5. Ends: Threaded, flared, or socket as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. CWP Rating: 600-psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125-psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125-psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125- psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.06 DIELECTRIC FITTINGS

A. Dielectric Unions:
1. Minimum Operating-Pressure Rating: 150-psig.
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:
1. Minimum Operating-Pressure Rating: 150-psig
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.07 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural-gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Appliance Pressure Regulators: Comply with ANSI Z21.18/CSA 6.3.
1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 2-psig

2.08 SLEEVES

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural-gas to premises or piping section.

B. Inspect natural gas piping according to the ICC (IFGC) to determine that natural gas utilization devices are turned off in piping section(s) affected.

C. Comply with the ICC (IFGC) requirements for prevention of accidental ignition.

3.03 INSTALLATION - OUTDOOR PIPING

A. Comply with the ICC (IFGC) for installation and purging of natural-gas piping.

B. Aboveground Natural-Gas Piping:
1. Pipe Diameter - 2-inches Diameter and Smaller: Steel pipe with malleable-iron fittings and threaded joints.
2. Pipe Diameter - Larger than 2-inches Diameter: Steel pipe with wrought-steel fittings and welded joints.

3.04 INSTALLATION - INDOOR PIPING

A. Comply with the ICC (IFGC) for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved by Architect/Engineer of Record.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building surfaces. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install escutcheons at penetrations of interior walls, ceilings, and floors.
1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
   d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
   e. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
   f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping:

a. Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
b. Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
c. Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
d. Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
e. Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements in Section 07 84 00 - Firestopping.

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Provide drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Concealed natural-gas piping shall be installed according to the ICC (IFGC).

Q. Natural-gas piping valves and regulators shall not be installed in concealed spaces.
1. Prohibited Locations:
a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator hoistways.
b. Do not install natural-gas piping in solid walls or partitions.
c. Do not install natural-gas piping underground below building slabs.

R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. Provide unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

U. Do not use natural-gas piping as grounding electrode.

3.05 INSTALLATION - VALVES

A. Provide manual gas shutoff valve for each gas appliance. Valve shall be located in same room as equipment.

3.06 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes and fittings before assembly.

C. Threaded Joints:
1. Thread pipe with tapered pipe threads according to ASME B1.20.1
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Provide gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.07 INSTALLATION - HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Division 23.

B. Provide hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.08 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Provide tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.09 IDENTIFICATION

A. Comply with requirements in Division 23 for piping and valve identification.

3.10 PAINTING

A. Comply with requirements in Division 09 for painting interior and exterior natural-gas piping.

3.11 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural-gas according to the ICC (IFGC) and authorities having jurisdiction.
   1. Natural-gas piping will be considered defective if it does not pass tests and inspections.
   2. Prepare test and inspection reports.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints NPS 2 and smaller.
   2. Steel pipe with wrought-steel fittings and welded joints NPS 2-1/2 and larger.
   3. Underground, below building, piping shall not be allowed.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 2 PSIG (BOILER ROOM ONLY)

A. Aboveground piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints smaller or equal to NPS 2.
   2. Steel pipe with steel welding fittings and welded joints NPS 2-1/2 and larger.
   3. All concealed natural-gas piping shall be in a double wall configuration and vented to the outdoors.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, non-lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

END OF SECTION 33 51 13

SECTION 33 51 13 (MEP)

NATURAL GAS PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipes, tubes, and fittings.

B. Piping specialties.

C. Joining materials for piping and tubing.

D. Valves.

E. Pressure regulators.

1.02 REFERENCE STANDARDS

A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2007 (Reaffirmed 2016).

B. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

C. ASME B1.20.3 - Dryseal Pipe Threads (Inch); 1976.

D. ASME B16.20 - Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed; 2012.

E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

F. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi (Sizes NPS ½ Through NPS 2); 2012.

G. ASME B16.38 - Large Metallic Valves for Gas Distribution Manually Operated, NPS 2 1/2 (DN 65) to NPS 12 (DN 300), 125 psig (8.6 bar) Maximum; 2012.

H. ASME B16.39 - Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300; 2014.

I. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2017.

J. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012, Including July 2013 Errata.

K. ASME BPVC - Boiler and Pressure Vessel Code; 2017.

L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).

M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2017.

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

O. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2014.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

Q. AWS D10.12M/D10.12 - Guid for Welding Mild Steel Pipe; 2000.

R. ICC (IFGC) - International Fuel Gas Code; 2018.

S. ANFPA 54 - National Fuel Gas Code; 2018.

T. ANFPA 70 - National Electrical Code; 2017.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roofs, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Anodeless Risers and Sweeps: Fittings that can be installed without additional cathodic protection.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Coordinate installation of anchorages for natural-gas systems. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation and to not cause a delay in the Work.
3. Coordinate requirements for access panels and doors for valves and controls installed concealed behind finished surfaces, and for areas requiring routine maintenance. Comply with requirements in Section 08 31 00 - Access Doors and Panels as applicable.

1.05 PERFORMANCE REQUIREMENTS

A. Natural-Gas System Pressure within Buildings: 2-psig or less.

B. Operating Pressure Ratings:
1. Piping and Valves: 100-psig minimum unless otherwise indicated.
2. Service Regulators: 65-psig minimum unless otherwise indicated.
3. Operating Pressure of Service Meter: 5-psig minimum unless otherwise indicated.

1.06 SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.

B. Shop Drawings: Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail locations of anchors, alignment guides, and expansion joints and loops. Include a site plan, on which natural-gas piping is indicated and coordinated with other services and utilities.
   1. Shop Drawing Scale: Not less than 1/4" = 1'-0".

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Installer Qualifications.

E. Reports:
   1. Field quality-control reports.
   2. Startup Reports: Submit reports documenting activities required during startup of gas boosters. Reports shall be submitted within two weeks following completion of startup activities.
   3. Training Reports: Submit reports regarding training of Board's maintenance personnel. Include date(s) of training and list of attendees.

F. Operation and Maintenance Data: For pressure regulators, include data in emergency, operation, and maintenance manuals.

G. Record Drawings: Indicate, at 1/4" = 1'-0" scale, the actual natural-gas piping installation layout and elevations, sections, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer that is experienced in the installation of natural-gas piping of the types required for the Project, and whose work has resulted in a record of successful in-service performance. Installer licensed to perform natural-gas piping installation and maintenance in Chicago, IL.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged gas boosters and are based on the specific system indicated.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME BPVC.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Regulatory Requirements: Natural-gas piping installations shall comply with ICC (IFGC).

1.08 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose flammable liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps throughout shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.09 FIELD CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by the Board or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify the Board no fewer than seven days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Board's written permission.

1.10 WARRANTY

A. Special Warranty: Submit written warranty, executed by the manufacturer and Installer, agreeing to repair or replace components that develop defects in material or workmanship within the specified warranty period.
   1. Warranty Period for Natural-Gas Systems: One year from date of Preliminary Acceptance. or eighteen months from date of shipment, whichever is greater.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers indicated for each component:
   1. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
      a. Conbraco Industries, Inc.; Apollo Div.
      b. Lyall, R. W. & Company, Inc.
      c. McDonald, A. Y. Mfg. Co.
      d. Perfection Corporation; a subsidiary of American Meter Company.
   2. Bronze Plug Valves:
      a. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.
   3. Cast-Iron, Non-lubricated Plug Valves:
      a. McDonald, A. Y. Mfg. Co.
      b. Mueller Co.; Gas Products Div.
      c. Xomox Corporation; a Crane company.
   4. Cast-Iron, Lubricated Plug Valves:
      a. Flowserve.
      b. McDonald, A. Y. Mfg. Co.
      c. Mueller Co.; Gas Products Div.
      d. R&M Energy Systems, a Unit of Robbins & Myers, Inc.
   5. Appliance Pressure Regulators:

a. Eaton Corporation; Controls Div.
b. Harper Wyman Co.
c. Maxitrol Company.
d. SCP, Inc.

6. Dielectric Unions: No preference.
7. Dielectric Flanges: No preference.
8. Mechanical Sleeves: No preference.

2.02 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.03 PIPING SPECIALTIES

A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.04 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural-gas pipe.

B. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.05 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125-psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch diameter and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125-psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Body: Complying with ASTM B584.
1. Ball: Chrome-plated bronze.
2. Stem: Bronze; blowout proof.
3. Seats: Reinforced TFE; blowout proof.
4. Packing: Threaded-body packnut design with adjustable-stem packing.
5. Ends: Threaded, flared, or socket as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. CWP Rating: 600-psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125-psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125-psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125- psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.06 DIELECTRIC FITTINGS

A. Dielectric Unions:
1. Minimum Operating-Pressure Rating: 150-psig.
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:
1. Minimum Operating-Pressure Rating: 150-psig
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.07 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural-gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Appliance Pressure Regulators: Comply with ANSI Z21.18/CSA 6.3.
1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 2-psig

2.08 SLEEVES

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural-gas to premises or piping section.

B. Inspect natural gas piping according to the ICC (IFGC) to determine that natural gas utilization devices are turned off in piping section(s) affected.

C. Comply with the ICC (IFGC) requirements for prevention of accidental ignition.

3.03 INSTALLATION - OUTDOOR PIPING

A. Comply with the ICC (IFGC) for installation and purging of natural-gas piping.

B. Aboveground Natural-Gas Piping:
1. Pipe Diameter - 2-inches Diameter and Smaller: Steel pipe with malleable-iron fittings and threaded joints.
2. Pipe Diameter - Larger than 2-inches Diameter: Steel pipe with wrought-steel fittings and welded joints.

3.04 INSTALLATION - INDOOR PIPING

A. Comply with the ICC (IFGC) for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved by Architect/Engineer of Record.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building surfaces. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install escutcheons at penetrations of interior walls, ceilings, and floors.
1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
   d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
   e. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
   f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping:

a. Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
b. Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
c. Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
d. Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
e. Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements in Section 07 84 00 - Firestopping.

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Provide drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Concealed natural-gas piping shall be installed according to the ICC (IFGC).

Q. Natural-gas piping valves and regulators shall not be installed in concealed spaces.
1. Prohibited Locations:
a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator hoistways.
b. Do not install natural-gas piping in solid walls or partitions.
c. Do not install natural-gas piping underground below building slabs.

R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. Provide unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

U. Do not use natural-gas piping as grounding electrode.

3.05 INSTALLATION - VALVES

A. Provide manual gas shutoff valve for each gas appliance. Valve shall be located in same room as equipment.

3.06 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes and fittings before assembly.

C. Threaded Joints:
1. Thread pipe with tapered pipe threads according to ASME B1.20.1
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Provide gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.07 INSTALLATION - HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Division 23.

B. Provide hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.08 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Provide tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.09 IDENTIFICATION

A. Comply with requirements in Division 23 for piping and valve identification.

3.10 PAINTING

A. Comply with requirements in Division 09 for painting interior and exterior natural-gas piping.

3.11 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural-gas according to the ICC (IFGC) and authorities having jurisdiction.
   1. Natural-gas piping will be considered defective if it does not pass tests and inspections.
   2. Prepare test and inspection reports.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints NPS 2 and smaller.
   2. Steel pipe with wrought-steel fittings and welded joints NPS 2-1/2 and larger.
   3. Underground, below building, piping shall not be allowed.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 2 PSIG (BOILER ROOM ONLY)

A. Aboveground piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints smaller or equal to NPS 2.
   2. Steel pipe with steel welding fittings and welded joints NPS 2-1/2 and larger.
   3. All concealed natural-gas piping shall be in a double wall configuration and vented to the outdoors.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, non-lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

END OF SECTION 33 51 13

32'-0" 0'-0" 16'-0" 32'-0" 64'-0"
1/32" = 1'-0"

16'-0" 0'-0" 8'-0" 16'-0" 32'-0"
1/16" = 1'-0"

8'-0" 0'-0" 4'-0" 8'-0" 16'-0"
1/8" = 1'-0"

4'-0" 0'-0" 2'-0" 4'-0" 8'-0"
1/4" = 1'-0"

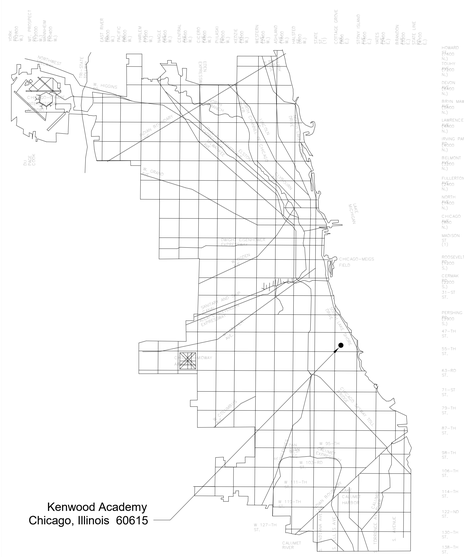
2'-0" 0'-0" 1'-0" 2'-0" 4'-0"
1/2" = 1'-0"

1'-0" 0'-0" 0'-6" 1'-0" 2'-0"
1" = 1'-0"

0'-0" 0'-6" 1'-0" 2'-0"
1-1/2" = 1'-0"

0'-0" 0'-3" 0'-6" 0'-9" 1'-0"
3" = 1'-0"

0'-0" 0'-1-1/2" 0'-3" 0'-4-1/2" 0'-6"
6" = 1'-0"



CITY OF CHICAGO LOCATION MAP

CITY OF CHICAGO BUILDING CODE CERTIFICATION STATEMENT

THIS IS TO CERTIFY THAT THESE DOCUMENTS HAVE BEEN PREPARED BY ME, OR UNDER MY DIRECT SUPERVISION, AND THAT TO THE BEST OF MY KNOWLEDGE THESE DOCUMENTS COMPLY WITH THE CITY OF CHICAGO BUILDING CODE.

SIGNATURE:

NAME: ANTHONY A. AKINDELE

ILLINOIS LICENSE NUMBER: 001-015385

REGISTRATION EXPIRATION DATE: 11-30-2024

ENERGY CONSERVATION CODE COMPLIANCE STATEMENT:

I CERTIFY THAT I AM REGISTERED DESIGN PROFESSIONAL AND THAT TO THE BEST OF MY KNOWLEDGE THE ATTACHED CONSTRUCTION DOCUMENTS FOR THE PROJECT AT 5015 SOUTH BLACKSTONE AVENUE, IN CHICAGO, IL 60615, FULLY COMPLY WITH THE REQUIREMENTS OF CHAPTER 18-13, ENERGY CONSERVATION IN THE MUNICIPAL CODE OF CHICAGO. ALSO IN COMPLIANCE WITH THE 2018 STATE OF ILLINOIS ENERGY CONSERVATION CODE.

SIGNITURE DATE

ILLINOIS ARCHITECT'S LICENSE NUMBER: 001-15385

STAMP

EXPIRES:
11.30.24

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, ILLINOIS 60615

PBC PROJECT NUMBER 05326

ADDENDUM #1
02.23.24

PUBLIC BUILDING COMMISSION OF CHICAGO
BRANDON JOHNSON, MAYOR
RAY GIDEROF, ACTING EXECUTIVE DIRECTOR

CHICAGO PUBLIC SCHOOLS
PEDRO MARTINEZ, CHIEF EXECUTIVE OFFICER
MIGUEL DEL VALLE, CHICAGO BOARD OF EDUCATION PRESIDENT
IVAN HANSEN, CHIEF FACILITIES OFFICER, FACILITIES & CAPITAL DEPARTMENT

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Exp. 11/30/22

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EXPIRES 11.30.2023

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Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates
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No.	Date	Description
3	02.23.24	ADDENDUM #1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326

Title
COVER SHEET

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ABBREVIATIONS

AB	ANCHOR BOLT
ACM	ALUMINUM COMPOSITE METAL
ACS FLR	ACCESS FLOOR
ACS PNL	PNL ACCESS PANEL
ACT	ACOUSTICAL CEILING TILE
AD	AREA DRAIN
ADA	AMERICANS WITH DISABILITIES ACT
ADH	ADHESIVE
ADJ	ADJUSTABLE
AFF	ABOVE FINISH FLOOR
AHU	AIR HANDLING UNIT
ALT	ALTERNATE
ALUM	ALUMINUM
APC	ACOUSTICAL PANEL CEILING
APC	ARCHITECTURAL PRECAST CONCRETE
B/	BOTTOM OF
BD	BOARD
BHMP	BUILDING HEIGHT MEASURING POINT
BLDG	BUILDING
BM	BENCH MARK
BOT	BOTTOM
BSMT	BASEMENT
CB	CATCH BASIN
CG	CORNER GUARD
CI	CAST IRON
CJ	CONTROL JOINT
CL	CENTER LINE
CLG	CEILING
CLO	CLOSET
CLR	CLEAR
CMT	COLOR TO MATCH
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT
COL	COLUMN
CONC	CONCRETE
CONST	CONSTRUCTION
CONT	CONTINUE
CORR	CORRIDOR
CPT	CARPET
CSK	COUNTERSUNK
CT	CERAMIC TILE
DEMO	DEMOLITION
DEPT	DEPARTMENT
DET	DETAIL
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DL	DEAD LOAD
DMPF	DAMP PROOF(ING)
DN	DOWN
DR	DOOR
DRN	DRAIN
DS	DOWNSPOUT
DWG / DWGS	DRAWING / DRAWINGS
E	EAST
EA	EACH
EC	EXPOSED CONSTRUCTION
EIFS	EXTERIOR INSULATION FINISH SYSTEM
EJ	EXPANSION JOINT
EL	ELEVATION
ELECT	ELECTRIC
ELEV	ELEVATOR
EMER	EMERGENCY
EMER SHR	EMERGENCY SHOWER
ENCL	ENCLOSURE
EPDM	EXPANDED POLYETHELENE DIENE MONOMER
EQ	EQUAL
EQUIP	EQUIPMENT
ETC	ET CETERA
EWC	ELECTRIC WATER COOLER
EWS	EYE WASH STATION
EXH	EXHAUST
EXIST / EX	EXISTING
EXP	EXPANSION JOINT
EXT	EXTERIOR
FA	FIRE ALARM
FAR	FLOOR AREA RATIO
FD	FLOOR DRAIN
FDN	FOUNDATION
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FH	FIRE HYDRANT
FHC	FIRE HOSE CABINET
FHCE	FIRE HOSE CABINET & EXTINGUISHER
FHR	FIXTURE
FIN	FINISH
FIN FLR EL	FINISH FLOOR ELEVATION
FLR	FLOOR
FLUOR	FLUORESCENT
FO	FACE OF
FRG	FIBERGLASS REINFORCED GYPSUM
FT	FOOT OR FEET
FTG	FOOTING
FURN	FURNISH(ED (FURNITURE)
GA	GAUGE
GALV	GALVANIZED
GL	GLASS
GYP	GYPSUM
H	HIGH
HB	HOSE BIBB
HC	HOLLOW CORE
HCP	HANDICAP(PED)
HDW	HARDWARE
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HPT	HIGH POINT
HR	HOUR
HT	HEIGHT
HVAC	HEATING, VENTILATION & AIR CONDITIONING
ID	INSIDE DIAMETER
IN	INCH
INCL	INCLUDE(D) / (ING)
INSUL	INSULATION / INSULATE
INT	INTERIOR
J.C.	JANITOR CLOSET
JT	JOINT
KIT	KITCHEN
KOP	KNOCK OUT PANEL

LAB	LABORATORY
LAV	LAVATORY
LB(S)	POUNDS
LF	LINEAL FEET
LL	LIVE LOAD
LPT	LOW POINT
LT WT	LIGHT WEIGHT
LTG	LIGHTING
MACH	MACHINE
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MED	MEDIUM
MEMB	MEMBRANE
MEZZ	MEZZANINE
MFR	MANUFACTURER
MH	MAN HOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MLDG	MOULDING
MO	MASONRY OPENING
MTD	MOUNTED
MTL	METAL
MWP	MEMBRANE WATERPROOFING
N	NORTH
NC	NOISE CRITERIA
NIC	NOT IN CONTRACT
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFD	OVERFLOW DRAIN
OH	OVERHEAD
OPNG	OPENING
OPP	OPPOSITE
PCC	PRECAST CONCRETE
PCMU	PREFACED CONCRETE MASONRY UNIT
PCP	PORTLAND CEMENT PLASTER
PERP	PERPENDICULAR
PL	PLATE
PLAM	PLASTIC LAMINATE
PLAS	PLASTIC
PLBG	PLUM(ING) / (ER)
PLYWD	PLYWOOD
PN	PROJECT NORTH
PNL	PANEL
PR	PAIR
PREFAB	PREFABRICATED
PROP	PROPERTY
PSF	POUND PER SQUARE FOOT
PSI	POUND PER SQUARE INCH
PT	PAINT
PTD	PAINTED
QT	QUARRY TILE
R	RISER / RADIUS
RAD	RADIUS
RB	RESILIENT BASE
RCP	REFLECTED CEILING PLAN
RD	ROOF DRAIN
RECV	RECEIVING
REF	REFRIDGERATOR, REFERENCE
REINF	REINFORCEMENT
REQ / REQS	REQUIREMENT / REQUIREMENTS
REQD / REQ'D	REQUIRED
REV	REVISION, REVISED
RF	RESILIENT FLOORING
RFG	ROOFING
RM	ROOM
RO	ROUGH OPENING
ROW	RIGHT OF WAY
RTU	ROOF TOP UNIT
S	SOUTH
SAB	SOUND ATTENUATION BATT (BLANKET)
SAN	SANITARY
SC	SOLID CORE
SCHED	SCHEDULE
SECT	SECTION
SF	SQUARE FOOT/FEET
SHT	SHEET
SIM	SIMILAR
SQ	SQUARE
SS	STAINLESS STEEL
STC	SOUND TRANSMISSION CLASS
STD	STANDARD
STL	STEEL
STOR	STORAGE
STRUCT	STRUCTURAL
SUSP	SUSPENDED
SYMM	SYMMETRICAL
T	TREAD
T/	TOP OF
TBD	TO BE DETERMINED
TEL	TELEPHONE
TEMP	TEMPORARY
TER	TERRAZZO
THK	THICK, THICKNESS
TN	TRUE NORTH
TS	TUBE STEEL
TV	TELEVISION
TYP	TYPICAL
UL	UNDERWRITER'S LABORATORIES
UNASSIG	UNASSIGNED
UNO / UON	UNLESS NOTED OTHERWISE
UR	URINAL
VAR	VARIES
VERT	VERTICAL
VEST	VESTIBULE
VIF	VERIFY IN FIELD
W	WEST, WIDTH, WIDE
W/	WITH
WBL	WOOD BLOCKING
WC	WATER CLOSET
WD	WOOD BLOCKING
WH	WATER HEATER
WP	WORK POINT
WWF	WELDED WIRE FABRIC
WWM	WELDED WIRE MESH

GENERAL NOTES

1 ALL WORK IS TO BE PERFORMED IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF ALL GOVERNING CODES AND ORDINANCES, INCLUDING BUT NOT LIMITED TO CHICAGO BUILDING CODE, ILLINOIS ACCESSIBILITY CODE, ICC/ANSI 117.1 - 2009, OSHA REGULATIONS, AND ALL AGENCIES HAVING JURISDICTION

2 CONTRACTOR AND ALL SUBCONTRACTORS SHALL VERIFY IN THE FIELD ALL CONDITIONS AFFECTING THEIR WORK. ANY CONDITIONS FOUND THAT ALTER OR OTHERWISE CHANGE THE REQUIREMENTS FOR THE WORK SHALL BE REPORTED TO THE ARCHITECT IMMEDIATELY.

3 IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE ALLOWABLE CONSTRUCTION LOADS AND TO PROVIDE PROPER DESIGN AND CONSTRUCTION OF FORMWORK, STAGINGS, BRACING, SHEETING AND SHORING, RESHORING, ETC. THIS INCLUDES THAT REQUIRED FOR THE CONTRACTOR VEHICLES, FORKLIFTS, MOBILE CRANES, MATERIALS STORAGE, ETC. MEANS AND METHODS OF CONSTRUCTION IS SOLELY THE RESPONSIBILITY OF THE GENERAL CONTRACTOR.

4 IMPLEMENTING JOB SITE SAFETY AND CONSTRUCTION PROCEDURES ARE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

5 ALL WORK OF THE PROJECT SHALL BE PERFORMED CAREFULLY AND SKILLFULLY BY WORKERS ADEPT IN THEIR TRADES.

6 CARE SHALL BE TAKEN TO AVOID DISTURBANCE OF ADJACENT FUNCTIONS/BUILDINGS. ALL WORK, DELIVERIES AND OTHER CONSTRUCTION RELATED ACTIVITIES SHALL ADHERE IN STRICT ACCORDANCE TO THE CITY OF CHICAGO RESTRICTIONS AND CONDITIONS. GENERAL CONTRACTOR IS TO HAVE A COPY OF SAID REQUIREMENTS AND CONDITIONS AVAILABLE AT THE JOB SITE AT ALL TIMES FOR REVIEW.

7 THE GENERAL CONTRACTOR IS RESPONSIBLE FOR THE COORDINATION OF ALL TRADES.

8 ALL CONTRACTORS SHALL EXAMINE THE CONTRACT DOCUMENTS, AND REFERENCED, NON-CONTRACTUAL DOCUMENTS, AND SHALL BE INFORMED OF THE ENTIRE CONTENTS THEREOF PRIOR TO SUBMISSION OF PROPOSAL. ANY ERRORS OR AMBIGUITIES NOTED DURING SAID EXAMINATION SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ARCHITECT, PRIOR TO THE SUBMISSION OF A BID. THE ARCHITECT WILL ISSUE AN ADDENDUM OF INTERPRETATION OF THE CITED ERROR OR AMBIGUITY. NO SUBSEQUENT CLAIM FOR EXTRA WORK WILL BE ALLOWED ON ACCOUNT OF CLAIMED MISUNDERSTANDING OF THE MEANING OR INTENT OF THE CONTRACT DOCUMENTS OF ANY PORTION THEREOF IF THE ITEM OCCASIONING THE CLAIM APPEARED IN, OR WAS INFERABLE FROM, SAID CONTRACT DOCUMENTS AS FURNISHED FOR BIDDING.

9 ALL CONTRACTORS SHALL CHECK AND VERIFY ALL DIMENSIONS, ELEVATIONS AND CONDITIONS AT THE SITE PRIOR TO COMMENCEMENT OF WORK AND NOTIFY THE ARCHITECT IN WRITING OF ANY DISCREPANCIES IN PLANS AND SPECIFICATIONS BEFORE PROCEEDING.

10 FIRE STOPS, DRAFT STOPS AND ALL FIRE SAFING IS TO BE MAINTAINED AND/OR PROVIDED AS REQUIRED BY THE CODE: a) FIRE ALARM, SPRINKLER AND STANDPIPE SYSTEMS SHALL BE MAINTAINED IN AN OPERABLE CONDITION AT ALL TIMES AND WILL BE REQUIRED TO BE ADAPTED FOR SPACES WITH NO CEILINGS FOLLOWING REMOVAL (UP-TURNED HEADS TO UNDERSIDE OF DECK), WHEN REQUIRED BY CODE, AND ALL APPLICABLE LAWS, ORDINANCES, AND REGULATIONS; b) FIRE-RESISTANCE-RATED PARTITIONS, FIRE BARRIERS, AND FIRE WALLS SEPARATING OCCUPIED OR VACANT TENANT SPACES FROM THE REMAINDER OF THE BUILDING SHALL BE MAINTAINED. OPENINGS, JOINTS, AND PENETRATIONS IN FIRE-RESISTANCE-RATED ASSEMBLIES SHALL BE PROTECTED IN ACCORDANCE WITH CHICAGO BUILDING CODE; AND c) PERSONS, IN CHARGE OR CONTROL OF, A BUILDING OR PORTION THEREOF, SHALL REMOVE HERE FROM ALL ACCUMULATIONS OF COMBUSTIBLE MATERIALS, FLAMMABLE OR COMBUSTIBLE WASTE OR RUBBISH AND SHALL SECURELY LOCK OR OTHERWISE SECURE DOORS, WINDOWS AND OTHER OPENINGS TO PREVENT ENTRY BY UNAUTHORIZED PERSONS. THE PREMISE SHALL BE MAINTAINED CLEAR OF WASTE/HAZARDOUS MATERIALS.

11 ALL DIMENSIONS, NOTES AND DETAILS SHOWING A PORTION OF A DRAWING SHALL APPLY TYPICALLY TO ALL OPPOSITE HAND AND/OR SIMILAR CONDITIONS. DO NOT SCALE DRAWINGS & VERIFY ALL LISTED DIMENSIONS IN FIELD AS REQUIRED FOR THE SCOPE OF THE WORK.

12 THE FOLLOWING SHALL BE MAINTAINED AND/OR PROVIDED IN COMPLIANCE WITH CURRENT OSHA STANDARDS IN ADDITION TO ALL OTHER GOVERNING CODES AND ORDINANCES: a)ADEQUATE EXITS AND UNOBSTRUCTED ACCESS TO SUCH SHALL BE MAINTAINED; b) VISIBLE EXIT SIGNAGE SHALL BE PROVIDED OR MAINTAINED; c) FIRE PROTECTION PROGRAM AS WELL AS EQUIPMENT SHALL BE PROVIDED BY CONTRACTOR; d) ACCESS TO A SUFFICIENT WATER SUPPLY SHALL BE AVAILABLE UPON ACCUMULATION OF COMBUSTIBLE MATERIAL; e) PROVIDE FIRE EXTINGUISHING DEVICES AND EQUIPMENT OF PROPER RATING, STANDARD, AND LOCATION; AND f) SERVICE OF FIRE RESPONSE SYSTEMS SHALL BE MAINTAINED AND CHECKED DAILY TO INSURE THAT PROTECTION IS IN SERVICE.

13 IN BUILDINGS OF TYPES I-A, I-B, I-C AND II CONSTRUCTION, PARTITION FRAMING SHALL BE OF EITHER OR BOTH OF THE FOLLOWING MATERIALS: (1) NONCOMBUSTIBLE MATERIALS; (2) FIRE-RETARDANT TREATED WOOD WITHIN ASSEMBLIES OF ONE-HOUR MINIMUM RATING.

14 CLIMATE ZONE: 5A

15 ALL ELECTRICAL RISERS AND SHAFTS SERVING ELEVATORS, EMERGENCY & EXIT LIGHTS, VOICE COMMUNICATION SYSTEMS, AND SMOKE CONTROL FANS ARE TO BE ENCLOSED WITH TWO HOUR CONSTRUCTION AND ARE TO INCLUDE CONTINUOUS THREE INCH HIGH WATER STOPS ON ALL SIDES AS APPROPRIATE.

16 ALL GUARDRAILS AND HANDRAILS SHALL MEET IBC 13-52-100: STAIRWAY, PORCH, DECK AND BALCONY RAILING, BOTH EXTERIOR AND INTERIOR, SHALL BE DESIGNED TO RESIST A SIMULTANEOUS VERTICAL AND HORIZONTAL THRUST OF 50 LBS./FT (POUNDS-FORCE, PER LINEAR FOOT) APPLIED AT THE TOP OF THE RAILING OR A CONCENTRATED LOAD OF 200 LBS./FT IN ANY DIRECTION, WHICHEVER PRODUCES THE GREATEST STRESS. FOR ONE- AND TWO-FAMILY DWELLING UNITS, A THRUST OF 20 LBS./FT MAY BE USED OF 50 LBS./FT FOR INTERIOR STAIR BALUSTERS OR WALL-MOUNTED INTERIOR HANDRAILS ONLY.

17 PROVIDE FIRE-RETARDANT TREATED PLYWOOD BACKERBOARDS AROUND THE INSIDES OF ALL ELECTRICAL AND TELEPHONE ROOMS.

BUILDING MATERIALS CAUTIONS

1. **WARNING**: ASBESTOS-CONTAINING BUILDING MATERIALS (ACBM) ARE OR MAY BE PRESENT IN THIS BUILDING. AN ASBESTOS MANAGEMENT PLAN IS AVAILABLE IN THE SCHOOL FOR REVIEW UPON REQUEST. NO PERSON MAY DISTURB ASBESTOS-CONTAINING MATERIALS (ACM) OR ACBM UNLESS THAT PERSON IS A LICENSED ASBESTOS ABATEMENT WORKER AND CONDUCTS SUCH WORK IN ACCORDANCE WITH PROJECT SPECIFICATION(S) CONTAINED IN THE PROJECT DOCUMENTS AND IN COMPLIANCE WITH THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH (IDPH) RULES AND REGULATIONS. IF OTHER SUSPECT MATERIALS, NOT REFERENCED IN THE ASBESTOS MANAGEMENT PLAN OR PROJECT DOCUMENTS, ARE IDENTIFIED DURING RENOVATION OR CONSTRUCTION RELATED ACTIVITIES, THESE MATERIALS ARE TO BE ASSUMED ACM AND NO DISTURBANCE SHALL BE ALLOWED UNTIL THE ARE CAN BE FULLY ASSESSED BY THE MEC.

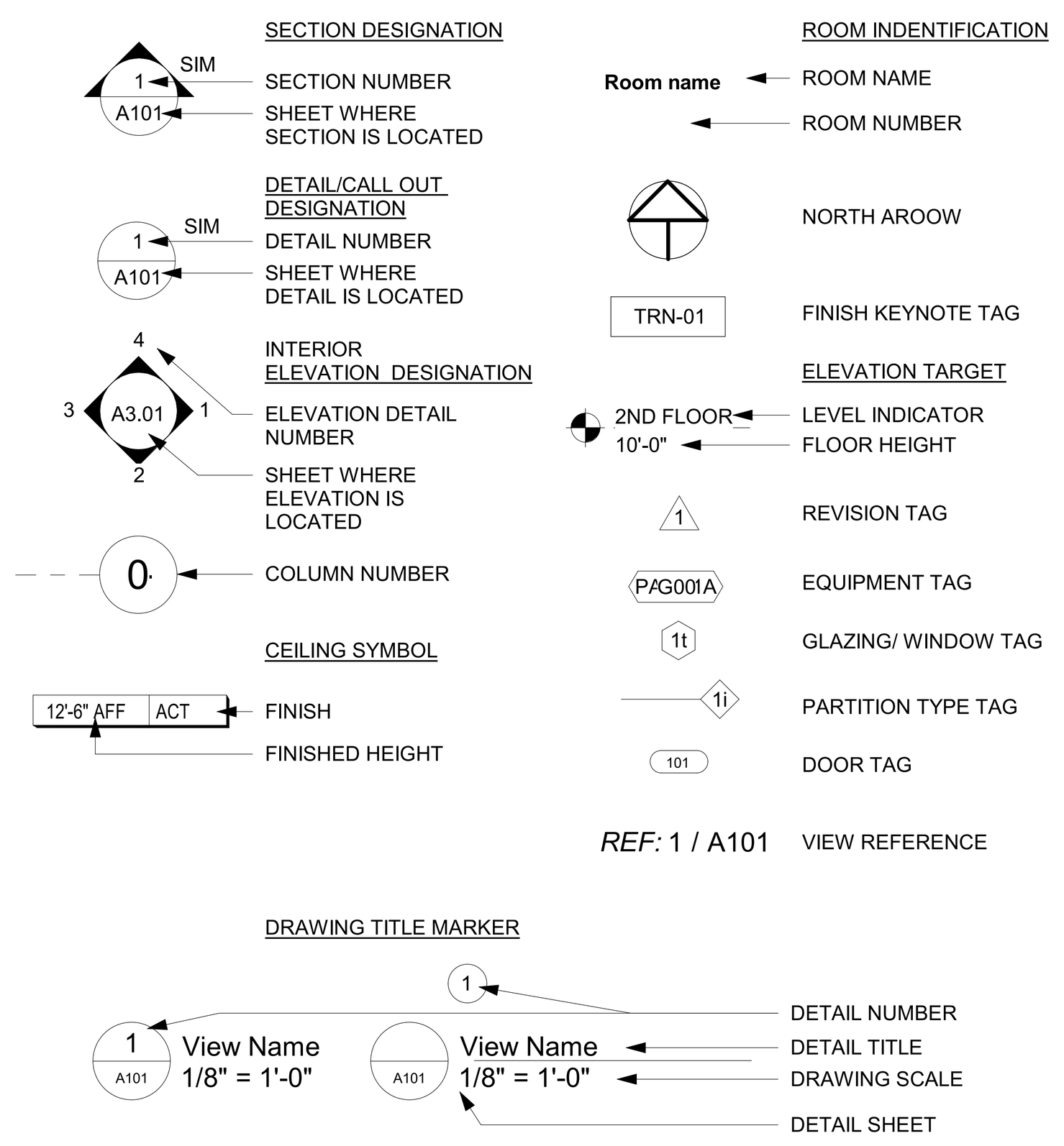
2. **WARNING**: LEAD-BASED PAINT (LBP) IS OR MAY BE PRESENT WITHIN THE BUILDING. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO TAKE APPROPRIATE COMPLIANCE AND SAFETY MEASURES IN ACCORDANCE WITH APPLICABLE FEDERAL (INCLUDING OSHA 1926.62), STATE, AND LOCAL RULES AND REGULATIONS TO PREVENT LEAD EXPOSURE TO BUILDING OCCUPANTS, VISITORS, AND CONTRACTORS. ALL WORK WITH SURFACES CONTAINING LBP OR SUSPECTED TO CONTAIN LBP TO PERFORMED IN ACCORDANCE WITH PROJECT SPECIFICATIONS CONTAINED WITHIN THE PROJECT DOCUMENTS AN IN COMPLIANCE WITH THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH (IDPH) RULES AND REGULATIONS. IN ADDITION, VARIOUS COMPONENTS/SURFACES WITHIN THE SCHOOL HAVE TESTED ABOVE AND BELOW THE LBP THRESHOLD OF 1.0 MG/CM^2 (OR 0.5% BY WEIGHT - 5,000 MG/KG) OR HAVE NOT BEEN TESTED AND SHOULD BE ASSUMED TO HAVE LEAD PRESENT. REGARDLESS OF LEAD CONCENTRATION, THERE IS A POTENTIAL FOR LEAD DUST GENERATION DURING DRILLING, CORING, PAINTING PREPARATION, AND OTHER RENOVATION, DEMOLITION, AND CONSTRUCTION RELATED ACTIVITIES. FOR SMALL-SCALE DISTURBANCES, THE CONTRACTOR SHALL FACILITATE THE APPROPRIATE MEASURES FOUND IN THE APPLICABLE PROJECT SPECIFICATIONS, INCLUDING 01 56 11, TO PREVENT DUST MIGRATION ONTO CPS POSSESSIONS OR ONTO OTHER PARTS OF THE BUILDING.

3. **WARNING**: CRYSTALLINE SILICA MAY BR PRESENT WITHIN CERTAIN BUILDING MATERIALS, INCLUDING BUT NOT LIMITED TO, SAND, STONE, CONCRETE, MASONRY, AND MORTAR. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO TAKE APPROPRIATE SAFETY MEASURES IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL RULES AND REGULATIONS (INCLUDING OSHA 1926.1153) TO PREVENT SILICA EXPOSURE AND DUST MIGRATION.

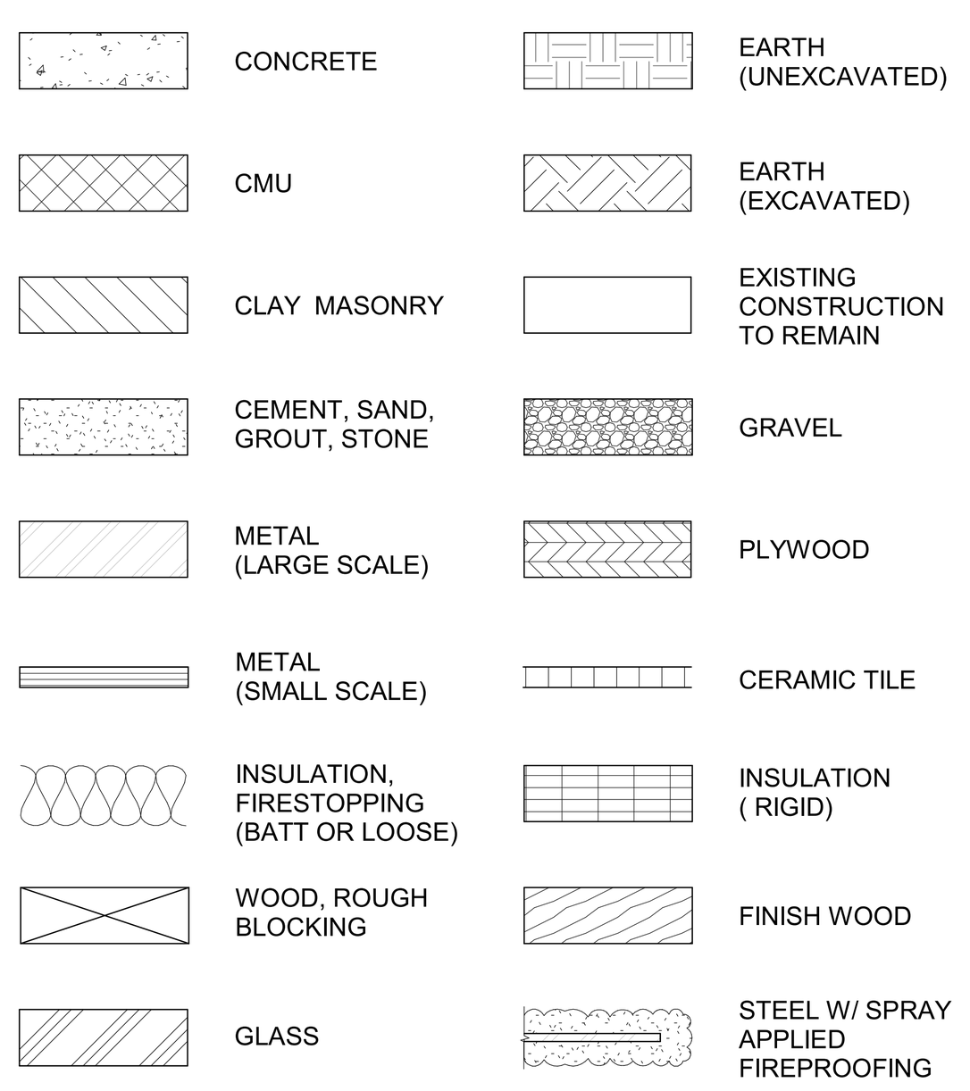
GENERAL SCOPE OF WORK

1. CONSTRUCT NEW ADDITION TO THE NORTH SIDE OF KENWOOD ACADEMY BUILDING C (PE BUILDING) THEN EXTENDS ACROSS THE FORMER PARKING LOT INTO AN ADDITION WHICH EXTENDS THE CURRENT MAIN ENTRANCE OF CANTER AND 2ND FLOOR CORRIDOR OF THE CANTER ELEMENTARY ANNEX.
2. DEMOLITION OF EXISTING FACADES AT CONNECTION POINTS OF BOTH BUILDINGS ON THE FIRST AND SECOND LEVELS
3. SELECTIVE DEMOLITION OF STRUCTURAL SYSTEMS AT CONNECTION POINTS ON THE EXISTING FACADES WHERE NOTED ON DEMOLITION DRAWINGS AND STRUCTURAL DRAWINGS
4. NEW STAIRS AND RAMPS AT FIRST LEVEL OF KENWOOD AND CANTER GOING DOWN TO GRADE FOR EGRESS PURPOSES
5. ASPHALT BETWEEN THE BUILDINGS ALONG WITH EXPANDED NEW PARKING LOT TO THE NORTH OF CANTER.
6. SECOND FLOORS WILL PROVIDE AN ELEVATED, ENCLOSED PEDESTRIAN BRIDGE CONNECTION (LINK) BETWEEN THE TWO BUILDINGS.
7. CONCRETE FLOOR CONSTRUCTION IS RATED AT 1-HRze.
8. THE ENCLOSURES CLADDING WILL CONSIST OF A METAL PANEL SYSTEM ON TOP OF RIGID & BATT INSULATION ON A METAL STUD SYSTEM. THE WINDOWS ARE FIXED ALUMINUM WINDOWS PUNCHED INTO THE FACADES.
9. THE ROOF WILL BE A BUILT-UP MODIFIED BIT. WITH TAPERED INSULATION OF R-30, MINIMUM. THE ROOF DRAINS WILL DRAIN INTERNALLY. ROOF SYSTEM IS RATED AT 1 HR.
10. LOAD BEARING WALLS ARE 2-HR RATED.
11. INTERNAL, EXPOSED STRUCTURAL STEEL IS TO RECIEVE 2-HR. ZEZEINTUMESCENT PAINT FOR FIRE-PROOFING
12. TWO NEW ACCESSIBLE 2-HOUR FIRE RATED EGRESS DOORS WILL BE INSTALLED AT THE LINK VESTIBULE ON THE 2ND FLOOR OF THE CANTER BUILDING.
13. NEW INTERCONNECTED FIRE ALARMS WILL BE INSTALLED AT THE WALKWAYS WITH NEW CAMERAS PROVIED FOR STURDENTS AND FACULTY SAFETY.

SYMBOLS LEGEND



MATERIALS LEGEND



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G005	TOPOGRAPHIC SURVEY II
G010	ICC/ANSI A117.1-2019
G011	ICC/ ANSI A117.1-2019
G014	CHICAGO FIRE EXHIBITION
G015	LOGISTICS, PHASING & SITE UTILIZATION PLANS
LS 101	LIFE SAFETY PLANS
01 CPS ADA	
ADA.00	CPS ACCESSIBILITY GENERAL NOTES & DRAWING INDEX
ADA.01	CPS ACCESSIBILITY DETAILS - EXTERIOR SIGNAGE DETAILS
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ADA.03	CPS ACCESSIBILITY DETAILS - PERMANENT ROOM IDENTIFICATION SIGNAGE DETAILS
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ADA.05	CPS ACCESSIBILITY DETAILS - RAMP FLOOR PLANS AND ELEVATIONS
ADA.06	CPS ACCESSIBILITY DETAILS - RAMP & THRESHOLD DETAILS
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E100-LNK	FIRST FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C) AND CANTER
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M300-MEP	BAS GEN SYMBOLS
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M301-MEP	BAS CONTROL DIAGRAM
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M402-MEP	2ND FLOOR LEGACY PLAN
M403-MEP	3RD FLOOR LEGACY PLAN
P000-LNK	PLUMBING NOTES, SYMBOLS AND ABBREVIATIONS
P000-MEP	PLUMBING NOTES, SYMBOLS AND ABBREVIATIONS
P101-MEP	PARTIAL FIRST FLOOR PLUMBING PLAN
P103-MEP	PENTHOUSE PLUMBING PLAN
P105-LNK	FIRST FLOOR LINK PLAN- KENWOOD (BUILDING C) AND CANTER
P105A-LNK	PLUMBING SITE PLAN
P106-LNK	SECOND FLOOR LINK PLAN- KENWOOD (BUILDING C) AND CANTER, PENTHOUSE PLAN (BUILDING C)

3

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS.

2/23/2024 2:09:44 PM

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates
223 West Jackson Blvd
Suite 820
Chicago, IL 60606
312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM #1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326

Title
INDEX, GENERAL NOTES, ABBR. & LEGENDS

Sheet
G002

GENERAL NOTES **DEMOLITION ELEVATIONS**

1. DASHED LINES INDICATE AREA TO BE DEMOLISHED.
2. FOR SITE DEMOLITION PLAN, SEE CIVIL
3. CONTRACTOR SHALL REVIEW ALL EXISTING CONDITIONS IN EXISTING DRAWINGS TO ESTIMATE COST OF DEMOLITION IN EACH BUILDING, CANTER AND KENWOOD-BUILDING C.
4. CONTRACTOR SHALL BE CAREFUL NOT TO DISTURB, DISRUPT OR DAMAGE EXISTING FOUNDATIONS ON EITHER BUILDING EXCEPT WHERE NECESSARY TO BUILD NEW FOUNDATIONS AND CONSTRUCTION. FOR NEW FOUNDATIONS, SEE STRUCTURAL DRAWINGS.
5. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE EXISTING BRICK WHERE TO REMAIN EXPOSED AT ADDITIONS TO THE ENTRANCES, TYPICAL.

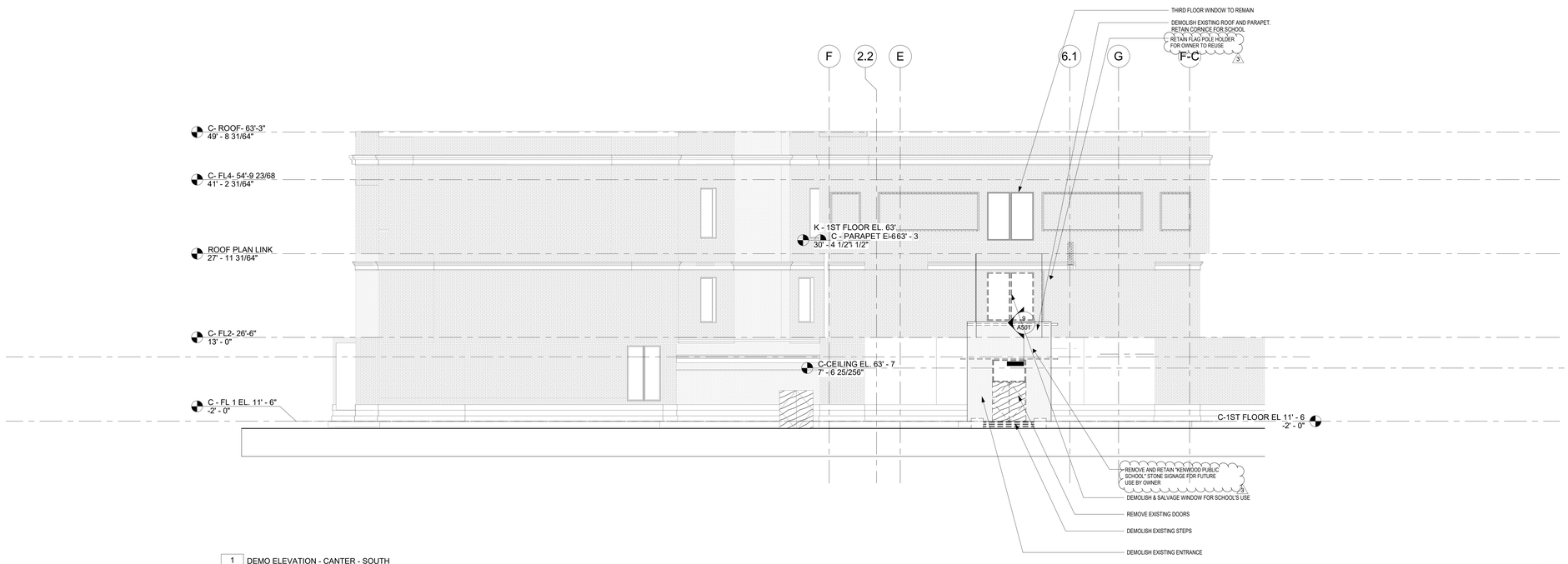
GENERAL NOTES TO CUTTING & PATCHING:
PERFORM WORK IN AN ORDERLAY MANNER
TO ACHIEVE A CLEAN FINISH BETWEEN EXISTING
& NEW CONSTUCTION. REFER TO SPEC. SECTIONS
FOR WORK IN CONC., VCT, DRYWALL CEILING & GRID,
PLASTER, BRICK & BLOCK & PAINTED FINISHES.

PERFORM WORK IN AN ORDERLY MANNER AS
MANUFACTURER RECOMMENDS.

CLEAN UP DUST DAILY FROM CONCRETE, BRICK &
BLOCK, PLASTER & PAINT.

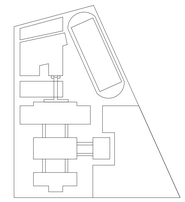
REMOVE EXISTING ENTRANCE

2 D201 EXISTING CANTER ENTRANCE
12" = 1'-0"



1 D201 DEMO ELEVATION - CANTER - SOUTH
1/8" = 1'-0"

8'-0" 0'-0" 4'-0" 8'-0" 16'-0"
1/8" = 1'-0"



KEY PLAN N

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS.

11/9/2024 11:10:21 PM

PUBLIC BUILDING COMMISSION — Chicago Public Schools

KENWOOD ACADEMY LINK

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Melvin & Cohen Associates
223 West Jackson Blvd
Suite 820
Chicago, IL 60606
312 663 3700

STATE OF ILLINOIS — ANTHONY A. ANNDELES — 001-015385 — LICENSED ARCHITECT

No.	Date	Description
3	02.23.24	ADDENDUM #1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link
PBC Contract No: C1602R
Project No.: 05326

Title
DEMO ELEVATION CANTER SOUTH

Sheet
D201

TOTAL FLOOR AREA 354,420 SF; PROPOSED ADDITION 4,219 SF
F.A.R. ORDINANCE REQUIREMENT 2.0. EXISTING; 0.72, PROPOSED 0.73
RM-5 CZO TITLE 17; J SCHOOL

GENERAL NOTES — SITE PLAN

1. FOR DEMO PLAN SITE PLAN, SEE CIVIL
2. FOR GRADING PLAN, SEE CIVIL
3. FOR STORMWATER, SEE CIVIL
4. FOR FOUNDATION PLAN, SEE STRUCTURAL
5. FOR LANDSCAPE PLAN, SEE LANDSCAPE
6. FOR PARKING COUNTS, SEE LANDSCAPE
7. FOR ELECTRICAL SITE LIGHTING & SCOPE, SEE ELECTRICAL

17-2-0305-B *Buildings* and structures in RT, RM and DR districts must be set back from the *front property line* a distance equal to either: the minimum *front setback* standard of 15 feet (or 12% of *lot* depth, whichever is less) or the average *front yard* depth that exists on the nearest 2 *lots* on either side of the subject *lot*. In RT, RM and DR districts the decision to comply with the fixed *front setback* standard or the average *front setback* standard is left to the builder / *property owner* except in the case of *lots* with *lot frontage* on a *primary boulevard*, as defined in Sec. 17-17-02124, where *buildings* and structures must be set back from the *front property line* a distance equal to the average *front yard* depth that exists on the nearest 2 *lots* on both sides of the subject *lot*; there is no maximum depth to the required setback along a *primary boulevard* as defined in Sec. 17-17-02124. (See Sec. 17-17-0306 for rules governing the measurement of *front setbacks*)

PARKING SPACES

190 EXISTING PARKING SPACES
INCL. 8 ACCESSIBLE SPACES

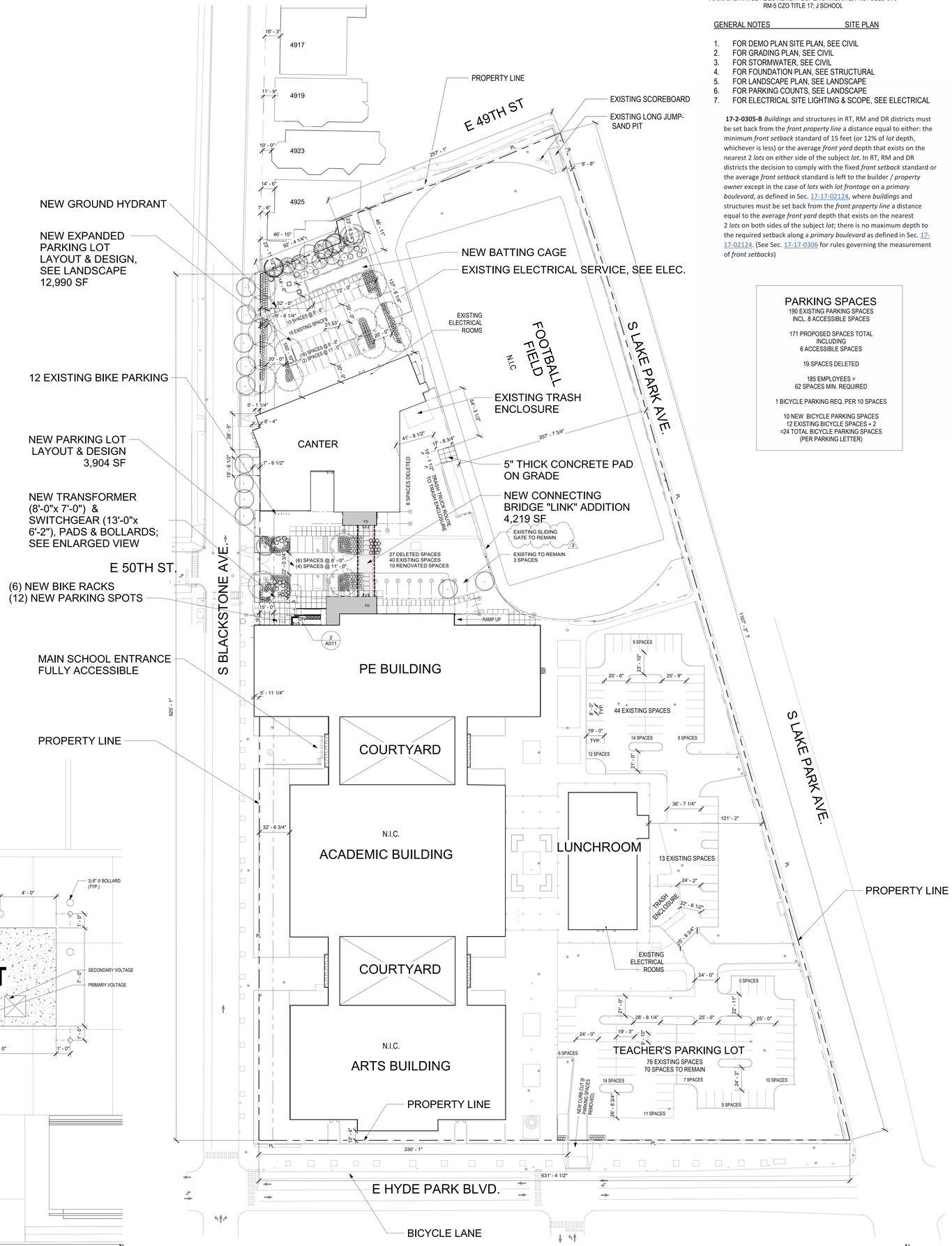
171 PROPOSED SPACES TOTAL
INCLUDING
6 ACCESSIBLE SPACES

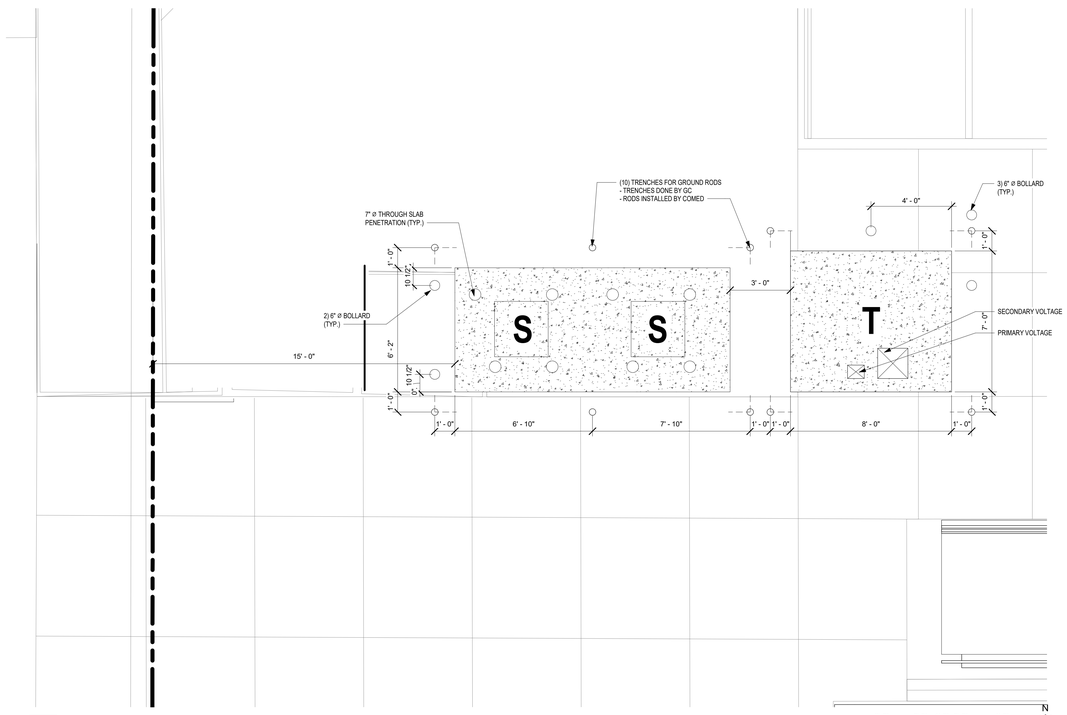
19 SPACES DELETED

185 EMPLOYEES =
62 SPACES MIN. REQUIRED

1 BICYCLE PARKING REQ. PER 10 SPACES

10 NEW BICYCLE PARKING SPACES
12 EXISTING BICYCLE SPACES + 2
=24 TOTAL BICYCLE PARKING SPACES
(PER PARKING LETTER)





2 A011 | A011 SITE PLAN - TRANSFORMER CALLOUT
3/8" = 1'-0"

1 A113 | A011 SITE PLAN
1" = 40'-0"

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS.

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

Architect:
NIA ARCHITECTS, INC.
nia architects Inc
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PHONE: 312.431.9515
FAX: 312.431.9518
WEB: www.niaarch.com

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Chicago, IL 60602
872 216 9819

Landscape Architect:
Site Design
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Chicago, IL 60604
312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates
223 West Jackson Blvd
Suite 820
Chicago, IL 60606
312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM #1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326
Title
SITE PLAN

Sheet
A011

2/22/2024 9:10:22 AM

ROOF PLAN NOTES

1. PROVIDE GUARDRAIL PROTECTION FOR MECH. UNIT RTU-8. 42" HIGH W/ RAILS THAT NO 21" DIA. SPHERE COULD PASS THROUGH.
2. REF. STRUCTURAL DRAWINGS AND MECHANICAL DRAWINGS FOR LOCATION OF NEW STRUCTURAL STEEL, CURB OPENINGS FOR NEW CU AND RTU, PIPING, AND PATCHING OF EXISTING ROOF AROUND NEW ROOFTOP ELEMENTS

GENERAL NOTES

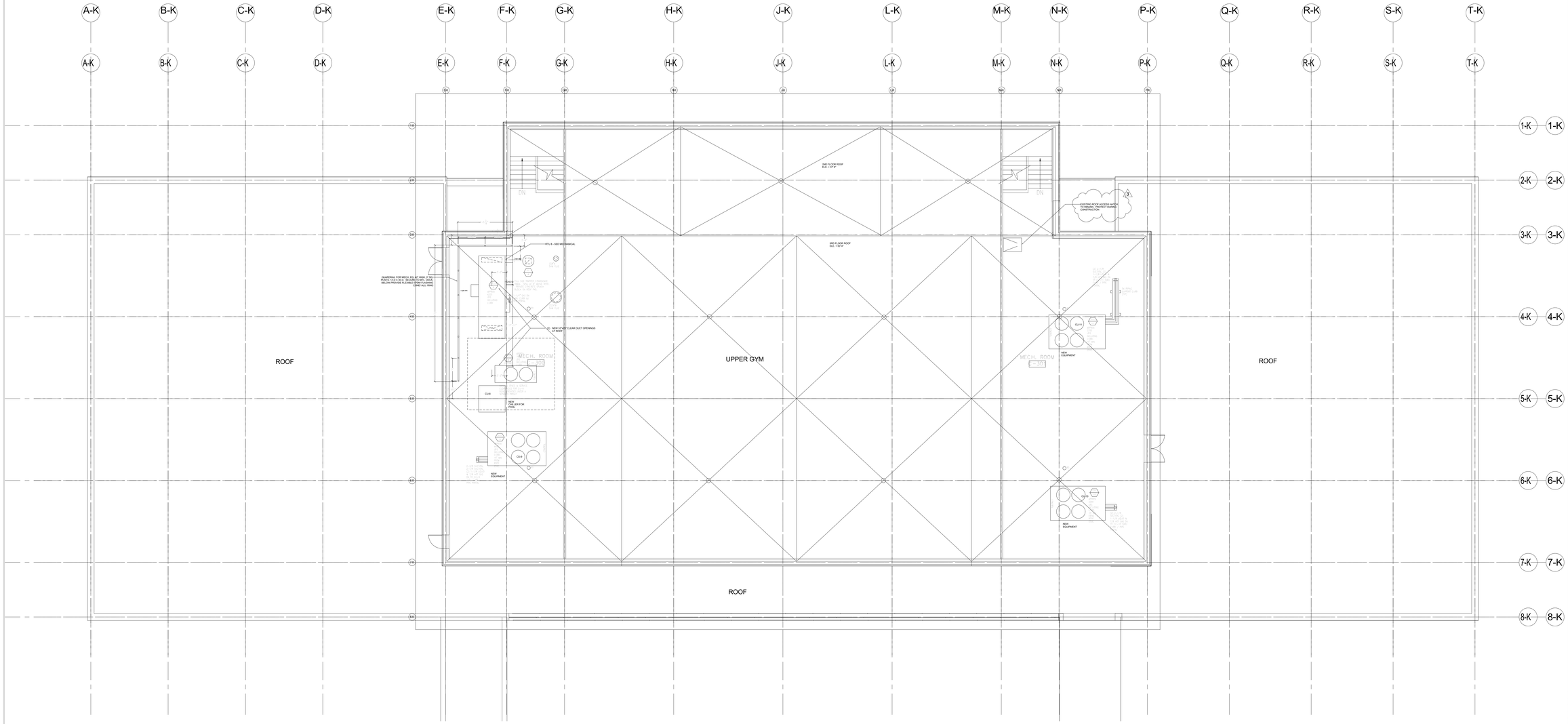
1. GLAZING BASIS OF DESIGN: VITRO SOLARBAN 60, ALU. WINDOW "WAUSAU"
2. METAL PANEL BASIS OF DESIGN: ATAS-OMAWALL
3. REFERENCE ARCH, LIFE SAFETY & STRUCT DWGS FOR ADD. INFO REGARDING DESIGNATED FIRE RATED SEPARATIONS & LOCATIONS OF STRUCTURAL COMPONENTS IDENTIFIED AS RECEIVING INTUMESCENT PAINT OR SPRAYED-ON FIREPROOFING.
4. BUILT-UP, MOD. BITUMEN ROOFING SYSTEM
5. ROOF SLOPE = 1/4" PER 1'-0, MIN
6. MTL. COPING TO BE PROVIDED BY MTL. PANEL MANUF.
7. ROOF DRAIN (R.D.) ARE TYPICALLY ABOVE ROOF DECKING.
8. SEE SHEET A-601 FOR WINDOW SCHEDULE.
9. FOR HANDRAIL DETAILS SEE ADA SHEETS ADA.05 & ADA.06

APPLICABLE BUILDING CODES

- ADA 2018 STANDARDS
- ILLINOIS ACCESSIBILITY CODE 2018
- CBC 2019 - CHAPTER 11; 14b
- ICC A117.1-2017
- 2021 IECC REQUIRED; ROOFS = R- 30, WALLS = R- 23
- ACTUAL: ROOFS = R- 30, WALLS = R- 40.79

- MINIMUM ROOF SLOPE = 1/4" : 1'-0"

- NOTE: ALL EXPOSED STRUCTURAL STEEL IS TO BE PAINTED WITH INTUMESCENT PAINT

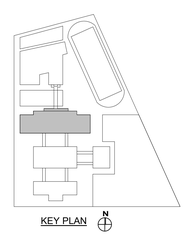


1 A107 MEP - A104
1/8" = 1'-0"

N

0' 4' 8' 16'

1/8" = 1'-0"



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2/22/2024 9:10:22 AM

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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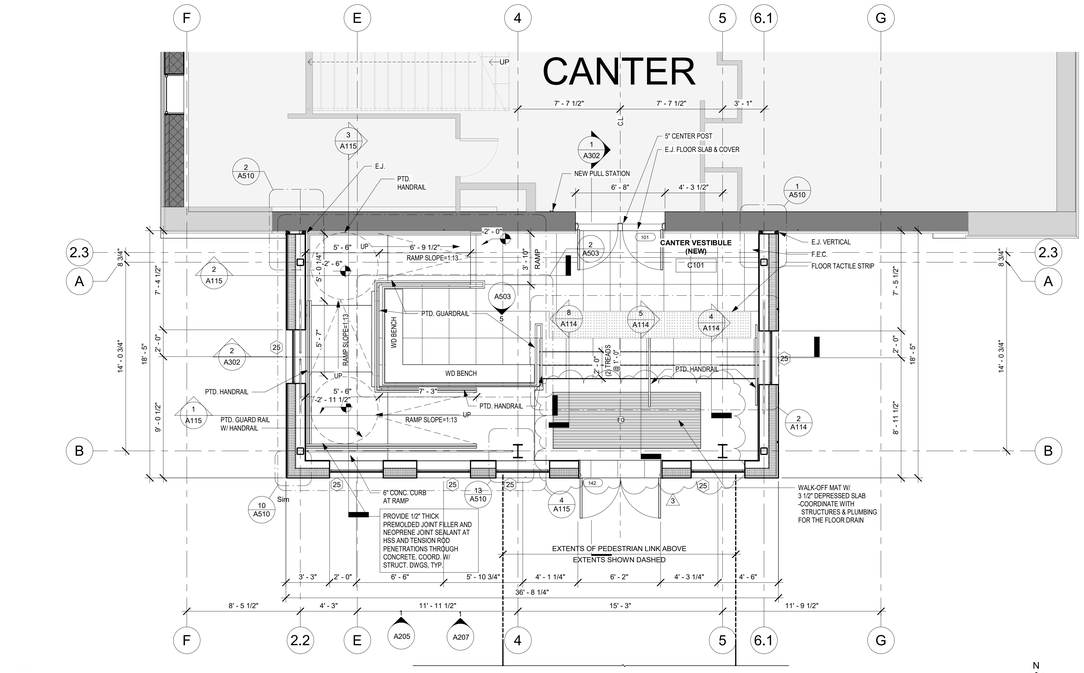
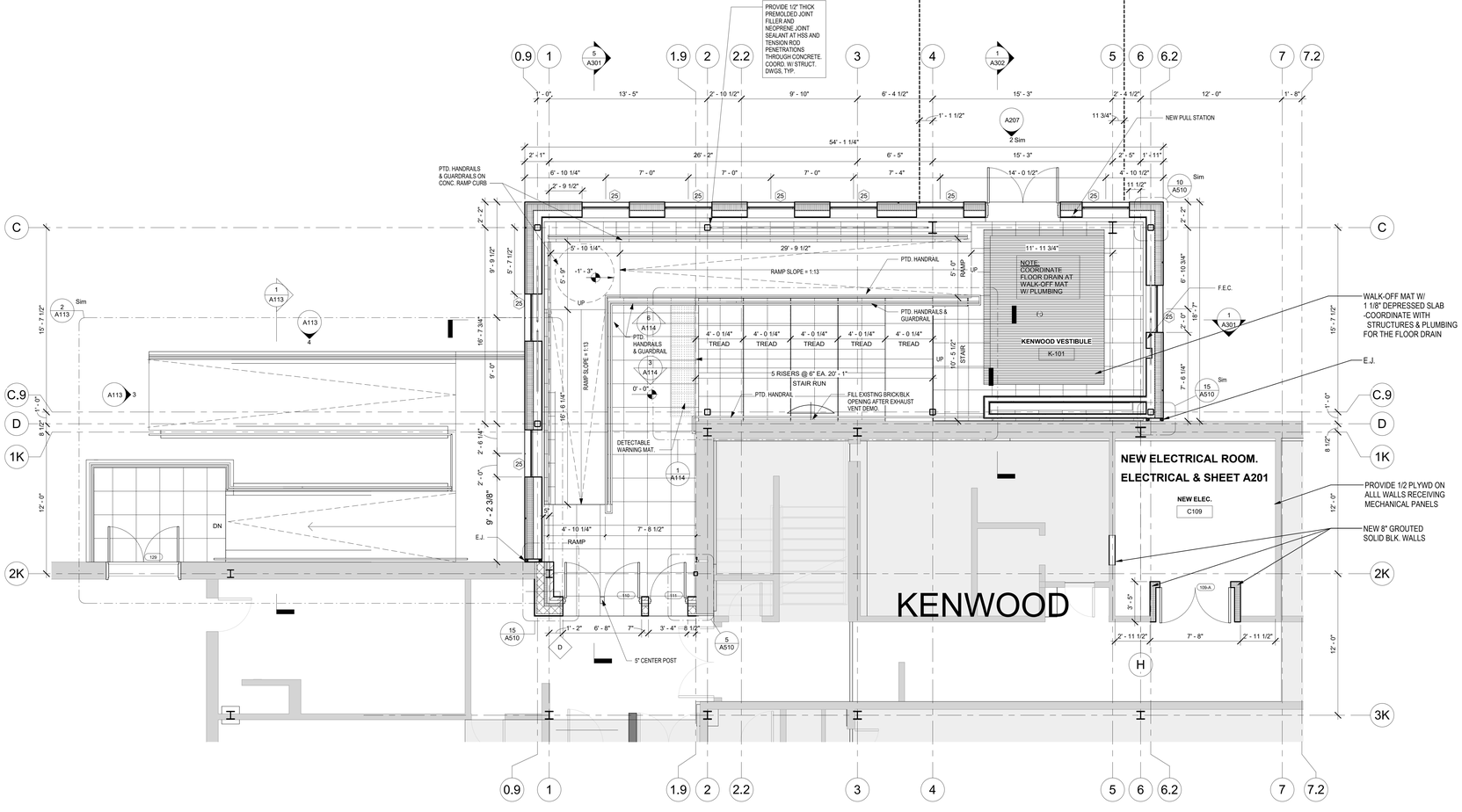
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326

Title
EXISTING ROOF PLAN

Sheet
A107



2 A101/A110 ENLARGED PARTIAL PLAN - FIRST FLOOR - CANTER
1/4" = 1'-0"



1 A101/A110 ENLARGED PARTIAL PLAN - FIRST FLOOR - KENWOOD
1/4" = 1'-0"

KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS.

GENERAL NOTES

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2. METAL PANEL BASIS OF DESIGN: ATAS-OMAWALL
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- MINIMUM ROOF SLOPE = 1/4" : 1'-0"

- NOTE: ALL EXPOSED STRUCTURAL STEEL IS TO BE PAINTED WITH INTUMESCENT PAINT

NOTE ON KENWOOD M.E.P. SCOPE

1. REFER TO SHEETS A201 AND A202 FOR SCOPE OF WORK RELATED TO MEP PORTION OF THE PROJECT INCLUDING, BUT NOT LIMITED TO, WORK RELATED TO FINISHES, FLOORS, AND CEILINGS.
2. REFER TO ELECTRICAL, MECHANICAL AND PLUMBING SHEETS FOR SCOPE OF WORK RELATED TO THOSE TRADES
3. PATCH EXISTING FINISHES AS NEEDED WHERE AFFECTED BY LINK OR MEP WORK.

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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PBC Contract No: C1602R
Project No.: 05326

Title
ENLARGED PARTIAL PLAN - FIRST FLOOR

Sheet
A110

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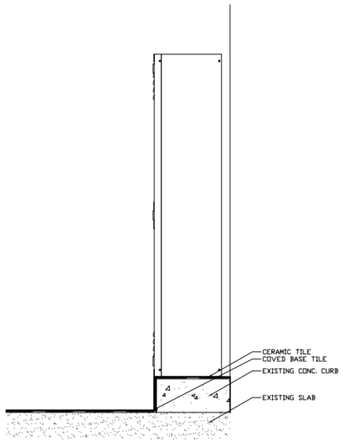
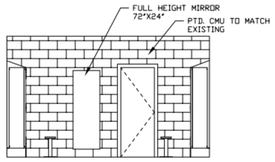
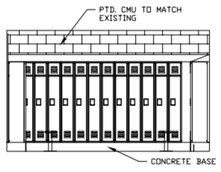


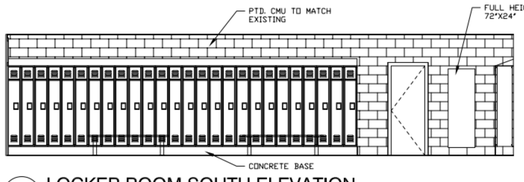
12 LOCKER BASE DETAIL
1"=1'-0"



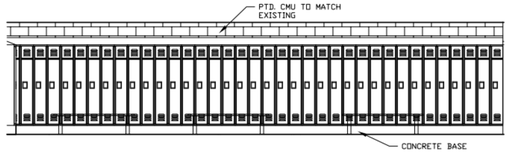
11 LOCKER ROOM EAST ELEVATION
1/4"=1'-0"



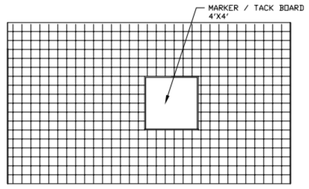
9 LOCKER ROOM WEST ELEVATION
1/4"=1'-0"



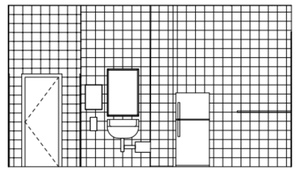
10 LOCKER ROOM SOUTH ELEVATION
1/4"=1'-0"



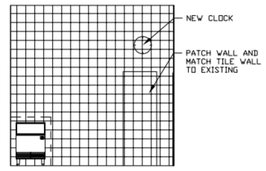
8 LOCKER ROOM NORTH ELEVATION
1/4"=1'-0"



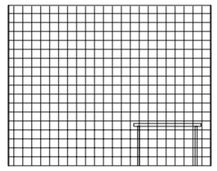
7 TRAINER ROOM NORTH ELEVATION
3/16"=1'-0"



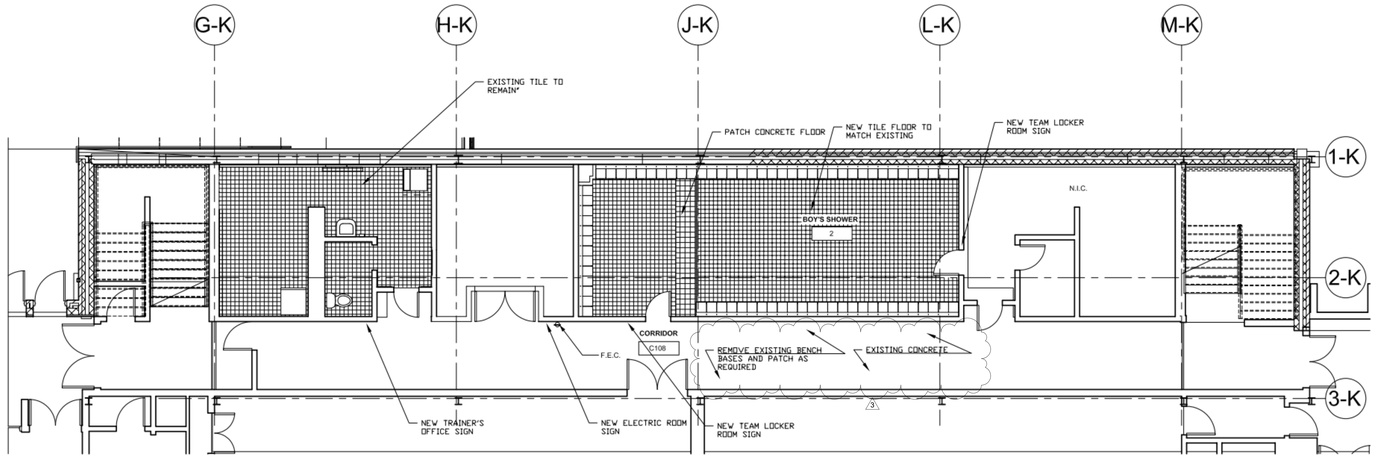
6 TRAINER ROOM SOUTH ELEVATION
3/16"=1'-0"



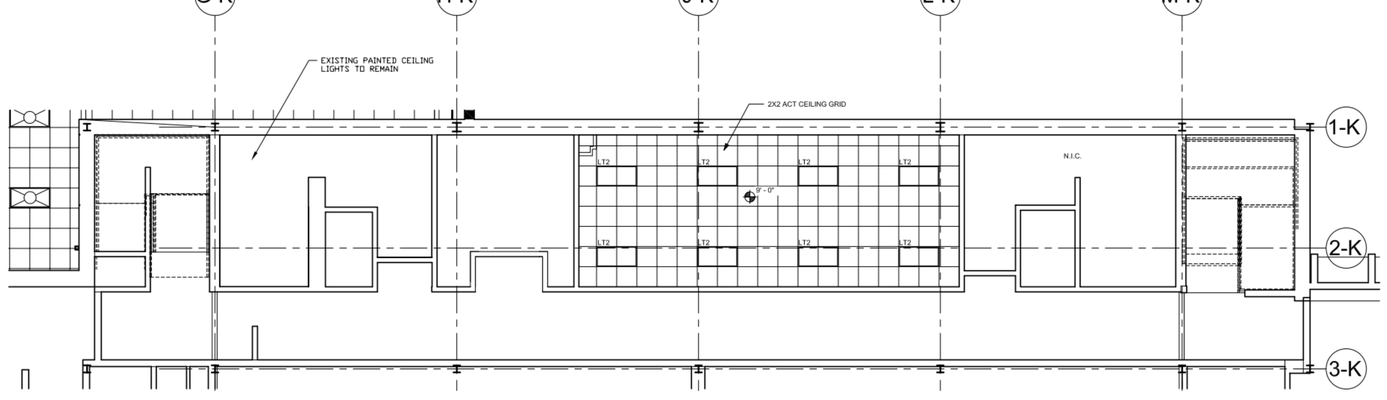
5 TRAINER ROOM EAST ELEVATION
3/16"=1'-0"



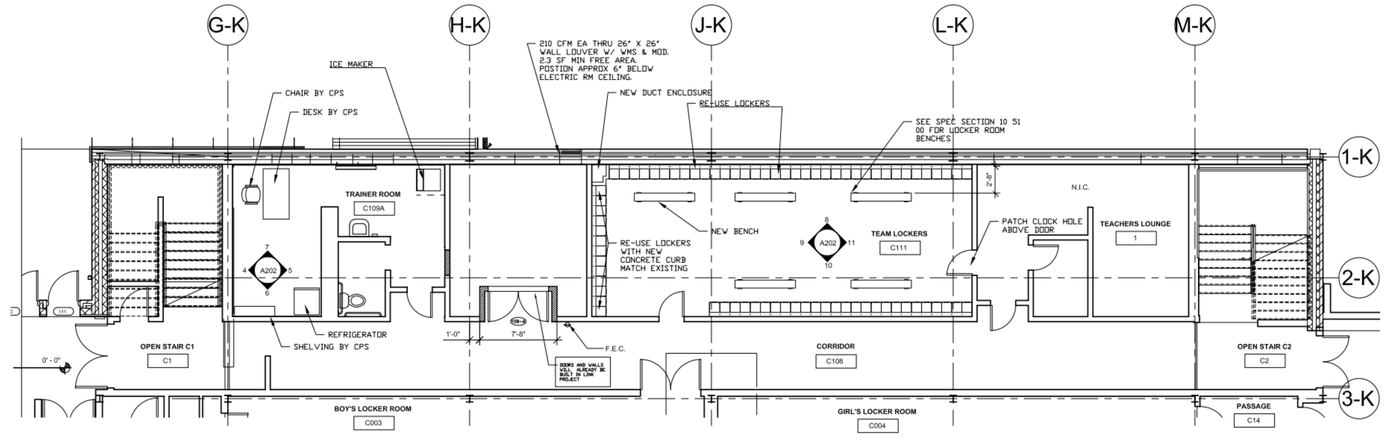
4 TRAINER ROOM WEST ELEVATION
3/16"=1'-0"



3 FIRST FLOOR FINISH PLAN
3/16"=1'-0"

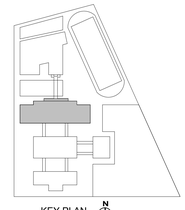


2 FIRST FLOOR PLAN RCP
3/16"=1'-0"



1 FIRST FLOOR FLOOR PLAN
3/16"=1'-0"

NOTE: REFERENCE ELECTRICAL, MECHANICAL AND PLUMBING SHEETS FOR ADDITIONAL SCOPE RELATED TO THE KENWOOD MEP PORTION OF THE PROJECT



NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS.

2/23/2024 2:18:03 PM

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

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Project No.: 05326

Title
MEP FIRST FLOOR PLANS, ELEVATIONS, RCPS

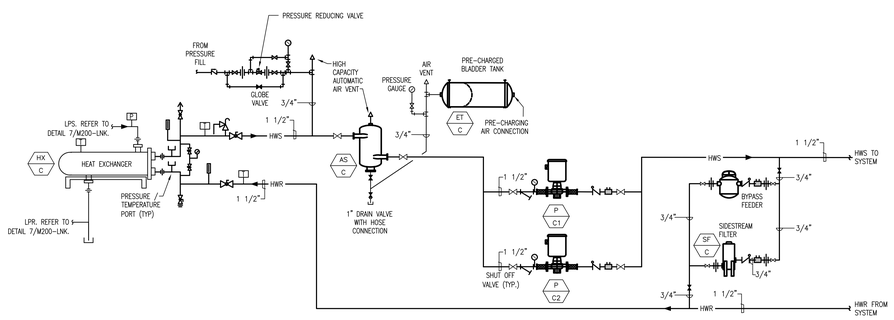
Sheet
A202

MECHANICAL GENERAL NOTES

1. SEQUENCE, COORDINATE, AND INTEGRATE THE VARIOUS ELEMENTS OF MECHANICAL SYSTEMS, MATERIALS, AND EQUIPMENT. COMPLY WITH THE FOLLOWING REQUIREMENTS:
2. ALL WORK SHALL CONFORM TO APPLICABLE INDUSTRY STANDARDS. ALL WORK SHALL COMPLY WITH ALL APPLICABLE LOCAL, MUNICIPAL, AND NATIONAL CODES.
3. MELVIN COHEN AND ASSOCIATES (MCA) SHALL NOT HAVE CONTROL OVER OR CHARGE OF AND SHALL NOT BE RESPONSIBLE FOR CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES, OR PROCEDURES, OR FOR SAFETY PRECAUTIONS AND PROGRAMS IN CONNECTION WITH THE WORK, SINCE THESE ARE SOLELY THE CONTRACTOR'S RESPONSIBILITY UNDER THE CONTRACT FOR CONSTRUCTION. MCA SHALL NOT BE RESPONSIBLE FOR THE CONTRACTOR'S SCHEDULES OR FAILURE TO CARRY OUT THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. MCA SHALL NOT HAVE CONTROL OVER OR CHARGE OF ACTS OR OMISSIONS OF THE CONTRACTOR, SUBCONTRACTORS, OR THEIR AGENTS OR EMPLOYEES OR ANY OTHER PERSONS PERFORMING PORTIONS OF THE WORK.
4. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL PERMITS AND INSPECTION FEES AS REQUIRED FOR HIS PORTION OF THE WORK.
5. THE CONTRACTOR SHALL MAKE ALL ARRANGEMENTS WITH THE OWNER PERTAINING TO WORKING HOURS, REFUSE DISPOSAL, SECURITY, INTERRUPTIONS OF BUILDING UTILITIES OR FUNCTIONS, OWNERSHIP OF SALVAGED MATERIALS, AND ALL OTHER ITEMS OF MUTUAL INTEREST.
6. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO BID TO DETERMINE THE FULL EXTENT OF THE WORK AND EXISTING FACILITIES.
7. THE CONTRACTOR SHALL VERIFY ALL EXISTING JOBSITE CONDITIONS PERTAINING TO THE WORK INDICATED ON THE DRAWINGS, AND REPORT ANY DISCREPANCIES OR OMISSIONS WHICH WOULD INTERFERE WITH SATISFACTORY COMPLETION OF THE WORK.
8. THESE DRAWINGS AND SPECIFICATIONS ARE PRESENTED TO THE CONTRACTOR WITH THE UNDERSTANDING THAT HE/SHE IS EXPERT AND COMPETENT IN THE PREPARATION OF SUBMITTING BID PROPOSAL ON THE BASIS OF SUCH INFORMATION AS IS CONTAINED IN THESE CONTRACT DOCUMENTS.
9. WHERE DRAWINGS, SPECIFICATIONS, OR NOTES CONFLICT ONE ANOTHER, THE CONTRACTOR SHALL IMMEDIATELY ADVISE THE ARCHITECT OF SUCH CONFLICTS. FOR PURPOSES OF BIDDING, AND PENDING WRITTEN RECEIPT OF ANY DIRECTION TO THE CONTRARY, THE CONTRACTOR SHALL INCLUDE IN HIS PROPOSAL THE MORE STRINGENT ALTERNATE DESCRIBED.
10. INSTALL SYSTEMS, MATERIALS, AND EQUIPMENT TO CONFORM WITH APPROVED SUBMITTAL DATA, INCLUDING COORDINATION DRAWINGS, TO GREATEST EXTENT POSSIBLE. CONFORM TO ARRANGEMENTS INDICATED BY THE CONTRACT DOCUMENTS, RECOGNIZING THAT PORTIONS OF THE WORK ARE SHOWN ONLY IN DIAGRAMMATIC FORM. WHERE COORDINATION REQUIREMENTS CONFLICT WITH INDIVIDUAL SYSTEM REQUIREMENTS, REFER CONFLICT TO THE ARCHITECT OF RECORD.
11. ALL WORK SHALL BE GUARANTEED TO BE FREE FROM LEAKS OR DEFECTS FOR A PERIOD OF ONE YEAR FROM DATE OF PROJECT COMPLETION. ANY DEFECTIVE MATERIALS OR WORKMANSHIP, AS WELL AS DAMAGE TO THE WORK OF ALL TRADES RESULTING FROM SAME, SHALL BE REPLACED OR REPAIRED AS DIRECTED BY THE OWNER FOR THE DURATION OF THE STIPULATED GUARANTEE PERIOD.
12. ALL EQUIPMENT, DUCTWORK, AND PIPING SHALL PASS ALL TESTS AS REQUIRED BY APPLICABLE LOCAL AND STATE CODES.
13. COORDINATE MECHANICAL SYSTEMS, EQUIPMENT, AND MATERIALS INSTALLATION WITH OTHER BUILDING COMPONENTS. VERIFY ALL DIMENSIONS BY FIELD MEASUREMENTS. THE CONTRACTOR SHALL INSTALL THE WORK TO MEET FIELD CONDITIONS AT NO ADDITIONAL COST TO THE CONTRACT, INCLUDING ADJUSTING RISERS TO AVOID BEAMS, TRUSSES, AND OTHER STRUCTURAL ELEMENTS.
14. ARRANGE FOR CHASES, SLOTS, AND OPENINGS IN OTHER BUILDING COMPONENTS DURING PROGRESS OF CONSTRUCTION, TO ALLOW FOR MECHANICAL INSTALLATIONS.
15. THE CONTRACTOR SHALL COORDINATE ALL WORK WITH THE RESPECTIVE TRADES, AND SHALL SUBMIT COORDINATED SHOP DRAWINGS FOR REVIEW.
16. THE CONTRACTOR SHALL PROVIDE THAT THE JURISDICTION OF WORK BE DONE BY THE PROPER TRADES WITH NO DELAY.
17. EQUIPMENT, PIPING, DUCTWORK, GRILLES, REGISTERS, DIFFUSERS, AND ALL ACCESSORIES SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS FOR A COMPLETE SYSTEM.
18. SHEET METAL DUCT GAGES, CONSTRUCTION, AND INSTALLATION SHALL BE IN ACCORDANCE WITH STANDARDS OF THE SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION, INC. (SMACNA). IF LOCAL CODES REQUIRE OTHER STANDARDS THAN DESCRIBED IN SMACNA, THE LOCAL CODES SHALL GOVERN.
19. GENERAL LOCATIONS AND ARRANGEMENTS: DRAWINGS (PLANS, SCHEMATICS, AND DIAGRAMS) INDICATE THE GENERAL LOCATION AND ARRANGEMENT OF THE SYSTEMS IN A DIAGRAMMATIC FORM ONLY. LOCATION AND ARRANGEMENT OF PIPE, DUCT, AND EQUIPMENT LAY-OUT SHALL TAKE INTO CONSIDERATION PIPE/DUCT SIZING AND PRESSURE LOSS, FAN SIZING, AND OTHER DESIGN CONSIDERATIONS. SO FAR AS PRACTICAL, INSTALL SYSTEM AS INDICATED. ADJUST ROUTING AND PROVIDE ALL OFFSETS, FITTINGS, ETC., AS REQUIRED FOR COORDINATION WITH BUILDING AND ALL OTHER SYSTEMS AT NO ADDITIONAL COST TO THE USING AGENCY. ALL DEVIATIONS FROM THE DESIGN DRAWINGS SHALL BE REFLECTED ON THE SHOP DRAWINGS FOR REVIEW BY THE ARCHITECT AND ENGINEER BEFORE PROCEEDING WITH FABRICATION OR INSTALLATION. CHANGES IN DUCT SIZE AND LOCATION SHALL BE MADE WHERE NECESSARY TO CONFORM TO SPACE CONDITIONS, AT NO ADDITION CHARGE. CONTRACTOR SHALL FIELD MEASURE DUCTWORK BEFORE FABRICATION.
20. DURING CONSTRUCTION, PROTECT ALL DUCTWORK, PIPING, AND EQUIPMENT FROM DAMAGE AND DIRT. CAP THE OPEN ENDS OF ALL DUCTWORK AND PIPING. CAP UNUSED DUCTS AND OPENINGS AIRTIGHT, WHETHER OR NOT INDICATED ON THE DRAWINGS.
21. THE CONTRACTOR SHALL STORE HIS MATERIALS IN A MANNER THAT WILL MAINTAIN AN ORDERLY CLEAN APPEARANCE. IF STORED ON SITE IN OPEN OR UNPROTECTED AREAS, ALL EQUIPMENT AND MATERIAL SHALL BE KEPT OFF THE GROUND AND COVERED FOR PROTECTION FROM WEATHER AND CONSTRUCTION. EQUIPMENT AND MATERIAL, IF DAMAGED OR LEFT UNPROTECTED, SHALL BE REJECTED, AND REPAIRED OR REPLACED AT THE DIRECTION OF THE OWNER.
22. INSTALL SYSTEMS, MATERIALS, AND EQUIPMENT LEVEL AND PLUMB, PARALLEL AND PERPENDICULAR TO OTHER BUILDING SYSTEMS AND COMPONENTS.
23. INSTALL MECHANICAL EQUIPMENT TO FACILITATE SERVICING, MAINTENANCE, AND REPAIR OR REPLACEMENT OF EQUIPMENT COMPONENTS. AS MUCH AS PRACTICAL, CONNECT EQUIPMENT FOR EASE OF DISCONNECTING, WITH MINIMUM OF INTERFERENCE WITH OTHER INSTALLATIONS. EXTEND GREASE FITTINGS TO AN ACCESSIBLE LOCATION.
24. PROVIDE AND MAINTAIN FOR THE DURATION OF CONSTRUCTION ALL SCAFFOLDS, TARPAULINS, CANOPIES, WARNING SIGNS, STEPS, PLATFORMS, BRIDGES, AND OTHER TEMPORARY CONSTRUCTION NECESSARY FOR PROPER COMPLETION OF WORK IN COMPLIANCE WITH PERTINENT SAFETY AND OTHER REGULATIONS.
25. CONTRACTOR SHALL INSTALL ALL AUXILIARY SUPPORTING STEEL AS REQUIRED FOR THE SUPPORTING OF THEIR PIPING, DUCTWORK, CONDUIT, EQUIPMENT, ETC. ALL SUPPORTING STEEL FOR ITEMS ABOVE A SUSPENDED CEILING SHALL BE FROM BUILDING STRUCTURAL MEMBERS ONLY. USE GALVANIZED STEEL RODS, TRAPEZE AND CLEVIS HANGERS, AS NEEDED AT MAXIMUM 5 FT. INTERVAL. PROVIDE GALVANIZED STEEL SADDLES AT INSULATED PIPING.
26. ALL DUCTWORK CONNECTIONS TO AIR MOVING EQUIPMENT SHALL BE MADE WITH FLEXIBLE DUCT CONNECTIONS ON THE INLET AND DISCHARGE OF ALL SUPPLY, RETURN, AND EXHAUST FANS.
27. PROJECT DESIGN IS BASED ON PARTICULAR EQUIPMENT MANUFACTURERS AS INDICATED IN THE SCHEDULES, AND ESTABLISHES THE QUALITY REQUIRED. USE OF EQUIPMENT BY ONE OF THE OTHER ACCEPTABLE MANUFACTURERS MAY REQUIRE ADDITIONAL WORK BE PERFORMED FOR PROPER INTEGRATION WITH THE BUILDING DESIGN. THE CONTRACTOR PROVIDING THE EQUIPMENT SHALL BE ENTIRELY RESPONSIBLE FOR COORDINATION, AND EXTRA LABOR AND MATERIAL REQUIRED AS A RESULT OF THE USE OF EQUIPMENT OTHER THAN THAT SCHEDULED, AND THE CONTRACTOR SHALL VERIFY THAT THIS EQUIPMENT FITS IN THE ALLOCATED SPACE. THIS RESPONSIBILITY SHALL INCLUDE ANY AND ALL EXTRA EXPENSE INCURRED BY AFFECTED CONTRACTORS; INCLUDING BUT NOT LIMITED TO THE GENERAL, MECHANICAL, PLUMBING, FIRE PROTECTION AND ELECTRICAL CONTRACTORS. THE CONTRACTOR PROVIDING THE EQUIPMENT SHALL ALSO BE RESPONSIBLE FOR ANY EXTRA EXPENSE INCURRED DUE TO CONSTRUCTION DELAYS AS A RESULT OF ANY ADDITIONAL COORDINATION AND/OR REVISION REQUIRED BY THE ALTERNATE EQUIPMENT MANUFACTURER SELECTION. ALL REVISIONS MUST BE REVIEWED BY THE ARCHITECT AND ENGINEER BEFORE PROCEEDING WITH THE INSTALLATION.
28. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING ALL THE DIMENSIONS OF THE PURCHASED EQUIPMENT TO VERIFY THAT IT WILL FIT IN THE SPACE SHOWN ON THE DRAWINGS. MINOR DEVIATIONS IN DIMENSIONS WILL BE PERMITTED, PROVIDED THE RATINGS MEET THOSE SHOWN ON THE DRAWINGS AND EQUIPMENT WILL PHYSICALLY FIT INTO THE SPACE ALLOCATED WITH REQUIRED ACCESS AROUND EQUIPMENT FOR OPERATION AND MAINTENANCE OF THE EQUIPMENT. THE CONTRACTOR SHALL BEAR ALL COSTS RELATED TO INSTALLATION OF THE EQUIPMENT WHERE MINOR DEVIATIONS EXIST BETWEEN THE SPECIFIED MANUFACTURERS, INCLUDING ITS IMPACT ON THE WORK OF OTHER TRADES.
29. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO MECHANICAL EQUIPMENT, MATERIALS OR WORK UNTIL FINAL ACCEPTANCE OF THE ENTIRE PROJECT BY THE USING AGENCY.
30. IT IS THE INTENT OF THESE SPECIFICATIONS AND DRAWINGS TO CALL FOR FINISHED WORK, TESTED, BALANCED, COMPLETE, AND OPERATING.
31. ORIENT RETURN AND EXHAUST GRILLES FACE THE DIRECTION THAT SHALL BE THE MOST SIGHT PROOF FROM VIEWING INTO THE DUCT THROUGH THE LOUVERED FACE.
32. ALL DUCTS AND PIPING SHALL BE SUPPORTED FROM APPROVED FOUNDATIONS AND SUPPORTS. DUCT HANGERS SHALL BE SOLID SHEET METAL STRAPS, RODS, OR ANGLES PER SMACNA.
33. CAP INDICATES THAT A DUCT OR PIPE SHALL BE PLUGGED OR CAPPED, AND SEALED WITH APPROVED MATERIALS.
34. SUPPLY REGISTERS SHALL BE NECK SIZE AND CFM AS NOTED.
35. SUBSTITUTIONS TO PRODUCTS SPECIFIED SHALL BE INDICATED ON BID FORM FOR REVIEW BY CPS BEFORE PURCHASE. REFER TO SECTION 01 25 00.
36. SHOULD THERE BE ANY DISCREPANCIES OR QUESTION OF INTENT, REFER THE MATTER TO THE ARCHITECT/ENGINEER FOR A FINAL DECISION BEFORE ORDERING ANY EQUIPMENT OR MATERIALS AND BEFORE STARTING ANY RELATING WORK.
37. SUBMIT VENTILATION TESTING REPORTS TO OWNER AND ENGINEER OF RECORD.
38. PROVIDE ASSISTANCE TO TEST, ADJUSTING AND BALANCING CONTRACTOR BY MAKING ADJUSTMENTS TO SYSTEM AND SYSTEM COMPONENTS REQUIRED FOR ACHIEVING DESIGN PERFORMANCE.
39. IF ACCEPTABLE PERFORMANCE OF ANY TEST IS NOT ACHIEVED, MAKE THE NECESSARY CORRECTIONS AND THE TEST SHALL BE REPEATED UNTIL ACCEPTABLE PERFORMANCE IS ACHIEVED.
40. AFTER CONSTRUCTION IS COMPLETED, INCLUDING PAINTING, CLEAN EQUIPMENT AND ACCESSORIES INSIDE AND OUT. RETOUCH ANY MARRED OR SCRATCHED SURFACES OF FACTORY FINISHED EQUIPMENT, USING FINISH MATERIALS FURNISHED BY MANUFACTURER AND APPLIED TO MATCH THE QUALITY OF THE ORIGINAL FINISH.
41. PROVIDE GUARDS AT ADJUSTABLE THERMOSTATS, VALVES, ETC. THAT ARE ACCESSIBLE IN PUBLIC SPACES.

TAB NOTES

1. REFER TO SPECIFICATION 23 05 93 FOR ADDITIONAL REQUIREMENTS. SEE BELOW FOR SOME SPECIFIC REQUIREMENTS BEYOND THE STANDARD BALANCING REQUIRED FOR THE PROJECT.
2. COMPLETELY BALANCE SUPPLY AIR, RETURN AIR, AND EXHAUST AIR SYSTEMS TO THE DESIGN AIRFLOWS.
3. CALIBRATE EXISTING OUTSIDE AIRFLOW MEASURING STATIONS.
4. COMPLETELY BALANCE THE NEW HOT WATER HEATING SYSTEM.
5. INCLUDE HW HEATING PUMP MINIMUM FLOW SETPOINTS, FLOW THROUGH BYPASS FILTERS, ETC.



1 M000-LNK N.T.S. HOT WATER HEATING PIPING DIAGRAM

NOTES:
1. SEE DETAILS AND PLANS FOR ADDITIONAL VALVING AND ACCESSORY REQUIREMENTS.
2. SEE SECTION 23 09 26 FOR SEQUENCE OF OPERATION.

MECHANICAL SYMBOLS

- G — GAS PIPING
- DIRECTION OF FLOW
- NEW PIPING/DUCTWORK
- EXISTING PIPING / DUCTWORK
- EXISTING TO BE REMOVED
- HIDDEN
- UP/DN — PITCH PIPE UP OR DOWN.
- DC — UNDERCUT DOOR
- T — THERMOSTAT
- H — HUMIDISTAT
- CO — CARBON MONOXIDE SENSOR
- C2 — CARBON DIOXIDE SENSOR
- SD — SMOKE DETECTOR
- EQU NO — EQUIPMENT TAG
- NO DWG — DETAIL TAG
- CONNECT NEW WITH EXISTING
- FLEXIBLE DUCT CONNECTION
- N.I.C. — AREA NOT IN SCOPE OF WORK
- VOLUME DAMPER

PIPING SYMBOLS

- TEE
- TEE TURNED DOWN
- TEE TURNED UP
- ELBOW
- ELBOW TURNED UP
- ELBOW TURNED DOWN
- FLANGE
- CAPPED END CONNECTION
- FLEXIBLE CONNECTION
- BALL VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- HOSE END DRAIN VALVE
- SHUT-OFF VALVE
- GAS COCK
- MANUAL AIR VENT
- MOTORIZED CONTROL VALVE
- PRESSURE REDUCING VALVE
- SAFETY VALVE
- VACUUM BREAKER
- PRESSURE GAUGE WITH COCK
- THERMOMETER
- PIPE ANCHOR
- PIPE GUIDE
- UNION
- Y-TYPE STRAINER WITH HOSE END DRAIN VALVE
- G — GAS PIPING
- DIRECTION OF FLOW
- UP/DN — PITCH PIPE UP OR DOWN
- GM — NEW GAS METER

I HEREBY CERTIFY THAT THE HEATING SYSTEM WILL HEAT ALL ROOMS REGULARLY OCCUPIED BY HUMANS TO AN INSIDE TEMPERATURE OF 68°F WHEN THE OUTSIDE TEMPERATURE IS MINUS -10°F (AS REQUIRED BY SECTION 34(13-196-410) AND 425-4-270) OF THE CHICAGO BUILDING CODE AND BY PARAGRAPH 1204.1 OF CHAPTER 18-12 (INTERIOR ENVIRONMENT) OF THE PROPOSED BUILDING PLANING AND LIFE SAFETY PORTION OF THE CODE.

MECHANICAL ABBREVIATIONS

AD	ACCESS DOOR
A/E	ARCHITECT/ENGINEER
AFF	ABOVE FINISHED FLOOR
BAS	BUILDING AUTOMATION SYSTEM
BD	BACKDRAFT DAMPER
BTU	BRITISH THERMAL UNIT
CA	COMBUSTION AIR
CAI	COMBUSTION AIR INTAKE
CFM	CUBIC FEET PER MINUTE
CD	CONDENSATE DRAIN
CO	CARBON MONOXIDE
CO2	CARBON DIOXIDE
CONV	CONVECTOR
CUH	CABINET UNIT HEATER
DDC	DIRECT DIGITAL CONTROLS
DG	DOOR GRILLE
DIFF	DIFFUSER
(E)	EXISTING
EA	EXHAUST AIR, EACH
EF	EXHAUST FAN
ETR	EXISTING TO REMAIN
FA	FREE AREA
FLA	FULL LOAD AMPACITY
FD	FIRE DAMPER
FPI	FINS PER INCH
G	GAS
GC	GENERAL CONTRACTOR
GN	GOOSE NECK
GR	GRILLE
H	HIGH, HEIGHT
HP	HORSE POWER
MBH	1000 BTU PER HOUR
MOD	MOTOR OPERATED DAMPERS
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NK	NECK
OA	OUTSIDE AIR
OAI	OUTSIDE AIR INTAKE
PNEU	PNEUMATIC
RA	RETURN AIR
REG	REGISTER
R/E	RETURN/EXHAUST
RO	ROUGH OPENING
SA	SUPPLY AIR
SF	SUPPLY FAN
SFFA	SQUARE FEET FREE AREA
SP	STATIC PRESSURE
TEMP	TEMPERATURE
TSTAT	THERMOSTAT
UH	UNIT HEATER
UV	UNIT VENTILATOR
UNO	UNLESS NOTED OTHERWISE
VFD	VARIABLE FREQUENCY DRIVE
VIF	VERIFY IN FIELD
VTR	VENT THRU ROOF
VD	VOLUME DAMPER
W	WIDE, WIDTH
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
CD	CONDENSATE DRAIN
CR	CONDENSATE RETURN
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
H/CS	HOT/CHILLED WATER SUPPLY (DUAL TEMP)
H/CR	HOT/CHILLED WATER RETURN (DUAL TEMP)
HG	REFRIGERANT HOT GAS
HGB	REFRIGERANT HOT GAS BYPASS
HPS	HIGH PRESSURE STEAM
HPR	HIGH PRESSURE STEAM CONDENSATE RETURN
HPWS	HEAT PUMP WATER SUPPLY
HPWR	HEAT PUMP WATER RETURN
HWS	HOT WATER HEATING SUPPLY
HWR	HOT WATER HEATING RETURN
LPS	LOW PRESSURE STEAM
LPR	LOW PRESSURE STEAM CONDENSATE RETURN
RL	REFRIGERANT LIQUID
RS	REFRIGERANT SUCTION

DUCTWORK SYMBOLS AND STANDARDS

DOUBLE THICKNESS TURNING VANES

ROUND ELBOW WITH TURNING BLADES IF W > 18" — R = W/2 MIN

NOTE: IF R. IS LESS THAN W. THEN FULL ARC TURNING

NOTE:
1. PROVIDE STANDARD RADIUS ELBOWS WHEN POSSIBLE-SHORT RADIUS WHERE REQUIRED.
2. ALL SHORT RADIUS ELBOWS SHALL HAVE VANES. VANES SHALL BE CONSTRUCTED, SUPPORTED AND FASTENED AS RECOMMENDED BY SMACNA.
3. NO SQUARE OR RECTANGULAR HEEL ELBOWS SHALL BE ALLOWED.
4. UTILIZE FLEXIBLE DUCTS ONLY AT CONNECTIONS TO GRILLES AND DIFFUSERS, AND WITH 5'-0" MAXIMUM LENGTH.

VANE SCHEDULE	
WIDTH	NO. OF VANES
< 12"	1
12"-24"	2
24"-36"	3
36"-60"	4
60"-84"	5
> 84"	6

CONSTANT VOL — A,B SHALL BE PROPORTIONAL TO AIR QUANTITY IF A OR B IS LESS THAN 6", USE TAP DETAIL. PROVIDE DAMPER IN SMALLEST BRANCH.

CONICAL TEE — VARIABLE BOX TAKEOFF

PROVIDE ADJUSTABLE VOLUME DAMPER FOR ALL SUPPLY AND RETURN BRANCHES.

ELEVATION — OFFSET MADE WITH SMOOTH ELBOW FITTINGS

OFFSET FITTING — PLENUM OVER DIFFUSER; CONICAL FITTINGS; VOLUME DAMPER; FLEX

ACCESS DOOR IN DUCT — FD RATING EQUAL TO PARTITION RATING UNLESS NOTED OTHERWISE. (1-1/2 HR MIN.)

REHEAT COIL WITH FLANGED CONNECTION ALL AROUND

ACCESS DOORS

H HEATING COIL — C COOLING COIL — FILTER

MD MANUAL DAMPER (VOLUME DAMPER) — AUTOMATIC CONTROL DAMPER

TRANSITION

TYPE (SEE SCHEDULE); CFM; SUPPLY, RETURN OR EXHAUST

FLEXIBLE CONNECTION

SUPPLY — RETURN OR EXHAUST

SOLID CROSS INDICATES UP OR TOWARD. DASHED CROSS INDICATES DOWN OR AWAY.

GRILLE, REGISTER AND DIFFUSER SYMBOLS:

CEILING SUPPLY DIFFUSER OR REGISTER — CEILING RETURN OR EXHAUST GRILLE OR REGISTER — SIDEWALL SUPPLY REGISTER — SIDEWALL RETURN OR EXHAUST GRILLE OR REGISTER

TYPICAL DUCT CONNECTION DETAIL

RECTANGULAR DUCT SUPPLY BRANCH TAKE-OFF — RECTANGULAR DUCT SUPPLY BRANCH TAKE-OFF — TRANSITION PIECE — RECTANGULAR SUPPLY TEE — RECTANGULAR SUPPLY TEE

RECTANGULAR DUCT SUPPLY BRANCH TAKE-OFF — RECTANGULAR DUCT SUPPLY BRANCH TAKE-OFF — ROUND TO RECTANGULAR — RECTANGULAR TO ROUND

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION — Chicago Public Schools

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LINK + MECHANICAL PROJECT
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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS

Sheet: M000-LNK

MECHANICAL GENERAL DEMOLITION NOTES

MECHANICAL DEMOLITION NOTES:

1. WHERE MECHANICAL SYSTEMS OR PORTIONS OF SYSTEMS ARE INDICATED TO BE REMOVED, REMOVE ALL MISCELLANEOUS COMPONENTS THAT ARE MADE OBSOLETE BY REMOVAL OF THE SYSTEM.
2. ALL DEMOLITION OF THE HVAC SYSTEM AS CALLED FOR ON THE CONTRACT DOCUMENTS SHALL BE UNDER THIS CONTRACTORS WORK. INCLUDE DEMOLITION OF ALL MECHANICAL COMPONENTS, NOT REQUIRED FOR THE NEW WORK, WHETHER SPECIFICALLY INDICATED ON CONTRACT DOCUMENTS OR NOT.
3. BEFORE STARTING ANY DEMOLITION ON HVAC EQUIPMENT WHICH HAS AN ELECTRICAL CONNECTION COORDINATE DISCONNECTING OF THE POWER SUPPLY WITH THE DIVISION 26 CONTRACTOR. DO NOT PROCEED WITH MECHANICAL DEMOLITION UNTIL ALL ELECTRICAL POWER HAS BEEN SAFELY DISCONNECTED FROM EQUIPMENT TO BE DEMOLISHED. REMOVE ALL EQUIPMENT, ELECTRICAL TEMPERATURE CONTROL WIRING AND CONDUIT AND COMPONENTS, ETC. THAT ARE BEING MADE OBSOLETE BY THE SCOPE OF THIS PROJECT.
4. WARNING: ASBESTOS-CONTAINING BUILDING MATERIALS ARE OR MAY BE PRESENT IN THIS BUILDING. NO PERSON MAY DISTURB ASBESTOS-CONTAINING BUILDING MATERIALS UNLESS THAT PERSON IS A LICENSED ASBESTOS WORKER AND CONDUCTS SUCH WORK IN ACCORDANCE WITH SPECIFICATION(S) CONTAINED IN THE PROJECT DOCUMENTS AND IN COMPLIANCE WITH ILLINOIS DEPARTMENT OF PUBLIC HEALTH RULES AND REGULATIONS.
5. VERIFY SIZE OF ALL EXISTING OPENINGS, DOORS, ETC. FOR GETTING EQUIPMENT AND MATERIAL OUT OF BUILDING. CONTRACTOR SHALL PROVIDE DISASSEMBLY OF MECHANICAL COMPONENTS BEING REMOVED AS REQUIRED TO FACILITATE EXITING OF HIS EQUIPMENT/MATERIAL FROM THE BUILDING.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN CLEANUP THROUGHOUT THE COURSE OF THE DEMOLITION WORK.
7. ALL HVAC EQUIPMENT, MATERIAL, ETC. THAT IS BEING DEMOLISHED WILL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE NOTED. ALL SUCH ITEMS WILL BE REMOVED FROM THE BUILDING SITE BY THE CONTRACTOR. NO ITEM WHICH IS BEING REMOVED UNDER THE DEMOLITION CONTRACT MAY BE REUSED UNDER THE NEW WORK CONTRACT UNLESS NOTED ON THE DRAWINGS.
8. SEQUENCE OF ALL DEMOLITION WORK SHALL BE IN STRICT ACCORDANCE WITH THE CONTRACT DOCUMENTS AND/OR AS DIRECTED BY THE USING AGENCY.
9. CONTRACTOR TO PROTECT ALL WINDOWS AND BUILDING SURFACES DURING DEMOLITION. ANY COSTS INCURRED BY DAMAGE FROM CUTTING TORCHES, SPARKS, HEAT OR OTHER DEMOLITION PROCEDURES WILL BE BACK CHARGED TO THE CONTRACTOR.
10. CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING ALL LABOR AND MATERIAL REQUIRED TO PATCH ALL OPENINGS IN EXISTING WALLS AND FIRE SEPARATIONS CREATED BY THE REMOVAL OF CONTRACTOR'S MATERIAL AND EQUIPMENT. WHERE THESE OPENINGS ARE NOT TO BE REUSED, PATCHING OF ALL EXISTING FLOOR, WALL AND ROOF OPENINGS IS THE RESPONSIBILITY OF THE CONTRACTOR.
11. PRIOR TO THE START OF DEMOLITION, THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING PIPING, DUCTWORK AND SERVICE SIZES NOTED IN THESE DRAWINGS. ANY DISCREPANCY IN THE NOTED SIZES COULD NOT BE THE BASIS OF ADDITIONAL COST CLAIM.
12. CONTRACTOR IS RESPONSIBLE FOR ALL COSTS INCURRED IN REPAIRS, RELOCATIONS, OR REPLACEMENT OF ANY CABLES, CONDUITS, OR OTHER SERVICES THAT ARE TO REMAIN BUT DAMAGED WITHOUT PROPER INVESTIGATIONS.
13. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES FOR THE DEMOLITION, REMOVAL, AND LEGAL DISPOSAL OF EXISTING EQUIPMENT, DUCTWORK, PIPING, ASSOCIATED CONTROLS, ASSOCIATED STRUCTURAL SUPPORTS, HANGERS, RODS, SUPPORTS, ANCHORS, MISCELLANEOUS HARDWARE, MISCELLANEOUS EQUIPMENT, REMOVAL OF APPURTENANT EQUIPMENT AND MATERIALS, AND LAWFULLY DISPOSE OF ALL EQUIPMENT AND MATERIALS RENDERED OBSOLETE OFF THE PREMISES.
14. MAINTAIN TEMPORARY WARNING SIGNAGE, BARRICADES, YELLOW PROTECTION TAPE, WARNING LIGHTS, AND OTHER SIMILAR ITEMS AROUND ANY AREAS THAT CREATE A HAZARD DURING THE DEMOLITION PROCESS.
15. PROVIDE TEMPORARY WEATHER PROTECTION AT ALL ROOF OPENINGS WHERE MECHANICAL EQUIPMENT IS BEING REMOVED.

TAB SCOPE NOTES

1. REFER TO SPECIFICATION 23 05 93 FOR ADDITIONAL REQUIREMENTS. SEE BELOW FOR SOME SPECIFIC REQUIREMENTS BEYOND THE STANDARD BALANCING REQUIRED FOR THE PROJECT.
2. PERFORM PRECONSTRUCTION READINGS PRIOR TO THE START OF ANY WORK ON THE SYSTEMS AND PERFORM FINAL TESTING AND BALANCING AT THE COMPLETION OF THE PROJECT FOR THE FOLLOWING SYSTEMS:
   A. AIR HANDLING UNITS AHU-9 THRU 11, ASSOCIATED RETURN / EXHAUST FANS E-9 THRU 11 AND TOILET EXHAUST FANS E-25 & 26. PERFORM TOTAL SYSTEM READINGS AND READINGS AT EACH ASSOCIATED AIR INLET & OUTLET. RECORD FILTER CONDITION, ECONOMIZER & BYPASS DAMPER POSITIONS DURING TESTING. PERFORM TESTING WITH ALL MULTIZONE UNIT ZONE DAMPERS POSITIONED FOR FULL HEAT. DUPLICATE PRECONSTRUCTION CONDITIONS FOR FINAL TESTING.
3. UPON COMPLETION OF PROJECT:
   A. COMPLETELY BALANCE ALL NEW & EXISTING SUPPLY AIR, RETURN AIR AND EXHAUST AIR SYSTEMS TO THE DESIGN AIRFLOWS.
   B. CALIBRATE OUTSIDE AIRFLOW MEASURING STATIONS AT RTU-8, AHU-9 THRU 11 AT DESIGN MINIMUM OUTSIDE AIR.
   C. DETERMINE RTU-8 MINIMUM EXHAUST FAN SPEED TO MATCH OUTSIDE AIRFLOW AND COORDINATE W/ BAS CONTRACTOR.

MECHANICAL GENERAL NOTES

1. SEQUENCE, COORDINATE, AND INTEGRATE THE VARIOUS ELEMENTS OF MECHANICAL SYSTEMS, MATERIALS, AND EQUIPMENT. COMPLY WITH THE FOLLOWING REQUIREMENTS:
2. ALL WORK SHALL CONFORM TO APPLICABLE INDUSTRY STANDARDS. ALL WORK SHALL COMPLY WITH ALL APPLICABLE LOCAL, MUNICIPAL, AND NATIONAL CODES.
3. MELVIN COHEN AND ASSOCIATES (MCA) SHALL NOT HAVE CONTROL OVER OR CHARGE OF AND SHALL NOT BE RESPONSIBLE FOR CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES, OR FOR SAFETY PRECAUTIONS AND PROGRAMS IN CONNECTION WITH THE WORK, SINCE THESE ARE SOLELY THE CONTRACTOR'S RESPONSIBILITY UNDER THE CONTRACT FOR CONSTRUCTION. MCA SHALL NOT BE RESPONSIBLE FOR THE CONTRACTOR'S SCHEDULES OR FAILURE TO CARRY OUT THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. MCA SHALL NOT HAVE CONTROL OVER OR CHARGE OF ACTS OR OMISSIONS OF THE CONTRACTOR, SUBCONTRACTORS, OR THEIR AGENTS OR EMPLOYEES OR ANY OTHER PERSONS PERFORMING PORTIONS OF THE WORK.
4. THE CONTRACTOR SHALL OBTAIN AND PAY FOR ALL PERMITS AND INSPECTION FEES AS REQUIRED FOR HIS PORTION OF THE WORK.
5. THE CONTRACTOR SHALL MAKE ALL ARRANGEMENTS WITH THE OWNER PERTAINING TO WORKING HOURS, REFUSE DISPOSAL, SECURITY, INTERRUPTIONS OF BUILDING UTILITIES OR FUNCTIONS, OWNERSHIP OF SALVAGED MATERIALS, AND ALL OTHER ITEMS OF MUTUAL INTEREST.
6. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO BID TO DETERMINE THE FULL EXTENT OF THE WORK AND EXISTING FACILITIES.
7. THE CONTRACTOR SHALL VERIFY ALL EXISTING JOBSITE CONDITIONS PERTAINING TO THE WORK INDICATED ON THE DRAWINGS, AND REPORT ANY DISCREPANCIES OR OMISSIONS WHICH WOULD INTERFERE WITH SATISFACTORY COMPLETION OF THE WORK.
8. THESE DRAWINGS & SPECIFICATIONS ARE PRESENTED TO THE CONTRACTOR WITH THE UNDERSTANDING THAT HE IS EXPERT & COMPETENT IN THE PREPARATION OF CONTRACT BID PRICES ON THE BASIS OF SUCH INFORMATION AS IS CONTAINED IN THESE SPECIFICATIONS & DRAWINGS.
9. WHERE DRAWINGS, SPECIFICATIONS, OR NOTES CONFLICT ONE ANOTHER, THE CONTRACTOR SHALL IMMEDIATELY ADVISE THE ARCHITECT OF SUCH CONFLICTS. FOR PURPOSES OF BIDDING, AND PENDING WRITTEN RECEIPT OF ANY DIRECTION TO THE CONTRARY, THE CONTRACTOR SHALL INCLUDE IN HIS PROPOSAL THE MORE STRINGENT ALTERNATE DESCRIBED.
10. INSTALL SYSTEMS, MATERIALS, AND EQUIPMENT TO CONFORM WITH APPROVED SUBMITTAL DATA, INCLUDING COORDINATION DRAWINGS, TO GREATEST EXTENT POSSIBLE. CONFORM TO ARRANGEMENTS INDICATED BY THE CONTRACT DOCUMENTS, RECOGNIZING THAT PORTIONS OF THE WORK ARE SHOWN ONLY IN DIAGRAMMATIC FORM. WHERE COORDINATION REQUIREMENTS CONFLICT WITH INDIVIDUAL SYSTEM REQUIREMENTS, REFER CONFLICT TO THE ARCHITECT.
11. ALL WORK SHALL BE GUARANTEED TO BE FREE FROM LEAKS OR DEFECTS FOR A PERIOD OF ONE YEAR FROM DATE OF PROJECT COMPLETION. ANY DEFECTIVE MATERIALS OR WORKMANSHIP, AS WELL AS DAMAGE TO THE WORK OF ALL TRADES RESULTING FROM SAME, SHALL BE REPLACED OR REPAIRED AS DIRECTED BY THE OWNER FOR THE DURATION OF THE STIPULATED GUARANTEE PERIOD.
12. COORDINATE MECHANICAL SYSTEMS, EQUIPMENT, AND MATERIALS INSTALLATION WITH OTHER BUILDING COMPONENTS. VERIFY ALL DIMENSIONS BY FIELD MEASUREMENTS. THE CONTRACTOR SHALL INSTALL THE WORK TO MEET FIELD CONDITIONS AT NO ADDITIONAL CHARGE, INCLUDING ADJUSTING RISERS TO AVOID BEAMS & TRUSSES.
13. ARRANGE FOR CHASES, SLOTS, AND OPENINGS IN OTHER BUILDING COMPONENTS DURING PROGRESS OF CONSTRUCTION, TO ALLOW FOR MECHANICAL INSTALLATIONS.
14. THE CONTRACTOR SHALL COORDINATE ALL WORK WITH THE RESPECTIVE TRADES, AND SHALL SUBMIT COORDINATED SHOP DRAWINGS FOR REVIEW.
15. THE CONTRACTOR SHALL PROVIDE THAT THE JURISDICTION OF WORK BE DONE BY THE PROPER TRADES WITH NO DELAY.
16. EQUIPMENT, PIPING, DUCTWORK, GRILLES, REGISTERS, DIFFUSERS, AND ALL ACCESSORIES SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS FOR A COMPLETE SYSTEM.
17. SHEET METAL DUCT GAGES, CONSTRUCTION, AND INSTALLATION SHALL BE IN ACCORDANCE WITH STANDARDS OF THE SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION, INC. (SMACNA). IF LOCAL CODES REQUIRE OTHER STANDARDS THAN DESCRIBED IN SMACNA, THE LOCAL CODES SHALL GOVERN.
18. GENERAL LOCATIONS AND ARRANGEMENTS: DRAWINGS (PLANS, SCHEMATICS, AND DIAGRAMS) INDICATE THE GENERAL LOCATION AND ARRANGEMENT OF THE SYSTEMS IN A DIAGRAMMATIC FORM ONLY. LOCATION AND ARRANGEMENT OF PIPE, DUCT, AND EQUIPMENT LAY-OUT SHALL TAKE INTO CONSIDERATION PIPE/DUCT SIZING AND PRESSURE LOSS, FAN SIZING, AND OTHER DESIGN CONSIDERATIONS. SO FAR AS PRACTICAL, INSTALL SYSTEM AS INDICATED. ADJUST ROUTING AND PROVIDE ALL OFFSETS, FITTINGS, ETC., AS REQUIRED FOR COORDINATION WITH BUILDING AND ALL OTHER SYSTEMS AT NO ADDITIONAL COST TO THE USING AGENCY. ALL DEVIATIONS FROM THE DESIGN DRAWINGS SHALL BE REFLECTED ON THE SHOP DRAWINGS FOR REVIEW BY THE ARCHITECT AND ENGINEER BEFORE PROCEEDING WITH FABRICATION OR INSTALLATION. CHANGES IN DUCT SIZE AND LOCATION SHALL BE MADE WHERE NECESSARY TO CONFORM TO SPACE CONDITIONS, AT NO ADDITION CHARGE. CONTRACTOR SHALL FIELD MEASURE DUCTWORK BEFORE FABRICATION.
19. DURING CONSTRUCTION, PROTECT ALL DUCTWORK, PIPING, AND EQUIPMENT FROM DAMAGE AND DIRT. CAP THE OPEN ENDS OF ALL DUCTWORK AND PIPING. CAP UNUSED DUCTS AND OPENINGS AIRTIGHT, WHETHER OR NOT INDICATED ON THE DRAWINGS.
20. THE CONTRACTOR SHALL STORE HIS MATERIALS IN A MANNER THAT WILL MAINTAIN AN ORDERLY CLEAN APPEARANCE. IF STORED ON SITE IN OPEN OR UNPROTECTED AREAS, ALL EQUIPMENT AND MATERIAL SHALL BE KEPT OFF THE GROUND AND COVERED FOR PROTECTION FROM WEATHER AND CONSTRUCTION. EQUIPMENT AND MATERIAL, IF DAMAGED OR LEFT UNPROTECTED, SHALL BE REJECTED, AND REPAIRED OR REPLACED AT THE DIRECTION OF THE OWNER.
21. INSTALL SYSTEMS, MATERIALS, AND EQUIPMENT LEVEL AND PLUMB, PARALLEL AND PERPENDICULAR TO OTHER BUILDING SYSTEMS AND COMPONENTS.
22. INSTALL MECHANICAL EQUIPMENT TO FACILITATE SERVICING, MAINTENANCE, AND REPAIR OR REPLACEMENT OF EQUIPMENT COMPONENTS. AS MUCH AS PRACTICAL, CONNECT EQUIPMENT FOR EASE OF DISCONNECTING, WITH MINIMUM OF INTERFERENCE WITH OTHER INSTALLATIONS. EXTEND GREASE FITTINGS TO AN ACCESSIBLE LOCATION.
23. PROVIDE AND MAINTAIN FOR THE DURATION OF CONSTRUCTION ALL SCAFFOLDS, TARPAULINS, CANOPIES, WARNING SIGNS, STEPS, PLATFORMS, BRIDGES, AND OTHER TEMPORARY CONSTRUCTION NECESSARY FOR PROPER COMPLETION OF WORK IN COMPLIANCE WITH PERTINENT SAFETY AND OTHER REGULATIONS.
24. CONTRACTOR SHALL INSTALL ALL AUXILIARY SUPPORTING STEEL AS REQUIRED FOR THE SUPPORTING OF THEIR PIPING, DUCTWORK, CONDUIT, EQUIPMENT, ETC. ALL SUPPORTING STEEL FOR ITEMS ABOVE A SUSPENDED CEILING SHALL BE FROM BUILDING STRUCTURAL MEMBERS ONLY. USE GALVANIZED STEEL RODS, TRAPEZE AND CLEVIS HANGERS, AS NEEDED AT MAXIMUM 5 FT. INTERVAL. PROVIDE GALVANIZED STEEL SADDLES AT INSULATED PIPING.
25. ALL DUCTWORK CONNECTIONS TO AIR MOVING EQUIPMENT SHALL BE MADE WITH FLEXIBLE DUCT CONNECTIONS ON THE INLET AND DISCHARGE OF ALL SUPPLY, RETURN, AND EXHAUST FANS.
26. PROJECT DESIGN IS BASED ON PARTICULAR EQUIPMENT MANUFACTURERS AS INDICATED IN THE SCHEDULES, AND ESTABLISHES THE QUALITY REQUIRED. USE OF EQUIPMENT BY ONE OF THE OTHER ACCEPTABLE MANUFACTURERS MAY REQUIRE ADDITIONAL WORK BE PERFORMED FOR PROPER INTEGRATION WITH THE BUILDING DESIGN. THE CONTRACTOR PROVIDING THE EQUIPMENT SHALL BE ENTIRELY RESPONSIBLE FOR COORDINATION, AND EXTRA LABOR AND MATERIAL REQUIRED AS A RESULT OF THE USE OF EQUIPMENT OTHER THAN THAT SCHEDULED, AND THE CONTRACTOR SHALL VERIFY THAT THIS EQUIPMENT FITS IN THE ALLOCATED SPACE. THIS RESPONSIBILITY SHALL INCLUDE ANY AND ALL EXTRA EXPENSE INCURRED BY AFFECTED CONTRACTORS; INCLUDING BUT NOT LIMITED TO THE GENERAL, MECHANICAL, PLUMBING, FIRE PROTECTION AND ELECTRICAL CONTRACTORS. THE CONTRACTOR PROVIDING THE EQUIPMENT SHALL ALSO BE RESPONSIBLE FOR ANY EXTRA EXPENSE INCURRED DUE TO CONSTRUCTION DELAYS AS A RESULT OF ANY ADDITIONAL COORDINATION AND/OR REVISION REQUIRED BY THE ALTERNATE EQUIPMENT MANUFACTURER SELECTION. ALL REVISIONS MUST BE REVIEWED BY THE ARCHITECT AND ENGINEER BEFORE PROCEEDING WITH THE INSTALLATION.
27. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING ALL THE DIMENSIONS OF THE PURCHASED EQUIPMENT TO VERIFY THAT IT WILL FIT IN THE SPACE SHOWN ON THE DRAWINGS. MINOR DEVIATIONS IN DIMENSIONS WILL BE PERMITTED, PROVIDED THE RATINGS MEET THOSE SHOWN ON THE DRAWINGS AND EQUIPMENT WILL PHYSICALLY FIT INTO THE SPACE ALLOCATED WITH REQUIRED ACCESS AROUND EQUIPMENT FOR OPERATION AND MAINTENANCE OF THE EQUIPMENT. THE CONTRACTOR SHALL BEAR ALL COSTS RELATED TO INSTALLATION OF THE EQUIPMENT WHERE MINOR DEVIATIONS EXIST BETWEEN THE SPECIFIED MANUFACTURERS, INCLUDING ITS IMPACT ON THE WORK OF OTHER TRADES.
28. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO MECHANICAL EQUIPMENT, MATERIALS OR WORK UNTIL FINAL ACCEPTANCE OF THE ENTIRE PROJECT BY THE USING AGENCY.
29. IT IS THE INTENT OF THESE SPECIFICATIONS AND DRAWINGS TO CALL FOR FINISHED WORK, TESTED, BALANCED, COMPLETE, AND OPERATING.
30. ALL DUCTS AND PIPING SHALL BE SUPPORTED FROM APPROVED FOUNDATIONS AND SUPPORTS. DUCT HANGERS SHALL BE SOLID SHEET METAL STRAPS, RODS, OR ANGLES PER SMACNA.
31. CAP INDICATES THAT A DUCT OR PIPE SHALL BE PLUGGED OR CAPPED, AND SEALED WITH APPROVED MATERIALS.
32. ALTERNATES TO PRODUCTS SPECIFIED SHALL BE SUBMITTED FOR REVIEW BEFORE PURCHASE.
33. SHOULD THERE BE ANY DISCREPANCIES OR QUESTION OF INTENT, REFER THE MATTER TO THE ARCHITECT/ENGINEER FOR A FINAL DECISION BEFORE ORDERING ANY EQUIPMENT OR MATERIALS AND BEFORE STARTING ANY RELATING WORK.
34. SUBMIT VENTILATION TESTING REPORTS TO OWNER & ENGINEER.
35. PROVIDE ASSISTANCE TO TEST, ADJUSTING AND BALANCING CONTRACTOR BY MAKING ADJUSTMENTS TO SYSTEM AND SYSTEM COMPONENTS REQUIRED FOR ACHIEVING DESIGN PERFORMANCE.
36. IF ACCEPTABLE PERFORMANCE OF ANY TEST IS NOT ACHIEVED, MAKE THE NECESSARY CORRECTIONS AND THE TEST SHALL BE REPEATED UNTIL ACCEPTABLE PERFORMANCE IS ACHIEVED.
37. PRIME AND PAINT ALL EXPOSED EXTERIOR GAS PIPING WITH EXTERIOR ENAMEL OF COLOR APPROVED BY ARCHITECT. PROVIDE PIPE LABELS WITH YELLOW BACKGROUND AND THE WORD "GAS" IN BLACK LETTERS AT INTERVALS NOT EXCEEDING 5'-0".
38. AFTER CONSTRUCTION IS COMPLETED, INCLUDING PAINTING, CLEAN EQUIPMENT AND ACCESSORIES INSIDE AND OUT. RETOUCH ANY MARRED OR SCRATCHED SURFACES OF FACTORY FINISHED EQUIPMENT, USING FINISH MATERIALS FURNISHED BY MANUFACTURER AND APPLIED TO MATCH THE QUALITY OF THE ORIGINAL FINISH.

MECHANICAL ABBREVIATIONS

AD	ACCESS DOOR
A/E	ARCHITECT/ENGINEER
AFF	ABOVE FINISHED FLOOR
BAS	BUILDING AUTOMATION SYSTEM
BD	BACKDRAFT DAMPER
BTU	BRITISH THERMAL UNIT
CA	COMBUSTION AIR
CAI	COMBUSTION AIR INTAKE
CFM	CUBIC FEET PER MINUTE
CD	CONDENSATE DRAIN
CO	CARBON MONOXIDE
CO2	CARBON DIOXIDE
CONV	CONVECTOR
CUH	CABINET UNIT HEATER
DDC	DIRECT DIGITAL CONTROLS
DG	DOOR GRILLE
DIFF	DIFFUSER
(E)	EXISTING
EA	EXHAUST AIR, EACH
EF	EXHAUST FAN
ETR	EXISTING TO REMAIN
FA	FREE AREA
FLA	FULL LOAD AMPACITY
FD	FIRE DAMPER
FPI	FINS PER INCH
G	GAS
GC	GENERAL CONTRACTOR
GN	GOOSE NECK
GR	GRILLE
H	HIGH, HEIGHT
HP	HORSE POWER
MBH	1000 BTU PER HOUR
MOD	MOTOR OPERATED DAMPERS
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NK	NECK
OA	OUTSIDE AIR
OAI	OUTSIDE AIR INTAKE
PNEU	PNEUMATIC
RA	RETURN AIR
REG	REGISTER
R/E	RETURN/EXHAUST
RO	ROUGH OPENING
SA	SUPPLY AIR
SF	SUPPLY FAN
SFFA	SQUARE FEET FREE AREA
SP	STATIC PRESSURE
TEMP	TEMPERATURE
TSTAT	THERMOSTAT
UH	UNIT HEATER
UV	UNIT VENTILATOR
UNO	UNLESS NOTED OTHERWISE
VFD	VARIABLE FREQUENCY DRIVE
VIF	VERIFY IN FIELD
VTR	VENT THRU ROOF
VD	VOLUME DAMPER
W	WIDE, WIDTH
WMS	WIRE MESH SCREEN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
CD	CONDENSATE DRAIN
CR	CONDENSATE RETURN
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
H/CS TEMP)	HOT/CHILLED WATER SUPPLY (DUAL
H/CR TEMP)	HOT/CHILLED WATER RETURN (DUAL
HG	REFRIGERANT HOT GAS
HGB	REFRIGERANT HOT GAS BYPASS
HPS	HIGH PRESSURE STEAM
HPR RETURN	HIGH PRESSURE STEAM CONDENSATE
HPWS	HEAT PUMP WATER SUPPLY
HPWR	HEAT PUMP WATER RETURN
HWS	HOT WATER HEATING SUPPLY
HWR	HOT WATER HEATING RETURN
LPS	LOW PRESSURE STEAM
LPR RETURN	LOW PRESSURE STEAM CONDENSATE
RL	REFRIGERANT LIQUID
RS	REFRIGERANT SUCTION

EXISTING GAS SERVICE INFORMATION

1. SITE UTILIZES (2) METERED GAS SERVICES (7"WC & 2 PSIG) WITH METERS LOCATED AT THE SOUTH END OF BUILDING D. BUILDING C IS FED FROM THE 2 PSIG SERVICE.
2. SUMMARY OF CONNECTED LOADS AT THE 2 PSIG SERVICE:
   A. (2) EXISTING STEAM HEATING BOILERS IN BUILDING B PENTHOUSE, 25,000 MBH TOTAL
   B. (1) EXISTING DOMESTIC HOT WATER HEATER IN BUILDING C PENTHOUSE, 1,800 MBH
   C. (1) NEW NATATORIUM POOL RTU-8, 500 MBH

I HEREBY CERTIFY THAT THE HEATING SYSTEM WILL HEAT ALL ROOMS REGULARLY OCCUPIED BY HUMANS TO AN INSIDE TEMPERATURE OF 68°F WHEN THE OUTSIDE TEMPERATURE IS MINUS -10°F (AS REQUIRED BY SECTION 34(13-196-410) AND 4(5-4-270) OF THE CHICAGO BUILDING CODE AND BY PARAGRAPH 1204.1 OF CHAPTER 18-12 (INTERIOR ENVIRONMENT) OF THE PROPOSED BUILDING PLANING AND LIFE SAFETY PORTION OF THE CODE.

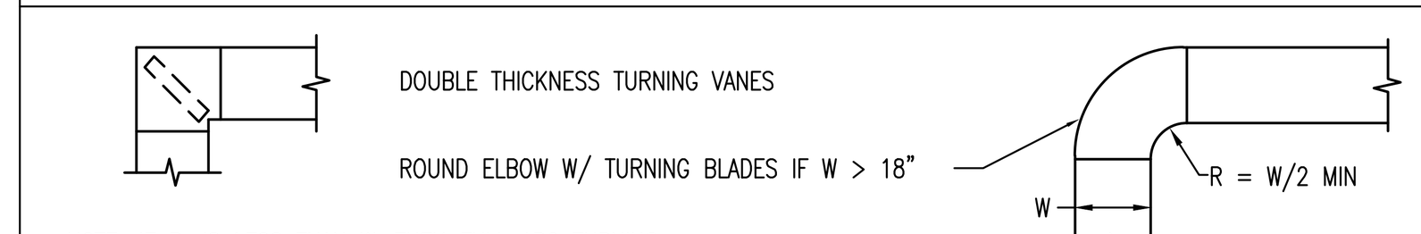
MECHANICAL SYMBOLS

- GAS PIPING
- DIRECTION OF FLOW
- NEW PIPING/DUCTWORK
- EXISTING PIPING / DUCTWORK
- EXISTING TO BE REMOVED
- HIDDEN
- PITCH PIPE UP OR DN.
- UNDERCUT DOOR
- THERMOSTAT
- HUMIDISTAT
- CARBON MONOXIDE SENSOR
- CARBON DIOXIDE SENSOR
- SMOKE DETECTOR
- EQUIPMENT TAG
- DETAIL TAG
- CONNECT NEW WITH EXISTING
- FLEXIBLE DUCT CONNECTION
- AREA NOT IN SCOPE OF WORK
- VOLUME DAMPER

PIPING SYMBOLS

- TEE
- TEE TURNED DOWN
- TEE TURNED UP
- ELBOW
- ELBOW TURNED UP
- ELBOW TURNED DOWN
- FLANGE
- CAPPED END CONNECTION
- FLEXIBLE CONNECTION
- BALL VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- HOSE END DRAIN VALVE
- SHUT-OFF VALVE
- GAS COCK
- MANUAL AIR VENT
- MOTORIZED CONTROL VALVE
- PRESSURE REDUCING VALVE
- SAFETY VALVE
- VACUUM BREAKER
- PRESSURE GAUGE WITH COCK
- THERMOMETER
- PIPE ANCHOR
- PIPE GUIDE
- UNION
- Y-TYPE STRAINER W/HOSE END DRAIN VALVE
- GAS PIPING
- DIRECTION OF FLOW
- PITCH PIPE UP OR DOWN
- NEW GAS METER

DUCTWORK SYMBOLS & STANDARDS

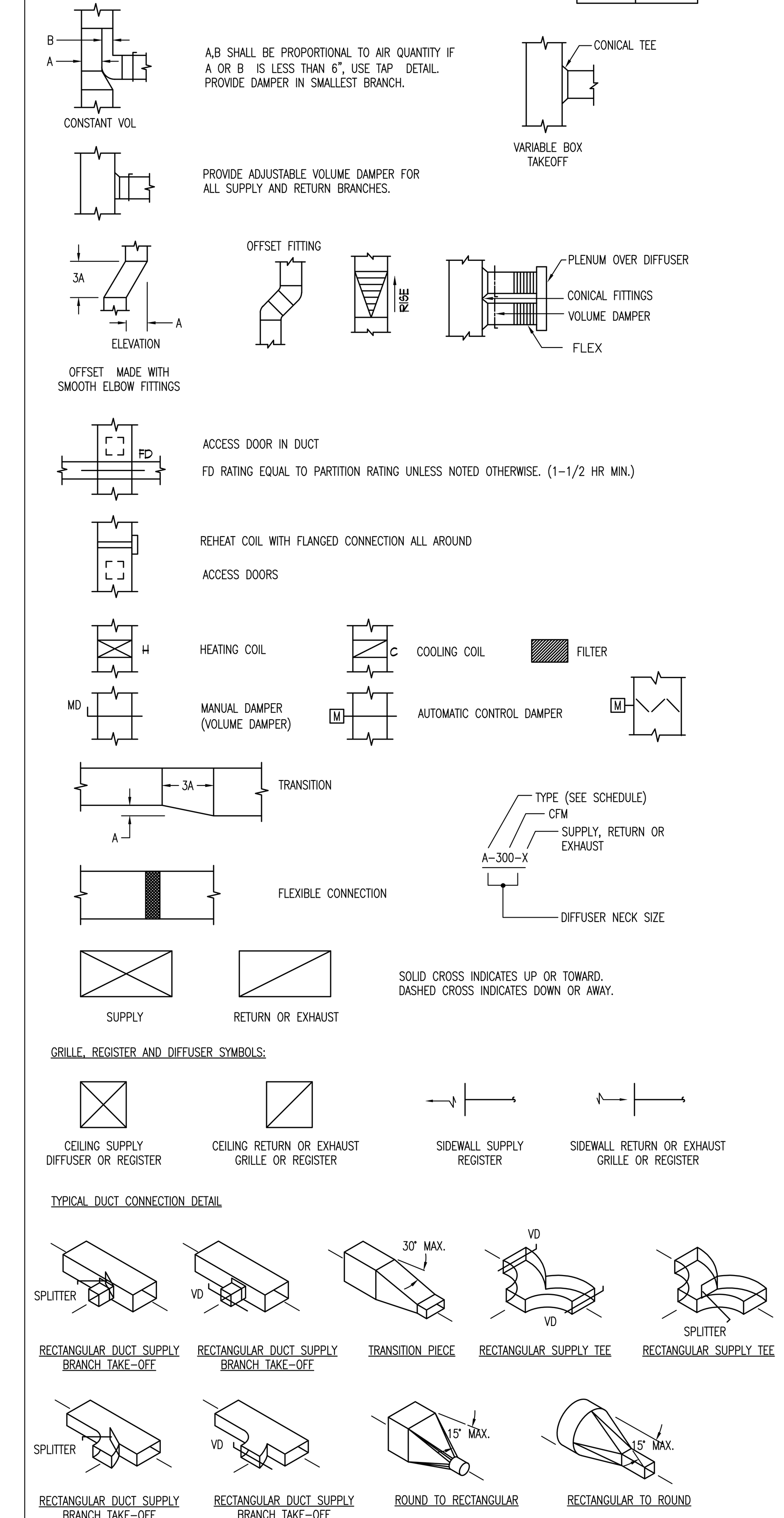


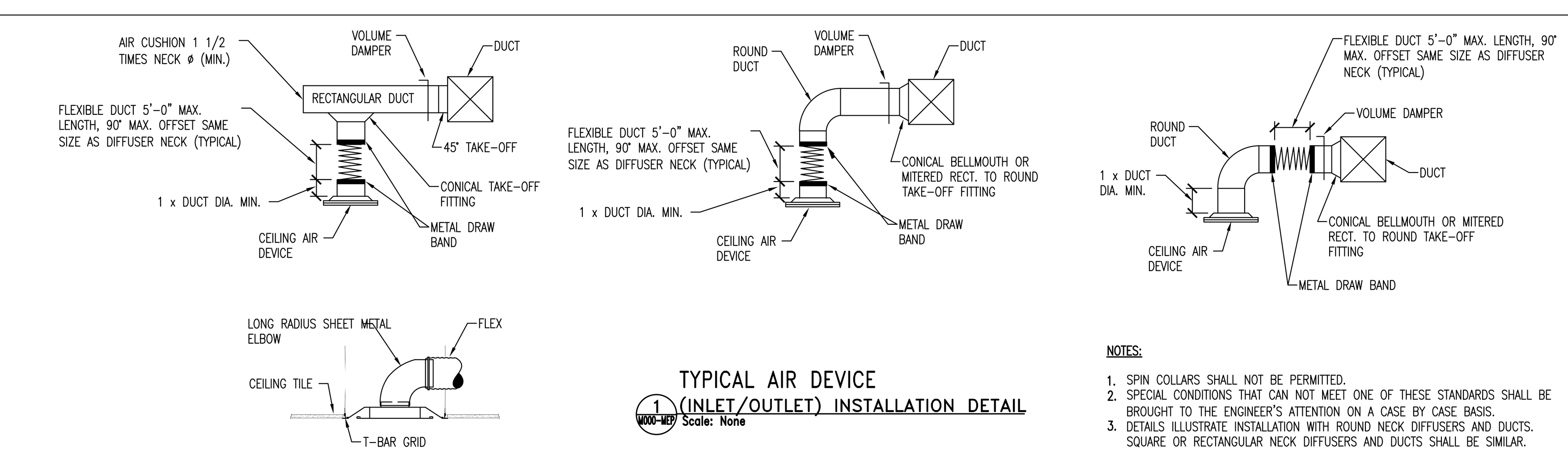
NOTE: IF R. IS LESS THAN W. THEN FULL ARC TURNING

NOTE:

1. PROVIDE STANDARD RADIUS ELBOWS WHEN POSSIBLE-SHORT RADIUS WHERE REQUIRED.
2. ALL SHORT RADIUS ELBOWS SHALL HAVE VANES. VANES SHALL BE CONSTRUCTED, SUPPORTED AND FASTENED AS RECOMMENDED BY SMACNA.
3. NO SQUARE OR RECTANGULAR HEEL ELBOWS SHALL BE ALLOWED.
4. UTILIZE FLEXIBLE DUCTS ONLY AT CONNECTIONS TO GRILLES & DIFFUSERS, AND WITH 5'-0" MAXIMUM LENGTH.

VANE SCHEDULE	
WIDTH	NO. OF VANES
< 12"	1
12"-24"	2
24"-36"	3
36"-60"	4
60"-84"	5
> 84"	6





TYPICAL AIR DEVICE (INLET/OUTLET) INSTALLATION DETAIL
1 M000-MEP Scale: None

NOTES:

1. SPIN COLLARS SHALL NOT BE PERMITTED.
2. SPECIAL CONDITIONS THAT CAN NOT MEET ONE OF THESE STANDARDS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION ON A CASE BY CASE BASIS.
3. DETAILS ILLUSTRATE INSTALLATION WITH ROUND NECK DIFFUSERS AND DUCTS. SQUARE OR RECTANGULAR NECK DIFFUSERS AND DUCTS SHALL BE SIMILAR.

AIR FLOW MEASURING DEVICE SCHEDULE

TAG	LOCATION	SYSTEM AND/OR SERVICE	AIR FLOW MIN CFM	AIR FLOW MAX CFM	DUCT SIZE WIDTH IN	DUCT SIZE HEIGHT IN	MANUFACTURER	MODEL	REMARKS
AFMS-1	RTU-8	MIN OUTSIDE AIR	2310	2310	COORD W/ RTU MFGR		EBTRON	GTx116	ALL
AFMS-2	RTU-8	PURGE OUTSIDE AIR	0	2170	COORD W/ RTU MFGR		EBTRON	GTx116	ALL
AFMS-3	RTU-8	PURGE OUTSIDE AIR	0	2170	COORD W/ RTU MFGR		EBTRON	GTx116	ALL

PROVIDE INDEPENDENT AIRFLOW / TEMPERATURE SENSORS AND TRANSMITTERS FOR EACH OF THE (3) RTU-8 OA HOODS. PROVIDE TRANSMITTERS IN NEMA 4X ENCLOSURES. PROVIDE 18" LONG SLEEVE TO BE SANDWICHED BETWEEN THE RTU OA HOOD AND UNIT INLET. PROVIDE PROBES MOUNTED INTERNAL TO THE 18" SLEEVE. PROVIDE INSTALLATION THAT IS FULLY WEATHERPROOF.

EXISTING AIR HANDLING UNIT SCHEDULE (FOR REFERENCE)

TAG	LOCATION	AREA SERVED	CFM	OUTSIDE AIR MIN	OUTSIDE AIR MAX	FAN TYPE	DRIVE	HP	VOLT	PH	HZ	SPEED CONTROL	COOLING COIL TAG	HEATING COIL	FILTERS	MANUFACTURER	MODEL	REMARKS
AHU-9	PENTHOUSE	LOCKER RMS	14620	12120	14620	PLENUM	DIRECT	2 @ 15	480	3	60	VFD	CC-9	EXIST STM 814 MBH PREHEAT & 563 MBH HOT DECK	(6) 24x24 + (2) 12x24 EACH BANK	YORK	XTI-60x102	ALL
AHU-10	PENTHOUSE	GIRL'S GYM	10540	2860	10540	PLENUM	DIRECT	2 @ 10	480	3	60	VFD	CC-10	EXIST STM 432 MBH HOT DECK	(3) 24x24 + (3) 12x24 EACH BANK	YORK	XTI-48x90	ALL
AHU-11	PENTHOUSE	BOY'S GYM	20000	6033	20000	PLENUM	DIRECT	2 @ 15	480	3	60	VFD	CC-11	EXIST STM 741 MBH HOT DECK	(8) 24x24 + (2) 12x24 EACH BANK	YORK	XTI-63x117	ALL

1. AHU'S WERE INSTALLED IN 2020.
2. FILTERS = PLEATED 2" MERV 8 PREFILTERS + 4" MERV 13 PRIMARY FILTERS.

REFRIGERATION SCHEDULE

TAG	NUMBER OF UNITS	MFGR	MODEL	DESCRIPTION	LOCATION	NO.OF COMP.	NOMINAL TONS	COMP. TYPE	REFRIGERANT TYPE	REFRIGERANT NUMBER OF CIRCUITS	REFRIGERANT LBS PER CIRCUIT	HEAT REJECTION	REMARKS
CU-9	1	YORK	YCUL0072	CONDENSING UNIT	ROOF	4	73.5	SCROLL	R-410A	2	65	AIR COOLED	ALL
CU-10	1	YORK	YCUL0045	CONDENSING UNIT	ROOF	4	41.6	SCROLL	R-410A	2	35	AIR COOLED	ALL
CU-11	1	YORK	YCUL0065	CONDENSING UNIT	ROOF	4	59.5	SCROLL	R-410A	2	50	AIR COOLED	ALL
RTU-8	1	DECTRON	DS-080-NB	DEHUMIDIFICATION	ROOF	2	14	SCROLL	R-410A	2	57.5	AIR COOLED	ALL

NOTES:

1. REFRIGERANT SAFETY VALVES SHALL BE LOCATED ON THE HIGH SIDE OF THE SYSTEM, UPSTREAM OF ANY STOP VALVES. VALVE SHALL NOT EXCEED 450 PSIG.
2. LOCATE ALL REFRIGERATION EXPANSION VALVES, CONNECTIONS, ETC. OUTSIDE THE AIR STREAM.
3. REFRIGERANT QUANTITIES INCLUDE CONDENSING UNIT, EVAPORATOR AND LINE SET.
4. ALL REFRIGERANT PIPING TO BE TYPE K COPPER WITH BRAZED JOINTS.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCA# 5031)

Title: MECHANICAL SYMBOLS, NOTES, AND ABBREVIATIONS

Sheet: M000-MEP

FAN SCHEDULE

TAG	LOCATION	SERVICE	CFM	E.S.P. IN WC	FAN				MOTOR ELECTRICAL							MANUFACTURER	MODEL	UNIT WT. (LBS)	NOTES
					FAN TYPE	RPM	DRIVE	MAX SONES	BHP	HP	VOLT	PH	HZ	FLA	SPEED CONTROL				
E-34	LINK ROOF	EQUIP RM EA	2500	0.75	ROOF	930	DIRECT	16.5	0.51	1	120	1	60	11.5	ECM	GREENHECK	G-180-VG	100	1 THRU 7
EF-35	ELECT RM C109	ELECT RM C109	165	0.25	PROPELLE	1555	DIRECT	5.7	0.03	1/15	120	1	60	1.3	ECM	GREENHECK	SE-8-440-VG	15	1,2,5,8

NOTES:

1. SELECT FAN CAPABLE OF PERFORMING 115% DESIGN AIRFLOW AT DESIGN STATIC W/ NO CHANGE IN MOTOR.
2. SUBMIT FAN CURVE SHOWING CURVES FOR DESIGN SELECTION POINT PLUS MINIMUM AND MAXIMUM FLOWS AVAILABLE WITH THE PROPOSED MOTOR SIZE & DRIVE.
3. PROVIDE SPECIAL NAMEPLATE W/ MARK, MOTOR INFORMATION, DESIGN CFM, DESIGN SP.
4. PROVIDE CURB WITH TOP 14" MINIMUM ABOVE THER ROOF SURFACE. PROVIDE HINGED BASE.
5. PROVIDE W/ DISCONNECT AND MOTORIZED DAMPER. INTERLOCK DAMPER TO OPEN WITH OPERATION OF FAN AND TO CLOSE WHEN FAN IS OFF. POWER DAMPER FROM MOTOR CCT AND PROVIDE TRANSFORMER AS REQUIRED.
6. ECM MOTOR WITH VARIABLE SPEED CONTROLLABLE THROUGH WALL MOUNTED SPEED CONTROLLER. PROVIDE W/ DISCONNECT. MAXIMUM INLET SOUND POWER IN OCTAVE BANDS 1 THRU 8: 78,75,74,69,63,61,56,51
7. PROVIDE WITH PROTECTIVE FINISH ON ALL AIRWAY COMPONENTS SUITABLE FOR CHLORINE ENVIRONMENT.
8. ECM MOTOR WITH MANUAL ADJUSTMENT FOR BALANCING PURPOSES.

AIR INLETS AND OUTLETS SCHEDULE

TAG	MANUF.	MODEL	TYPE	SERVICE	CFM RANGE	NECK SIZE	MODULE SIZE	MATERIAL	FINISH	FRAME	MAX SOUND (NC)	NOTES
A	TITUS	OMNI	ARCH. PLAQUE	SUPPLY	0 - 100	6" RD	24x24	STEEL	WHITE	LAY-IN	25	
					101 - 200	8" RD						
					201 - 375	10" RD						
					376 - 600	12" RD						
					601 - 850	14" RD						
					851 - 975	15" RD						
R	TITUS	OMNI	ARCH. PLAQUE	PLENUM RA	0 - 600	15" RD	24x24	STEEL	WHITE	LAY-IN	25	
E	TITUS	350 Z'L	0 DEGREE DEF	RET/EXH	SEE PLAN	SEE PLAN	SEE PLAN	ALUM	WHITE	SURFACE	25	

LOUVER SCHEDULE

TAG	LOCATION	SYSTEM SERVING	SERVICE	CFM	MIN FREE AREA SQ. FT.	MAX FPM THRU GROSS AREA	MAX. S.P. IN. WG	LOUVER DIMENSIONS (IN)			MANUFACTURER AND MODEL NUMBER	REMARKS
								W	H	D		
L-1	ELECT RM C109	E-35	EXHAUST	165	2.2	35	0.01	26	26	4	RUSKIN ELF-375X	ALL

1. WITH BIRD SCREEN. COORDINATE ARRANGEMENT WITH WALL CONSTRUCTION TYPE & MOUNTING.
2. PROVIDE WEATHER TIGHT INSTALLATION.

VENTILATION SCHEDULE

ROOM NO.	ROOM NAME	FLOOR AREA (SF)	ORDINANCE MECHANICAL VENTILATION SUPPLY AIR (CFM)	ORDINANCE MECHANICAL VENTILATION EXHAUST AIR (CFM)	ACTUAL MECHANICAL VENTILATION SUPPLY AIR (CFM)	ACTUAL MECHANICAL VENTILATION EXHAUST AIR (CFM)	EQUIPMENT SUPPLY	EQUIPMENT EXHAUST	NOTES / ROOM FUNCTION
C-001	VESTIBULE	595	0	0	640	440	AHU-8	RF-8	
C-002	VESTIBULE	477	0	0	480	480	AHU-8	RF-8	
	VESTIBULE	102	0	0	160	0	AHU-8	RF-8	
K-001	VESTIBULE	1115	0	0	900	700	AHU-8	RF-8	
K-002	VESTIBULE	1115	0	0	900	900	AHU-8	RF-8	
	WALKWAY LINK	848	1272	848	2100	2100	AHU-8	RF-8	PEDESTRIAN PASSAGEWAY

AIR FLOW MEASURING DEVICE SCHEDULE

TAG	LOCATION	SYSTEM AND/OR SERVICE	AIR FLOW MIN CFM	AIR FLOW MAX CFM	DUCT SIZE WIDTH IN	DUCT SIZE HEIGHT IN	MANUFACTURER	MODEL	REMARKS
AFS-L	RTU-L	OUTSIDE AIR	600	4500	COORD W RTU MFGR		EBTRON	GTx116	ALL

PROVIDE AIRFLOW / TEMPERATURE SENSORS AND TRANSMITTERS FOR RTU OA HOODS. PROVIDE TRANSMITTERS IN NEMA 4X ENCLOSURES. PROVIDE 18" LONG SLEEVE TO BE SANDWICHED BETWEEN THE RTU OA HOOD AND UNIT INLET. PROVIDE PROBES MOUNTED INTERNAL TO THE 18" SLEEVE. PROVIDE INSTALLATION THAT IS FULLY WEATHERPROOF.

ROOFTOP HVAC UNIT SCHEDULE (GAS HEATING)

TAG	SERVICE TYPE CAV	SERVICE TYPE VAV	SERVICE TYPE MULTI-ZONE (NO. OF ZONES)	LOCATION	AREA AND/OR BLDG SERVED	NOM. TONS	MIN. O.A. CFM	COOLING SECTION MIN TOTAL MBH	COOLING SECTION MIN SENS MBH	COOLING SECTION MIN IEER	COOLING SECTION EAT Db °F	COOLING SECTION EAT Wb °F	COOLING SECTION LAT Db °F	COOLING SECTION LAT Wb °F	HEATING CAPACITY OUTPUT MBH	HEATING CAPACITY STAGES	GAS INPUT MBH	GAS PRESSURE IN. W.C.	EVAPORATOR FAN CFM	EVAPORATOR FAN HP	EVAPORATOR FAN TSP IN. W.C.	EVAPORATOR FAN ESP IN. W.C.	RETURN RELIEF FAN CFM	RETURN RELIEF FAN HP	RETURN RELIEF FAN TSP IN. W.C.	RETURN RELIEF FAN ESP IN. W.C.	COMPRESSOR QTY	COMPRESSOR RLA	CONDENSER FANS QTY	CONDENSER FANS HP	COMB. AIR BLOWER HP	UNIT ELECTRICAL DATA FLA	UNIT ELECTRICAL DATA MCA	UNIT ELECTRICAL DATA MOCP	UNIT ELECTRICAL DATA SCCR	UNIT ELECTRICAL DATA VOLT	UNIT ELECTRICAL DATA PHASE	UNIT ELECTRICAL DATA HZ	OPERATING WT. (LBS) INCLUDING CURB	MANUFACTURER AND MODEL	NOTES
RTU-L		X		LINK ROOF	LINK	12.5	600	152.2	112.6	14	80	67	56.83	56	85 / 121.5	2	105 / 150	4.5 to 14	4500	5	2	1.3		0.87	0.45	0.45	2	14.6 / 6.5	1	1	1/15	36	36	50	65 KA	480	3	60	2000	TRANE YSJ150	ALL

NOTES:

1. PROVIDE GAS PRESSURE REGULATOR TO ACCOMODATE 2 PSIG BUILDING GAS PRESSURE. STAINLESS STEEL HEAT EXCHANGER AND BURNERS. THRU CURB UTILITIES.
2. MINIMUM TWO COMPRESSORS WITH INDEPENDENT CIRCUITS
3. PROVIDE 2" THICK, MERV 13 FILTERS. FAN SOUND POWER LEVELS dB IN OCTAVE BANDS 1-8: SUPPLY DISCHARGE = 85,88,80,74,70,67,67,66; RETURN = 81,80,75,68,65,62,60,59
4. PROVIDE SINGLE POINT POWER CONNECTION AND WEATHER PROOF MAIN HEAVY DUTY DISCONNECT SWITCH AND POWERED CONVENIENCE GFI OUTLET.
5. PROVIDE INSULATED ROOF CURB WITH TOP AT 14" ABOVE ROOF SURFACE.

SERIES FAN POWERED CONSTANT / VARIABLE AIR VOLUME TERMINAL UNIT SCHEDULE (HYDRONIC COIL)

TAG	LOCATION	PRIMARY AIR CFM MAX	PRIMARY AIR CFM MIN	FAN CFM	FAN ESP	DUCT SIZES INLET	DUCT SIZES OUTLET	AIR DATA PRI. EAT (DEG F)	AIR DATA LAT (DEG F)	AIR DATA MAX UNIT PD (IN WC)	MOTOR DATA HP	MOTOR DATA MCA	MOTOR DATA V	MOTOR DATA PH	MOTOR DATA HZ	MAX UNIT NC DISCHARGE	MAX UNIT NC RADIATED	WATER COIL DATA COIL EAT	WATER COIL DATA BTUH	WATER COIL DATA GPM	WATER COIL DATA EWT DEG F	WATER COIL DATA LWT DEG F	WATER COIL DATA ROWS	WATER COIL DATA MAX FACE VEL (FPM)	WATER COIL DATA MAX AIR PD IN. W.C.	WATER COIL DATA MAX WTR PD	MANUFACTURER	MODEL	NOTES
FPB-CT1	CANTER 1ST FLR	640	145	640	0.25	8	20.5x12.5	55	90	0.15	0.33	6.2	120	1	60	20	29	65	17242	2	140	123	2	700	0.08	2.5	TITUS	DTF-S-F SIZE C	ALL
FPB-CT2	CANTER 2ND FLOOR	640	145	640	0.25	8	20.5x12.5	55	90	0.15	0.33	6.2	120	1	60	20	29	65	17242	2	140	123	2	700	0.08	2.5	TITUS	DTF-S-F SIZE C	ALL
FPB-K1	KENWOOD 1ST FLOOR	900	230	1100	0.25	10	25x17.5	55	90	0.15	0.5	9.6	120	1	60	20	29	65	29365	1.9	140	109	2	700	0.08	2.5	TITUS	DTF-S-F SIZE D	ALL
FPB-K2	KENWOOD 2ND FLOOR	900	230	1100	0.25	10	25x17.5	55	90	0.15	0.5	9.6	120	1	60	20	29	65	29365	1.9	140	109	2	700	0.08	2.5	TITUS	DTF-S-F SIZE D	ALL
FPB-LK1	LINK	1050	230	1100	0.25	10	25x17.5	55	90	0.15	0.5	9.6	120	1	60	20	29	65	29365	1.9	140	109	2	700	0.08	2.5	TITUS	DTF-S-F SIZE D	ALL
FPB-LK2	LINK	1050	230	1100	0.25	10	25x17.5	55	90	0.15	0.5	9.6	120	1	60	20	29	65	29365	1.9	140	109	2	700	0.08	2.5	TITUS	DTF-S-F SIZE D	ALL

NOTES:

1. PROVIDE WITH TRANSFORMERS AND VELOCITY SENSORS. FACTORY INSTALL CONTROLLER AND ACTUATOR FURNISHED BY TEMPERATURE CONTROL CONTRACTOR. COIL PERFORMANCE BASED ON 30% PROPYLENE GLYCOL.
2. PROVIDE BOTTOM ACCESS DOOR TO SERVICE INLET FACE OF HEATING COIL.
3. PROVIDE W/ ECM MOTOR & 1" THROW AWAY FILTER AT INLET. FAN ESP DOES NOT INCLUDE COIL OR FILTER PRESSURE DROPS.

CABINET / UNIT HEATER SCHEDULE

TAG	LOCATION	MOUNTING	THERMOSTAT	UNIT SIZE	HEATING DATA MBH	GPM	WPD (FT)	EWT (°F)	LWT (°F)	EAT (°F)	FAN / MOTOR CFM	QTY	HP	ELECTRICAL V	PH	HZ	UNIT DIMENSIONS HEIGHT (IN.)	WIDTH (IN.)	DEPTH (IN.)	WEIGHT (LBS)	MANUF.	MODEL	NOTES
CUH-1	VESTIBULE C001	CEILING RECESSED	WALL	6	28.5	3	5	140	120	70	112.5	620	1	1/15	120	1	60	24	62	10	155	RITTLING	RFRC-420-06	1
CUH-2	VESTIBULE C001	CEILING RECESSED	WALL	6	28.5	3	5	140	120	70	112.5	620	1	1/15	120	1	60	24	62	10	155	RITTLING	RFRC-420-06	1

NOTES: 1. BOTTOM INLET, BOTTOM OUTLET. 30% PROPYLENE GLYCOL.

STEAM TO LIQUID HEAT EXCHANGER SCHEDULE

TAG	LOCATION	AREA AND/OR BLDG SERVED	SYSTEM AND/OR SERVICE	TYPE	WATER CONDITIONS FLOW GPM	WATER CONDITIONS EWT °F	WATER CONDITIONS LWT °F	WATER CONDITIONS WPD FT	STEAM PRESSURE CTRL VLV INLET PSIG	STEAM PRESSURE HX INLET PSIG	CONTROL VALVE LBS/HR	MANUFACTURER	MODEL	NOTES
HX-C	BLDG C W PENTHOUSE	LINK	HW HEATING COILS	SHELL & TUBE	17	120	140	4.2	5	3.0	170.0	BELL & GOSSET	SU-42-4	ALL

NOTES:

1. PROVIDE FLOOR MOUNTED SUPPORT STAND.
2. 30% PROPYLENE GLYCOL ON WATER SIDE. 170 MBH OUTPUT.

PUMP SCHEDULE

TAG	LOCATION	SERVICE	TYPE	FLUID TYPE	GPM	HEAD (FT)	MOTOR ELECTRICAL BHP	HP	RPM	VOLT	PH	HZ	SPEED CONTROL	MANUFACTURER	MODEL	NOTES
P-C1	BLGD C W PENTHOUSE	LINK HW HEATING	INLINE	30% PROP	18	80	0.9	3	3600	480	3	60	VFD	BELL & GOSSETT	e90 1AAB	ALL
P-C2	BLGD C W PENTHOUSE	LINK HW HEATING	INLINE	30% PROP	18	80	0.9	3	3600	480	3	60	VFD	BELL & GOSSETT	e90 1AAB	ALL

NOTES: 1. NON OVERLOADING MOTOR. EACH PUMP SIZED AT 100% BUILDING LOAD (1 AS STANDBY).

SIDESTREAM WATER FILTER SCHEDULE

TAG	LOCATION	SYSTEM SERVED	FLUID TYPE	CONNECTIONS INLET	CONNECTIONS OUTLET	FLOW (GPM)	PRESSURE DROP (PSI)	NUMBER OF CARTRIDGES	CARTRIDGE LENGTH	MANUFACTURER	MODEL	NOTES
SF-C	PENTHOUSE	LINK HEATING	30% PROPYLENE	2	2	1	0.25	1	10	CUNO	CT101 44152-01	ALL

NOTES:

1. 10 MICRON CARTRIDGE FILTER. BALANCE TO SCHEDULED FLOW.
2. 316 STAINLESS STEEL CONSTRUCTION WITH HOUSING DRAIN PLUG & MOUNTING BRACKET. PROVIDE UNISTRUT TYPE FRAME FOR MOUNTING.

PRESSURE FILL SYSTEM SCHEDULE

TAG	LOCATION	SYSTEM SERVED	FLUID TYPE	SYSTEM FILL PRV SETPOINT (PSIG)	TANK VOLUME (GAL)	PUMP DISCH PRESS (PSIG)	PUMP FLOW RATE (GPH)	PUMP HP	PUMP VOLT	PUMP PH	PUMP HZ	MANUFACTURER	MODEL	NOTES
PF-C	PENTHOUSE	LINK HW HEATING	30% PROP	15	55	30	10	0.5	120	1	60	BELL & GOSSETT	GMU-30	ALL

NOTES:

1. PROVIDE SIGNAGE ON THE TANK WITH THE FOLLOWING VERBIAGE: FILL TANK ONLY WITH 30% PROPYLENE GLYCOL SOLUTION"
2. MANUAL FILL, LOW LEVEL ALARM TO BAS.

EXPANSION TANK SCHEDULE

TAG	LOCATION	SIZE (IN)	CAPACITY (GALLONS)	WORKING PRESSURE	TEST PRESSURE	RELIEF VALVE PRESSURE	MAX WT FLOODED (LBS)	FLUID TYPE	MANUFACTURE	MODEL	NOTES
ET-C	PENTHOUSE	16.25 DIA X 29 L	21.7 TANK / 11.3 ACCEPT	15 PSIG	125 PSIG	50 PSIG	263	30% PROP	BELL & GOSSETT	D-40	ALL

NOTES: 1. ALL TANKS TO BE BLADDER TYPE, ASME RATED.

AIR SEPARATOR SCHEDULE

TAG	SYSTEM SERVED	PIPE SIZE	GPM	WPD (FT)	FLOODED WEIGHT	RATED WORKING PRESSURE	PHYSICAL SIZE	MANUFACTURE	MODEL	NOTES
AS-C	HOT WATER HEATING	1-1/2	18	--	20	150 PSIG	16"Hx6.625"D	BELL & GOSSETT	EAS-1-1/2	ALL

NOTES: 1. SUSPEND FROM BUILDING STRUCTURE. PROVIDE ALL SUPPORTS AND HANGERS AS REQUIRED.

REFRIGERATION SCHEDULE

TAG	NUMBER OF UNITS	MFGR	MODEL	DESCRIPTION	LOCATION	NO.OF COMP.	NOMINAL TONS	COMP. TYPE	REFRIGERANT TYPE	REFRIGERANT NUMBER OF CIRCUITS	REFRIGERANT LBS PER CIRCUIT	HEAT REJECTION	NOTES
RTU-L	1	TRANE	YSJ150	PACKAGED RTU	ROOF	2	12.5	SCROLL	R-410A	1	11.4	AIR COOLED	

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION — Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCA# 5031)

Title: MECHANICAL SCHEDULES

Sheet: M001-LNK

DEMOLITION GENERAL:

1. WHERE DEMOLITION OF MECHANICAL IS INDICATED, REMOVE ALL OBSOLETE COMPONENTS IN THEIR ENTIRETY, INCLUDING ALL ASSOCIATED INSULATION, HANGERS, SUPPORTS, RACEWAY, FITTING, ETC.
2. WHERE PIPING, RACEWAYS, ETC. ARE BEING REMOVED, FILL ALL UNUSED OPENINGS THROUGH WALLS, SLABS, CEILINGS, AIR CHAMBERS, ETC.

DEMO WORK KEYNOTES:

(1) REMOVE EXISTING SUPPLY GRILLE AND BRANCH DUCT AS INDICATED. CAP AT MAIN.

(2) REMOVE EXISTING SUPPLY GRILLE AND BRANCH DUCT AS INDICATED. PREPARE DUCTWORK FOR EXTENSION TO NEW SUPPLY GRILLE LOCATION.

(3) REMOVE EXISTING EXHAUST GRILLE AND ASSOCIATED BRANCH DUCTWORK. CAP AT MAIN.

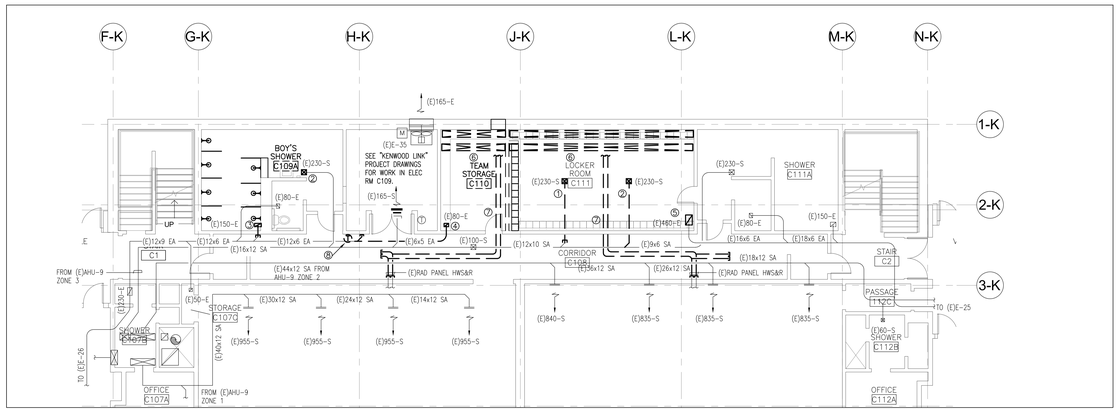
(4) REMOVE EXISTING EXHAUST GRILLE, BRANCH & MAIN DUCT TO POINT INDICATED. PREPARE FOR EXTENSION WITH LARGER DUCT.

(5) REMOVE EXISTING EXHAUST GRILLE AND SECTION OF DUCT WITH GRILLE TAP. PREPARE DUCTWORK FOR EXTENSION TO NEW EXHAUST GRILLE LOCATION.

(6) REMOVE EXISTING HOT WATER HEATING CEILING RADIANT PANELS AND ALL ASSOCIATED PIPING, VALVING, SUPPORTS, ETC.

(7) REMOVE EXISTING HOT WATER HEATING PIPING THAT IS MADE OBSOLETE BY REMOVAL OF THE RADIANT CEILING PANELS & CAP AT MAINS. FIELD VERIFY FUNCTION OF PIPING PRIOR TO START OF DEMOLITION AND DO NOT REMOVE ANY PIPING THAT IS STILL ACTIVE SERVING OTHER AREAS.

(8) REMOVE EXISTING THERMOSTAT AND ALL ASSOCIATED CABLING, TUBING, EXPOSED RACEWAY, ETC.



N 1 PARTIAL 1ST FLOOR DEMOLITION PLAN - KENWOOD (BUILDING C)

1/8" = 1'-0"

0 4' 8' 16'

Scale: 1/8" = 1'-0"

NEW WORK GENERAL:

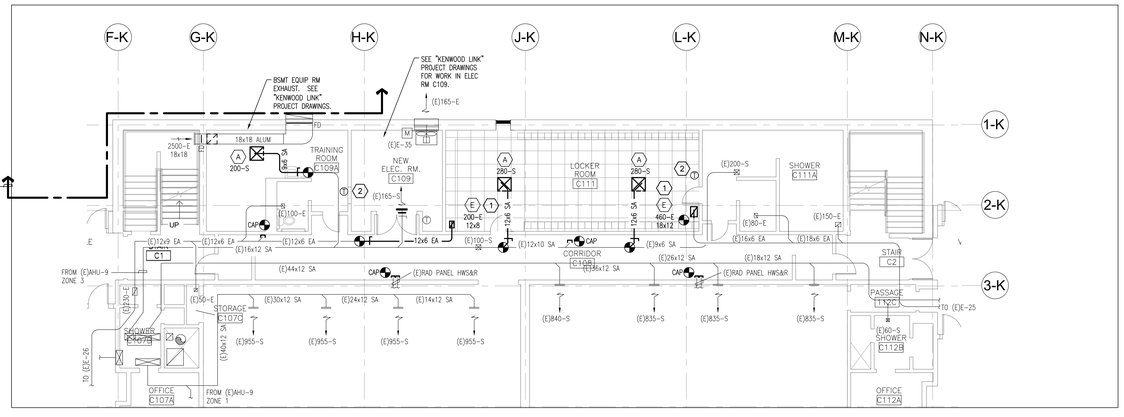
1. MAINTAIN MANUFACTURER'S RECOMMENDED SERVICE CLEARANCES AND CODE REQUIRED CLEARANCES AT ALL EQUIPMENT.
2. COORDINATE ALL WORK WITH "KENWOOD LINK" PROJECT. REFER TO "KENWOOD LINK" PROJECT DRAWINGS AND DO NOT OBSTRUCT WORK ASSOCIATED WITH THE LINK PROJECT.

NEW WORK KEYNOTES:

(1.) REPLACE EXISTING CEILING DIFFUSERS & GRILLES. MODIFY EXISTING DUCTWORK AS REQUIRED TO LOCATE THE NEW DIFFUSERS & GRILLES WITHIN THE NEW CEILING GRID.

(2.) AHU-9 ZONE 3 AVERAGING THERMOSTAT.

NEW LINK CONSTRUCTION. COORDINATE WORK IN THIS AREA WITH CONSTRUCTION OF NEW LINK. REFER TO "KENWOOD LINK" PROJECT DRAWINGS AND DO NOT OBSTRUCT WORK ASSOCIATED WITH THE LINK PROJECT.

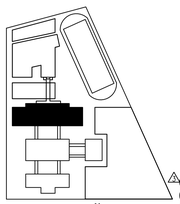


N 2 PARTIAL 1ST FLOOR PLAN - KENWOOD (BUILDING C)

1/8" = 1'-0"

0 4' 8' 16'

Scale: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION

Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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872 216 9819

Landscape Architect:
Site Design
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312 427 7240

Structural Engineer:
Milhouse Engineering, Inc.
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Chicago, IL 60604
312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: MECHANICAL FIRST FLOOR PLANS - KENWOOD (BUILDING C)

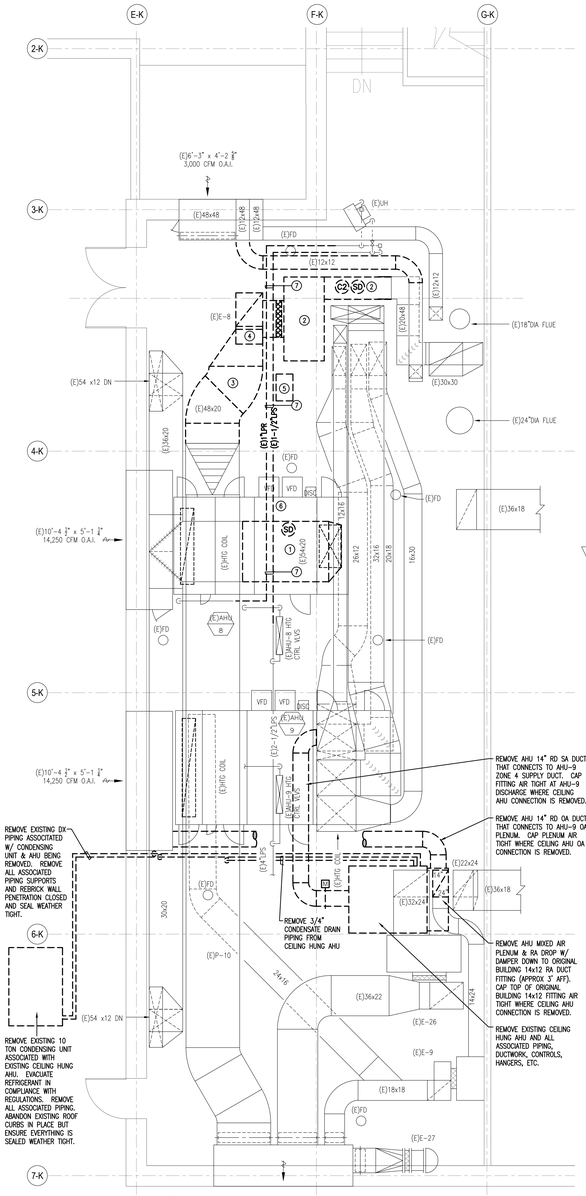
Sheet: M101-MEP

DEMOLITION GENERAL:

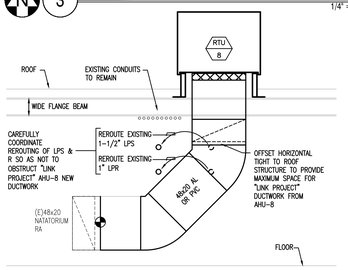
1. WHERE DEMOLITION OF MECHANICAL IS INDICATED, REMOVE ALL OBSOLETE COMPONENTS IN THEIR ENTIRETY, INCLUDING ALL ASSOCIATED INSULATION, HANGERS, SUPPORTS, RACEWAY, FITTING, ETC.
2. WHERE PIPING, RACEWAYS, ETC. ARE BEING REMOVED, FILL ALL UNUSED OPENINGS THROUGH WALLS, SLABS, CEILINGS, AIR CHAMBERS, ETC.
3. UNDER THIS PROJECT, AHU-8 IS BEING REMOVED FROM SERVICE AS THE NATATORIUM SUPPLY UNIT. EXISTING AHU-8 SUPPLY AND RETURN DUCT CONNECTIONS ARE BEING REROUTED TO A NEW ROOF MOUNTED DEHUMIDIFICATION UNIT. EXISTING AHU-8 WILL BE ABANDONED IN PLACE FOR SERVICE AS PART OF A SEPARATE PROJECT. PRIOR TO START OF DEMOLITION OF ANY EXISTING AHU-8 COMPONENTS, LOCK THE ELECTRICAL POWER OFF TO THE UNIT, VALVE OFF THE STEAM AND CONDENSATE CONNECTIONS, FULLY DRAIN THE STEAM COIL AND DISABLE THE EXISTING DDC CONTROLS. COORDINATE DISABLING OF THE CONTROLS WITH THE BAS CONTRACTOR.
4. WHERE DDC CONTROL COMPONENTS AND RACEWAY ARE SECURED TO EQUIPMENT / DUCTWORK IDENTIFIED TO BE REMOVED, ALSO REMOVE THE DDC ITEMS & RACEWAY. MINIMIZE REMOVAL OF THE EXISTING DDC COMPONENTS AND TAKE CARE SO AS TO FACILITATE REUSE OF THE UNIT AS PART OF A SEPARATE PROJECT. COORDINATE REMOVAL OF ANY DDC COMPONENTS AND RACEWAY WITH THE BAS CONTRACTOR.

DEMO WORK KEYNOTES:

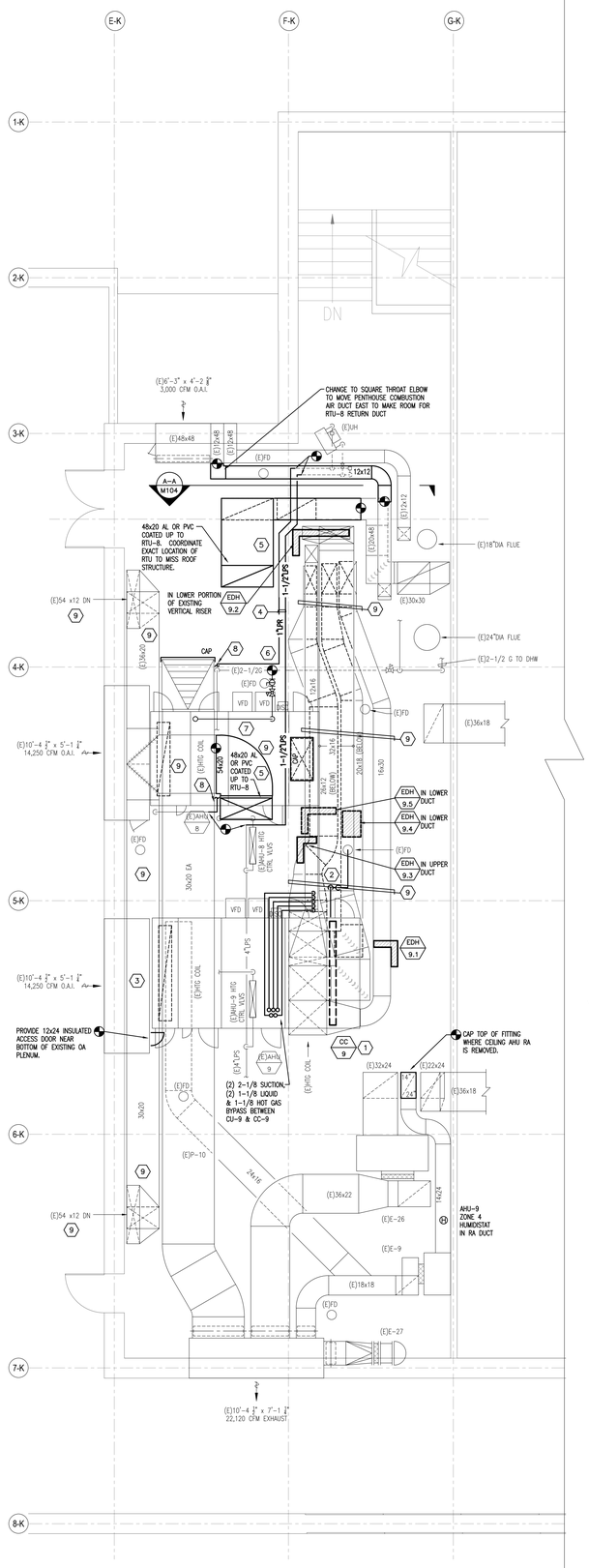
1. DISCONNECT EXISTING AHU-8 SA DUCT FROM THE UNIT DISCHARGE AND REMOVE DUCTWORK BACK TO THE LOCATION INDICATED. PREPARE FOR EXTENSION OF THE EXISTING DUCTWORK TO THE NEW ROOF MOUNTED DEHUMIDIFICATION UNIT. REMOVE EXISTING AHU-8 SA DUCT DETECTOR AND ASSOCIATED RACEWAY TO MAKE ROOM FOR THE NEW SUPPLY DUCT ROUTING. PROVIDE A CAP AT THE AHU-8 DUCT DISCHARGE CONNECTION.
2. REMOVE EXISTING E-8 RA PLENUM & ASSOCIATED DUCTWORK BACK TO THE LOCATION INDICATED. PREPARE FOR EXTENSION OF THE EXISTING DUCTWORK TO THE NEW ROOF MOUNTED DEHUMIDIFICATION UNIT. REMOVE EXISTING E-8 RA DUCT DETECTORS AND ASSOCIATED RACEWAY TO MAKE ROOM FOR THE NEW RETURN DUCT ROUTING.
3. DISCONNECT EXISTING E-8 RA DUCT FROM THE FAN DISCHARGE AND REMOVE DUCTWORK BACK TO THE LOCATION INDICATED. PROVIDE A TEMPORARY CAP ON THE REMAINING 48x20 RA DUCT.
4. REMOVE EXISTING FAN E-8 IN ITS ENTIRETY INCLUDING HOUSING, MOTOR, DRIVE, HOUSEKEEPING PAD, ETC. UPON REMOVAL OF HOUSEKEEPING PAD, REPAIR THE FLOOR AS REQUIRED TO ACHIEVE A SMOOTH FINISH.
5. REMOVE EXISTING E-8 VARIABLE FREQUENCY DRIVE AND ASSOCIATED SUPPORT GRILLAGE.
6. REROUTE & RECONFIGURE EXISTING BAS CONDUITS TO ACCOMMODATE THE NEW SA DUCT TO NEW RTU-8. RECONFIGURE ANY JUNCTION BOXES THAT WILL BE OBSTRUCTED BY THE NEW DUCTWORK.
7. REMOVE EXISTING LPS & LPR. REROUTE TO ACCOMMODATE NEW RTU-8 & ASSOCIATED DUCTWORK.



3 WEST PENTHOUSE DEMOLITION PLAN
1/4" = 1'-0"

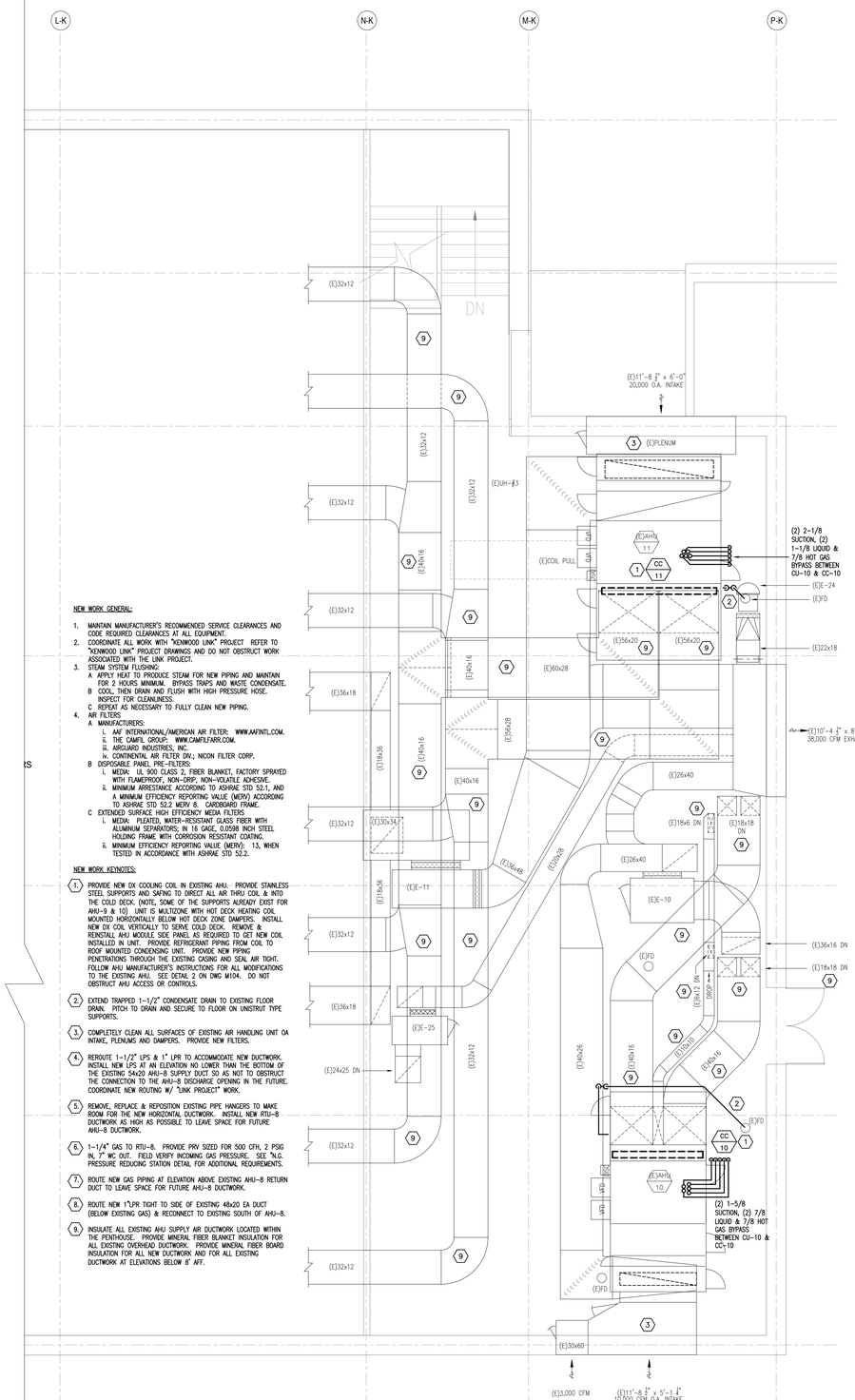


4 SECTION A-A
1/4" = 1'-0"



2 WEST PENTHOUSE PLAN - KENWOOD (BUILDING C)
1/4" = 1'-0"

Scale: 1/4" = 1'-0"



1 EAST PENTHOUSE PLAN - KENWOOD (BUILDING C)
1/4" = 1'-0"

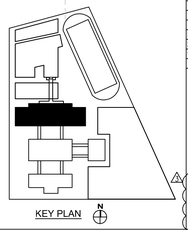
Scale: 1/4" = 1'-0"

NEW WORK GENERAL:

1. MAINTAIN MANUFACTURER'S RECOMMENDED SERVICE CLEARANCES AND CODE REQUIRED CLEARANCES AT ALL EQUIPMENT.
2. COORDINATE ALL WORK WITH "KENWOOD LINK" PROJECT REFER TO "KENWOOD LINK" PROJECT DRAWINGS AND DO NOT OBSTRUCT WORK ASSOCIATED WITH THE LINK PROJECT.
3. STEAM SYSTEM FLUSHING:
   A APPLY HEAT TO PRODUCE STEAM FOR NEW PIPING AND MAINTAIN FOR 2 HOURS MINIMUM. BYPASS TRAPS AND WASTE CONDENSATE.
   B COOL, THEN DRAIN AND FLUSH WITH HIGH PRESSURE HOSE. INSPECT FOR CLEANLINESS.
   C REPEAT AS NECESSARY TO FULLY CLEAN NEW PIPING.
4. AIR FILTERS
   A MANUFACTURERS:
      i. AAF INTERNATIONAL/AMERICAN AIR FILTER; WWW.AAFINTL.COM.
      ii. THE CAMFIL GROUP; WWW.CAMFILFARR.COM.
      iii. AIRGUARD INDUSTRIES, INC.
      iv. CONTINENTAL AIR FILTER DIV.; NICON FILTER CORP.
   B DISPOSABLE PANEL PRE-FILTERS:
      i. MEDIA: UL 900 CLASS 2, FIBER BLANKET, FACTORY SPRAYED WITH FLAMEPROOF, NON-DRIP, NON-VOLATILE ADHESIVE.
      ii. MINIMUM ARRESTANCE ACCORDING TO ASHRAE STD 52.1, AND A MINIMUM EFFICIENCY REPORTING VALUE (MERV) ACCORDING TO ASHRAE STD 52.2 MERV 8. CARDBOARD FRAME.
   C EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS:
      i. MEDIA: PLEATED, WATER-RESISTANT GLASS FIBER WITH ALUMINUM SEPARATORS, IN 16 GAGE, 0.0598 INCH STEEL HOLDING FRAME WITH CORROSION RESISTANT COATING.
      ii. MINIMUM EFFICIENCY REPORTING VALUE (MERV): 13, WHEN TESTED IN ACCORDANCE WITH ASHRAE STD 52.2.

NEW WORK KEYNOTES:

1. PROVIDE NEW DX COOLING COIL IN EXISTING AHU. PROVIDE STAINLESS STEEL SUPPORTS AND SAFING TO DIRECT ALL AIR THRU COIL & INTO THE COLD DECK. (NOTE, SOME OF THE SUPPORTS ALREADY EXIST FOR AHU-9 & 10) UNIT IS MULTIZONE WITH HOT DECK HEATING COIL MOUNTED HORIZONTALLY BELOW HOT DECK ZONE DAMPERS. INSTALL NEW DX COIL VERTICALLY TO SERVE COLD DECK. REMOVE & REINSTALL AHU MODULE SIDE PANEL AS REQUIRED TO GET NEW COIL INSTALLED IN UNIT. PROVIDE REFRIGERANT PIPING FROM COIL TO ROOF MOUNTED CONDENSING UNIT. PROVIDE NEW PIPING PENETRATIONS THROUGH THE EXISTING CASING AND SEAL AIR TIGHT. FOLLOW AHU MANUFACTURER'S INSTRUCTIONS FOR ALL MODIFICATIONS TO THE EXISTING AHU. SEE DETAIL 2 ON DWG M104. DO NOT OBSTRUCT AHU ACCESS OR CONTROLS.
2. EXTEND TRAPPED 1-1/2" CONDENSATE DRAIN TO EXISTING FLOOR DRAIN. PITCH TO DRAIN AND SECURE TO FLOOR ON UNISTRUT TYPE SUPPORTS.
3. COMPLETELY CLEAN ALL SURFACES OF EXISTING AIR HANDLING UNIT OA INTAKE, PLENUMS AND DAMPERS. PROVIDE NEW FILTERS.
4. REROUTE 1-1/2" LPS & 1" LPR TO ACCOMMODATE NEW DUCTWORK. INSTALL NEW LPS AT AN ELEVATION NO LOWER THAN THE BOTTOM OF THE EXISTING 54x20 AHU-8 SUPPLY DUCT SO AS NOT TO OBSTRUCT THE CONNECTION TO THE AHU-8 DISCHARGE OPENING IN THE FUTURE. COORDINATE NEW ROUTING W/ "LINK PROJECT" WORK.
5. REMOVE, REPLACE & REPOSITION EXISTING PIPE HANGERS TO MAKE ROOM FOR THE NEW HORIZONTAL DUCTWORK. INSTALL NEW RTU-8 DUCTWORK AS HIGH AS POSSIBLE TO LEAVE SPACE FOR FUTURE AHU-8 DUCTWORK.
6. 1-1/4" GAS TO RTU-8. PROVIDE PRV SIZED FOR 500 CFH, 2 PSIG IN, 7" WC OUT. FIELD VERIFY INCOMING GAS PRESSURE. SEE 7x7 PRESSURE REDUCING STATION DETAIL FOR ADDITIONAL REQUIREMENTS.
7. ROUTE NEW GAS PIPING AT ELEVATION ABOVE EXISTING AHU-8 RETURN DUCT TO LEAVE SPACE FOR FUTURE AHU-8 DUCTWORK.
8. ROUTE NEW 1"LPR TIGHT TO SIDE OF EXISTING 48x20 EA DUCT (BELOW EXISTING GAS) & RECONNECT TO EXISTING SOUTH OF AHU-8.
9. INSULATE ALL EXISTING AHU SUPPLY AIR DUCTWORK LOCATED WITHIN THE PENTHOUSE. PROVIDE MINERAL FIBER BLANKET INSULATION FOR ALL EXISTING OVERHEAD DUCTWORK. PROVIDE MINERAL FIBER BOARD INSULATION FOR ALL NEW DUCTWORK AND FOR ALL EXISTING DUCTWORK AT ELEVATIONS BELOW 8' AFF.



NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

Architect:
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Landscape Architect:
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333 South Wabash Avenue Suite 2901 Chicago, IL 60604 312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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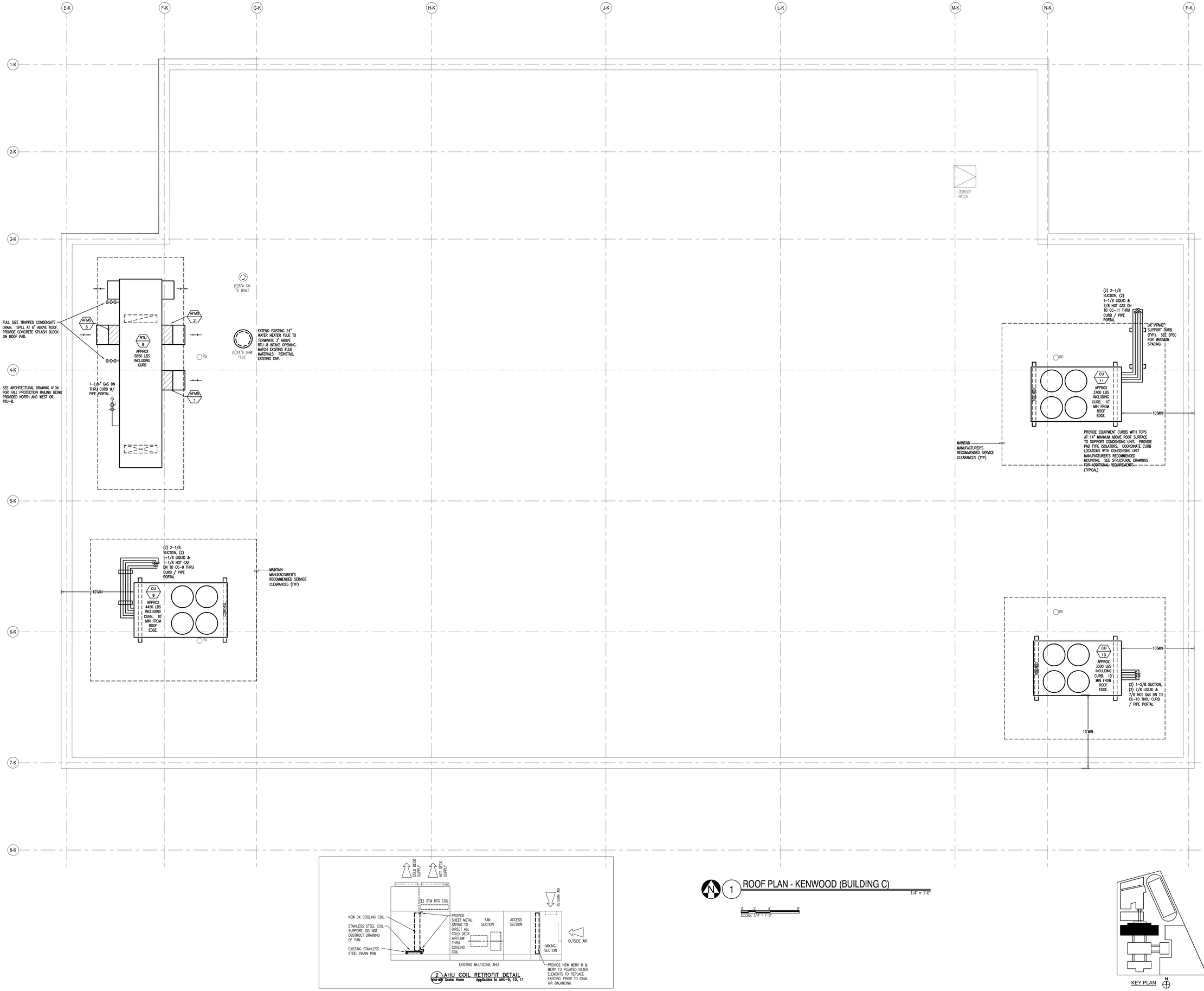
223 West Jackson Boulevard Suite 820 Chicago, IL 60606 312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title
MECHANICAL PENTHOUSE PLANS - KENWOOD (BUILDING C)

Sheet
M103-MEP



2 AHU COIL RETROFIT DETAIL
M104-MEP Scale: None Applicable to AHU-9, 10, 11

1 ROOF PLAN - KENWOOD (BUILDING C)
1/4" = 1'-0"
0 2' 4' 8'
Scale: 1/4" = 1'-0"

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

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Chicago Public Schools

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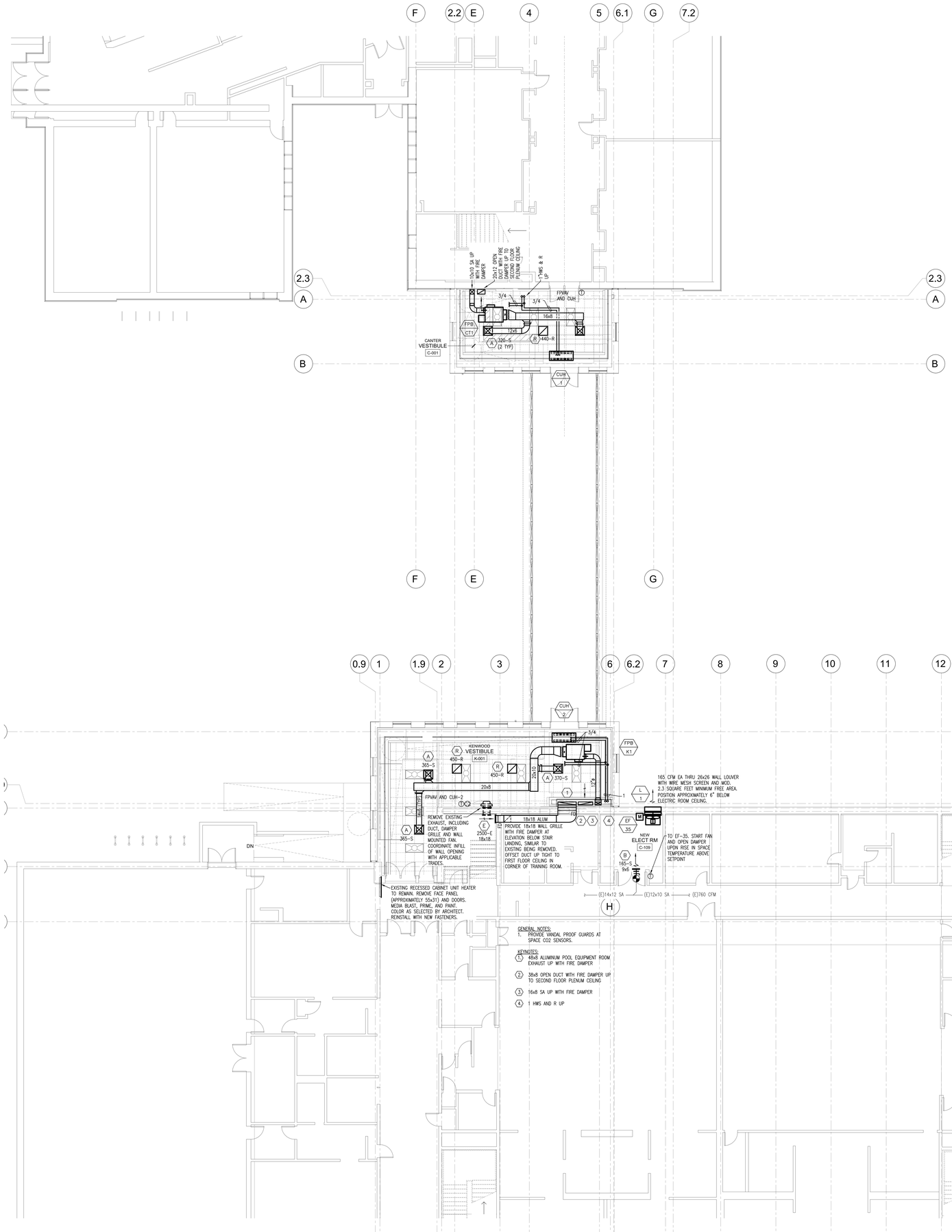
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanic
PBC Contract No: C1602R
Project No.: 05326 (MCM 8C)

Title
MECHANICAL
ROOF PLAN - KENWOOD (BUILDING C)

Sheet
M104-MEP



GENERAL NOTES:
1. PROVIDE VANDAL PROOF GUARDS AT SPACE CO2 SENSORS.

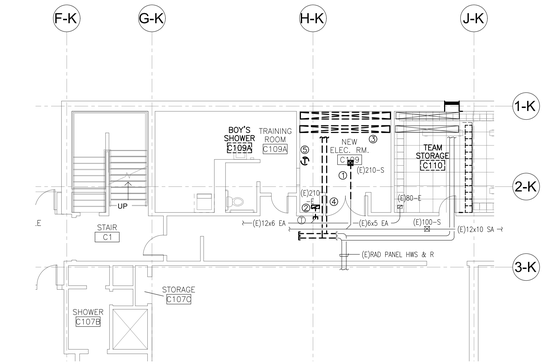
KEYNOTES:
1. 48x8 ALUMINUM POOL EQUIPMENT ROOM EXHAUST UP WITH FIRE DAMPER
2. 38x8 OPEN DUCT WITH FIRE DAMPER UP TO SECOND FLOOR PLENUM CEILING
3. 16x8 SA UP WITH FIRE DAMPER
4. 1 HWS AND R UP

1 FIRST FLOOR LINK PLAN - MECHANICAL
1/8" = 1'-0"

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

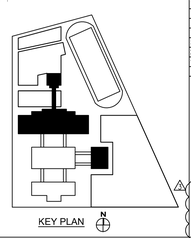
DEMOLITION GENERAL:
1. WHERE DEMOLITION OF MECHANICAL IS INDICATED, REMOVE ALL OBSOLETE COMPONENTS IN THEIR ENTIRETY, INCLUDING ALL ASSOCIATED INSULATION, HANGERS, SUPPORTS, RACEWAY, FITTINGS, ETC.
2. WHERE PIPING, RACEWAYS, ETC. ARE BEING REMOVED, FILL ALL UNUSED OPENINGS THROUGH WALLS, SLABS, CEILINGS, AIR CHAMBERS, ETC.

DEMO WORK KEYNOTES:
1. REMOVE EXISTING BRANCH SUPPLY DIFFUSER AND BRANCH AIR DUCTWORK BACK TO NEW SOUTH WALL LOCATION. PREPARE DUCT FOR INSTALLATION OF NEW FIRE DAMPER AND WALL GRILLE.
2. REMOVE EXISTING EXHAUST GRILLE AND ASSOCIATED BRANCH DUCTWORK. CAP AT MAIN.
3. REMOVE EXISTING HOT WATER HEATING CEILING RADIANT PANELS AND ALL ASSOCIATED PIPING, VALVING, SUPPORTS, ETC.
4. REMOVE EXISTING HOT WATER HEATING PIPING THAT IS MADE OBSOLETE BY REMOVAL OF THE RADIANT CEILING PANELS AND CAP AT MAINS. FIELD VERIFY FUNCTION OF PIPING PRIOR TO START OF DEMOLITION AND DO NOT REMOVE ANY PIPING THAT IS STILL ACTIVE SERVING OTHER AREAS.
5. REMOVE EXISTING THERMOSTAT AND ALL ASSOCIATED CABLING, TUBING, EXPOSED RACEWAY, ETC.



2 PARTIAL FIRST FLOOR DEMOLITION PLAN - KENWOOD (PE BUILDING C)
1/8" = 1'-0"

0 4' 8' 16'
Scale: 1/8" = 1'-0"



KEY PLAN

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Chicago Public Schools

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LINK + MECHANICAL PROJECT
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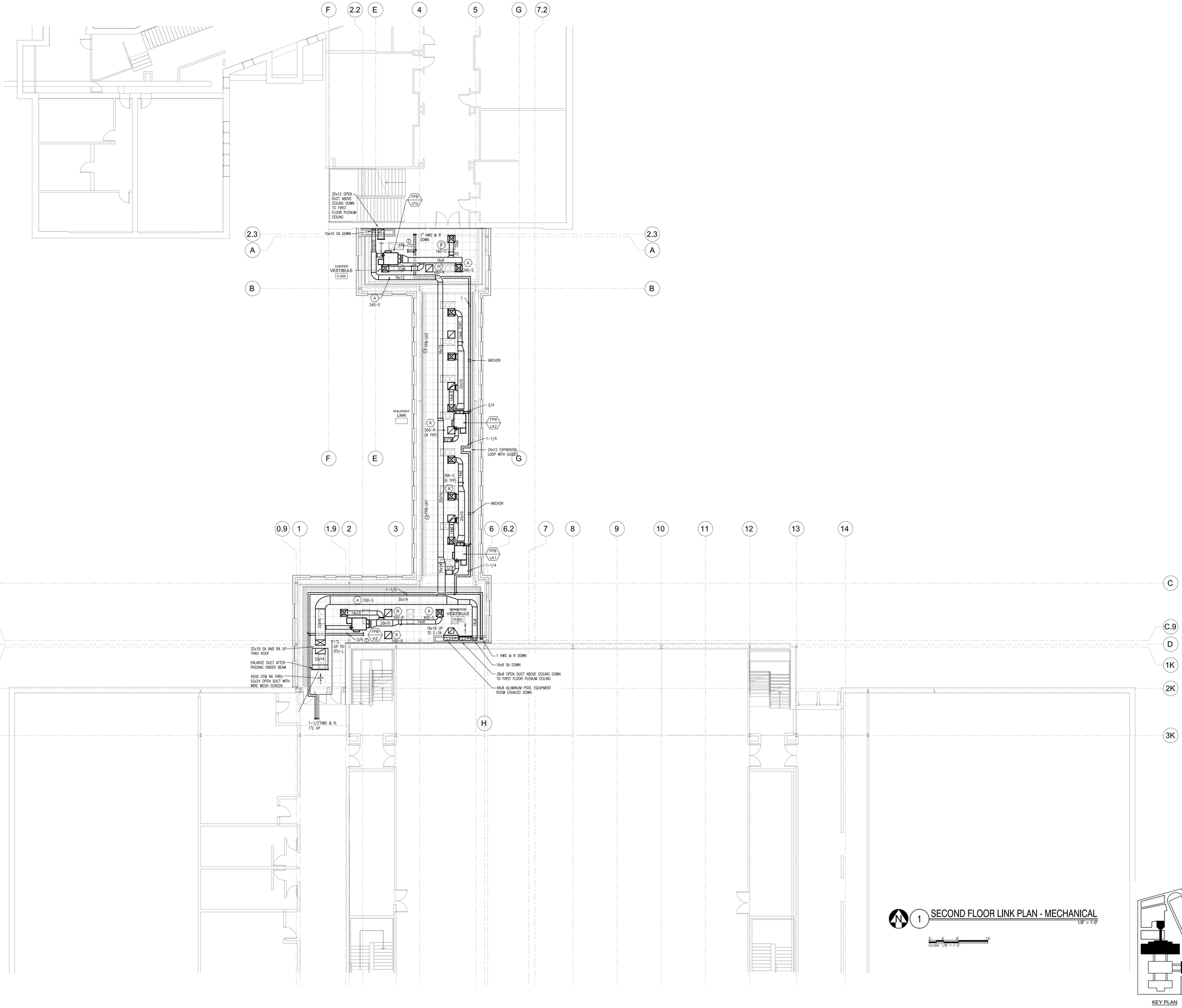
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

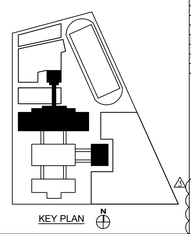
Title: FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet: M105-LNK



1 SECOND FLOOR LINK PLAN - MECHANICAL
1/8" = 1'-0"

0 4' 8' 16'
Scale: 1/8" = 1'-0"



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KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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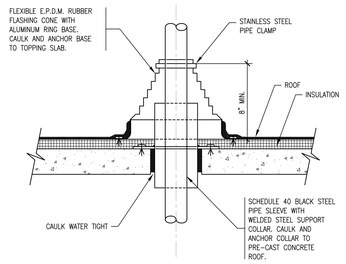
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCM 9311)

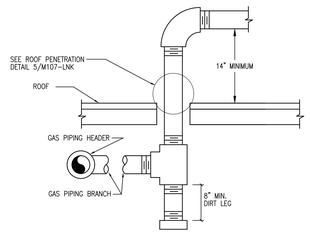
Title: SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet
M106-LNK



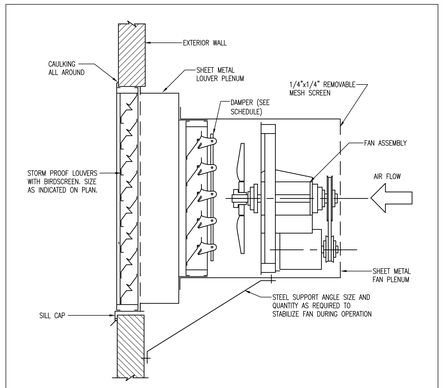
5 / M107-LNK N.T.S.

SINGLE PIPE ROOF PENETRATION DETAIL



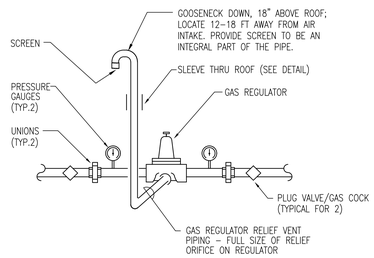
2 / M107-LNK N.T.S.

GAS PIPING AT ROOF EQUIPMENT DETAIL



3 / M107-LNK N.T.S.

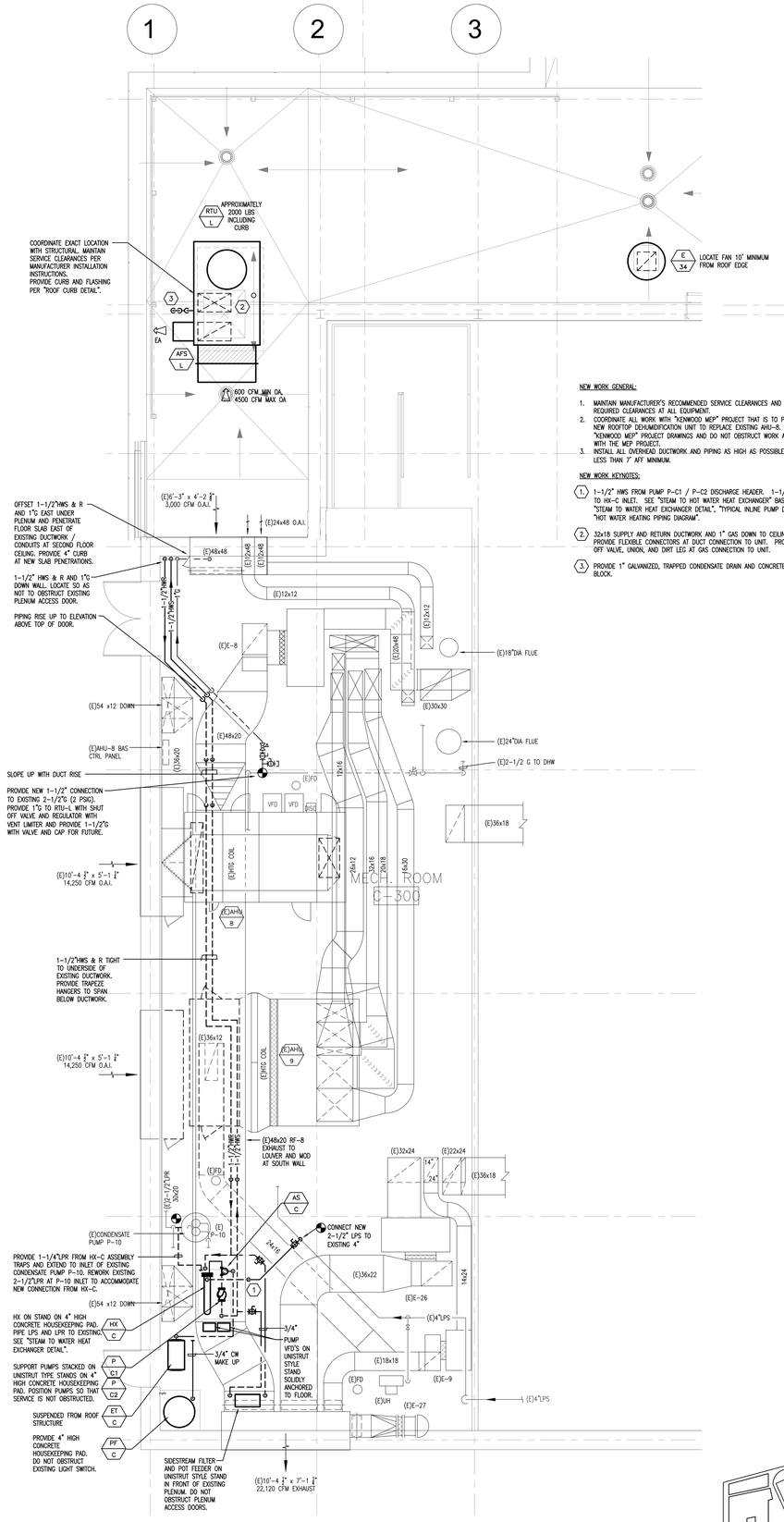
TYPICAL SIDEWALL FAN DETAIL



NOTE: REGULATOR VENT PIPING NOT REQUIRED FOR REGULATORS THAT INCLUDE VENT LIMITERS.

4 / M107-LNK NOT TO SCALE

N.G. PRESSURE REDUCING STATION DETAIL



N 1 PENTHOUSE PLAN - MECHANICAL
1/4" = 1'-0"

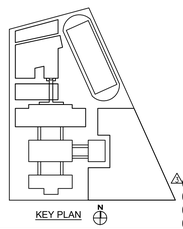
0 2" 4" 8"
Scale: 1/4" = 1'-0"

NEW WORK GENERAL:

1. MAINTAIN MANUFACTURER'S RECOMMENDED SERVICE CLEARANCES AND CODE REQUIRED CLEARANCES AT ALL EQUIPMENT.
2. COORDINATE ALL WORK WITH "KENWOOD MEP" PROJECT THAT IS TO PROVIDE A NEW ROOFTOP DEHUMIDIFICATION UNIT TO REPLACE EXISTING AHU-8. REFER TO "KENWOOD MEP" PROJECT DRAWINGS AND DO NOT OBSTRUCT WORK ASSOCIATED WITH THE MEP PROJECT.
3. INSTALL ALL OVERHEAD DUCTWORK AND PIPING AS HIGH AS POSSIBLE BUT NO LESS THAN 7' AFF MINIMUM.

NEW WORK KEYNOTES:

1. 1-1/2" HWS FROM PUMP P-C1 / P-C2 DISCHARGE HEADER. 1-1/2" HWR TO HX-C INLET. SEE "STEAM TO HOT WATER HEAT EXCHANGER" BAS DIAGRAM, "STEAM TO WATER HEAT EXCHANGER DETAIL", "TYPICAL INLINE PUMP DETAIL" AND "HOT WATER HEATING PIPING DIAGRAM".
2. 32x18 SUPPLY AND RETURN DUCTWORK AND 1" GAS DOWN TO CEILING BELOW. PROVIDE FLEXIBLE CONNECTORS AT DUCT CONNECTION TO UNIT. PROVIDE SHUT OFF VALVE, UNION, AND DIRT LEG AT GAS CONNECTION TO UNIT.
3. PROVIDE 1" GALVANIZED, TRAPPED CONDENSATE DRAIN AND CONCRETE SPLASH BLOCK.



KEY PLAN N

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KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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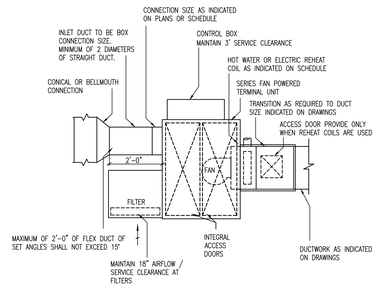
PBC Contract No: C1602R
Project No.: 05326 (MCM 9351)

Title: PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C)

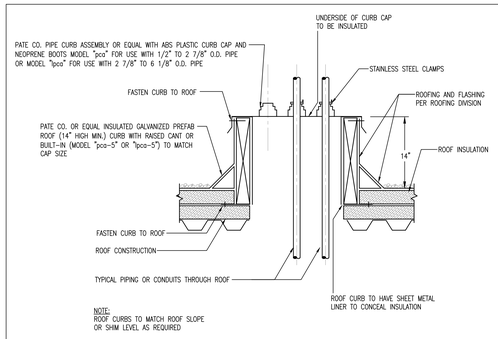
Sheet: M107-LNK



NOTE:

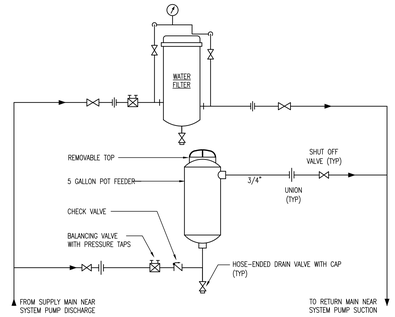
IF TOTAL LENGTH FROM MAIN TO INLET OF THE TERMINAL BOX EXCEEDS 5'-0", TRANSITION TO TWO ROUND DUCT SIZES GREATER THAN THE INLET SIZE.

1 SERIES FAN POWERED TERMINAL UNIT
M200-LNK Scale: None



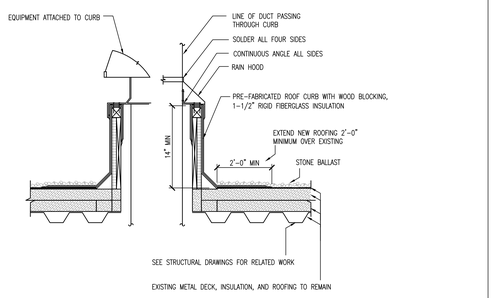
NOTE:
ROOF CURBS TO MATCH ROOF SLOPE OR SHIM LEVEL AS REQUIRED

2 PIPE PORTAL DETAIL
M200-LNK Scale: None 230529-MD-01

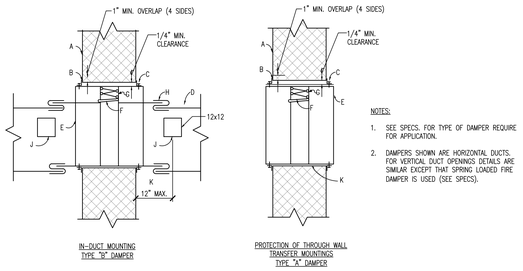


NOTE: POT FEEDER AND WATER FILTER SHALL BE SOLIDLY SUPPORTED FROM THE FLOOR OR WALL.

3 CHEMICAL POT FEEDER AND FILTER PIPING DETAIL
M200-LNK Scale: None 232500-MD-01



4 ROOF CURB DETAIL
M200-LNK Scale: None 230529-MD-10

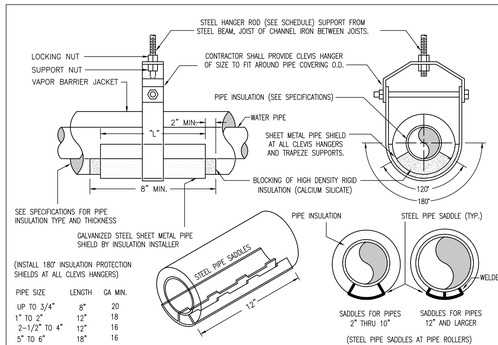


NOTES:
1. SEE SPECS. FOR TYPE OF DAMPER REQUIRE FOR APPLICATION.
2. DAMPERS SHOWN ARE HORIZONTAL DUCTS. FOR VERTICAL DUCT OPENINGS DETAILS ARE SIMILAR EXCEPT THAT SPRING LOADED FIRE DAMPER IS USED (SEE SPECS).

SYMBOLS

A-WALL
B-2"x1"x14 GAUGE RETAINING ANGLE FOR RETROFIT AND 1 1/2x1 1/2"x16 GAUGE FOR NEW WALLS
C-1/4"x20x3/4" ROUND HEAD STOVE BOLT 12" ON CENTER DUCT
D-DUCT
E-DAMPER SLEEVE, 16 GAUGE FOR DAMPERS NOT EXCEEDING 36"W OR 24"H 14 GAUGE FOR DAMPERS LONGER THAN 36"W OR 24"H
F-UNDERWRITERS LABEL LISTED FUSIBLE LINK
G-AUTOMATIC FIRE DAMPER, UNDERWRITERS LABEL LISTED, SEE SPECS.
H-BREAKAWAY CONNECTOR, "S" SLIP AROUND DUCT, MAXIMUM 4" FROM THE WALL.
J-ACCESS DOOR
K-CAULKING MINIMUM 1/4", MAXIMUM 1/2"

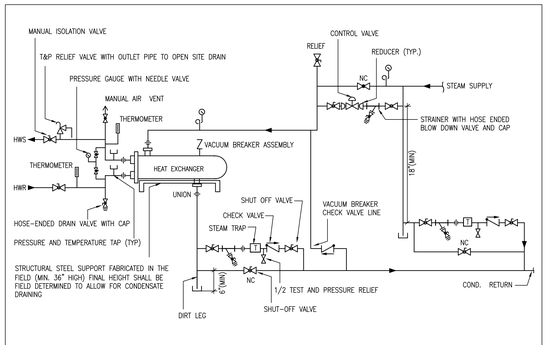
5 AUTOMATIC STATIC FIRE DAMPERS
M200-LNK Scale: None 233300-MD-02



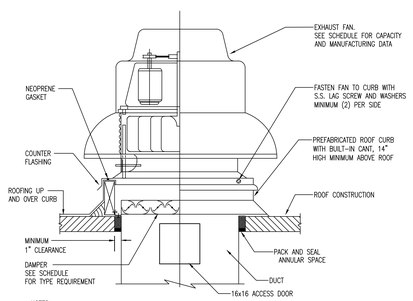
PIPE SIZE	LENGTH	GA MIN.
UP TO 3/4"	8"	20
1" TO 2"	12"	18
2-1/2" TO 4"	12"	16
5" TO 6"	18"	16

INSTALL 360° INSULATION PROTECTION SHIELDS AT ALL PIPING SECURED WITH U-BOLTS AND U-CLAMPS. PROVIDE HIGH DENSITY INSULATION SUPPORTS AT ALL CLEVIS HANGERS, SUPPORTS, AND TRAPEZE HANGERS. PROVIDE STEEL PIPE INSULATION SADDLES ON ALL PIPES SUPPORTED BY ROLLERS.

6 PIPE COVERING PROTECTION SHIELD AND PIPE SADDLES
M200-LNK Scale: None 230529-MD-16

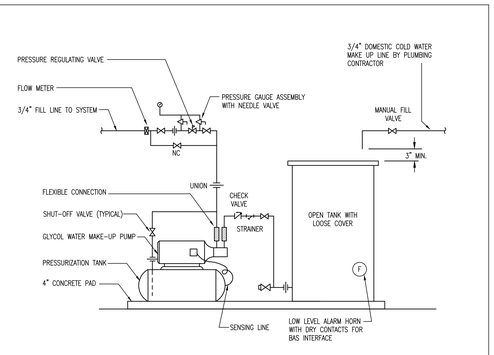


7 STEAM TO WATER HEAT EXCHANGER DETAIL
M200-LNK Scale: None

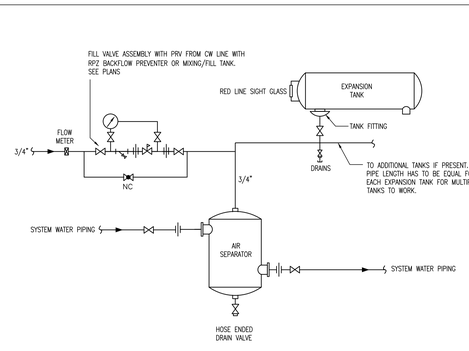


NOTES:
1. FOR CONSTRUCTION WITH INSULATION ABOVE ROOF SLAB, DECK, ETC. SUPPORT CURB DIRECTLY ON ROOF STRUCTURE.
2. COORDINATE INSTALLATION OF ROOF CURB WITH OWNER'S ROOFING CONTRACTOR TO MAINTAIN WARRANTY.

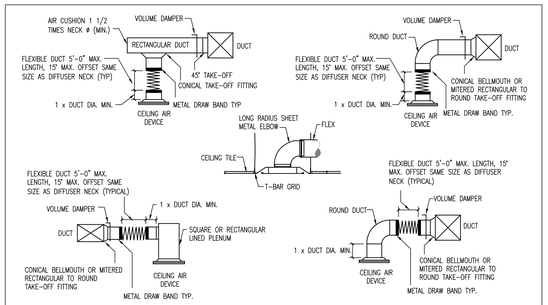
8 ROOF EXHAUST FAN DETAIL
M200-LNK Scale: None 233423-MD-01



9 BREAK/MIXING TANK ASSEMBLY DETAIL FOR GLYCOL SOLUTION
M200-LNK Scale: None 232113-MD-10

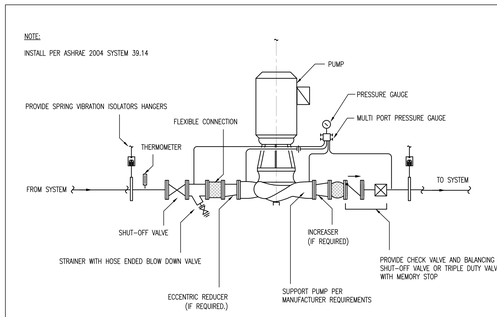


10 AIR SEPARATOR, EXPANSION TANK, AND MAKEUP PIPING DIAGRAM.
M200-LNK Scale: None 232113-MD-13A



NOTES:
1. SPIN COLLARS SHALL NOT BE PERMITTED.
2. SPECIAL CONDITIONS THAT CAN NOT MEET ONE OF THESE STANDARDS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION ON A CASE BY CASE BASIS.
3. DETAILS ILLUSTRATE INSTALLATION WITH ROUND NECK DIFFUSERS AND DUCTS. SQUARE OR RECTANGULAR NECK DIFFUSERS AND DUCTS SHALL BE SIMILAR.

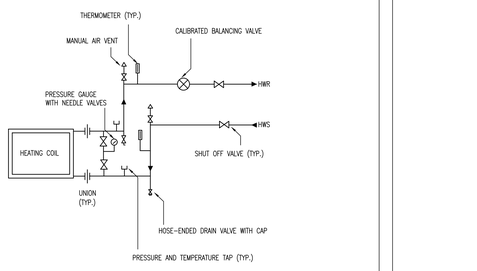
11 TYP AIR DEVICE (INLET/OUTLET) INSTALLATION DETAIL
M200-LNK Scale: None 233113-M-07



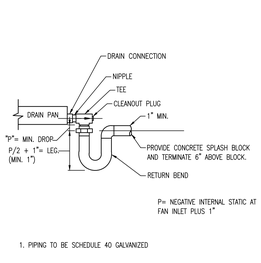
NOTE:
INSTALL PER ASHRAE 2004 SYSTEM 39.14

NOTE:
ORIENTATION OF PUMP MOTOR PER MANUFACTURER REQUIREMENTS

12 TYP IN-LINE PUMP DETAIL
M200-LNK Scale: None 232123-MD-03

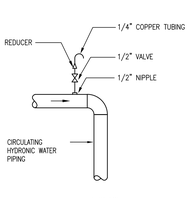


13 CABINET/SPACE HEATER HTG COIL PIPING DETAIL
M200-LNK Scale: None 232113-MD-07



1. PIPING TO BE SCHEDULE 40 GALVANIZED

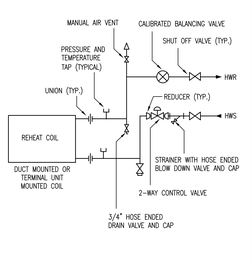
ROOF MOUNTED AHU CONDENSATE
14 DRIP PAN SEALANT PIPING DETAIL
M200-LNK Scale: None



ELEVATION

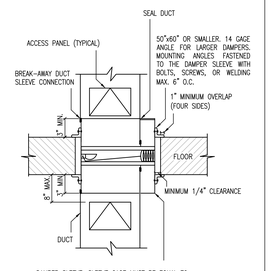
NOTES:
1. VENT ALL HIGH POINTS AS INDICATED ABOVE.
2. IF AUTOMATIC AIR VENTS ARE USED, PIPE DISCHARGE TO DRAIN.

15 TYP AIR VENT DETAIL
M200-LNK Scale: None 232113-MD-15



NOTE:
SEE DRAWINGS FOR PIPE SIZES

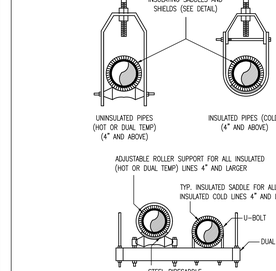
2-WAY REHEAT
16 COIL PIPING DETAIL
M200-LNK Scale: None 232113-MD-08



DAMPER SLEEVE. SLEEVE GAGE MUST BE EQUAL TO OR GREATER THAN THE DUCT CONNECTED TO IT

NOTE:
DUCT ACCESS PANEL DIMENSIONS SHALL BE THE DUCT WIDTH MINUS 2" WITH THE MAXIMUM WIDTH OF 24" AND THE HEIGHT TO BE 12"

17 FIRE DAMPER IN FLOOR
M200-LNK Scale: None 233300-MD-03



NOTE:
1. CONTRACTOR SHALL SIZE THE CHANNEL MEMBERS FOR THE LOADS TO BE SUPPORTED SO AS NOT TO EXCEED A MAXIMUM DEFLECTION OF 1/240 OF THE SPAN BETWEEN HANGER RODS
2. SEE PIPE COVERING PROTECTION SHIELD AND PIPE SADDLES. 230529-MD-16

PIPE SUPPORT AND HANGER DETAIL
18 M200-LNK Scale: None 230529-MD-04

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

PUBLIC BUILDING COMMISSION
Chicago Public Schools

Architect:
NIA ARCHITECTS, INC.
nia architects Inc
ADDRESS: 850 W. JACKSON BLVD. SUITE 600 CHICAGO, ILLINOIS 60607
PHONE: 312.431.9515
FAX: 312.431.9518
WEB: www.niaarch.com

Civil Engineer:
Engage Civil, Inc.
1 North State Street
15th Floor
Chicago, IL 60602
872 216 9819

Landscape Architect:
Site Design
888 South Michigan Avenue
Suite PH1
Chicago, IL 60605
312 427 7240

Structural Engineer:
Milhouse Engineering, Inc.
333 South Wabash Avenue
Suite 2901
Chicago, IL 60604
312 924 4584

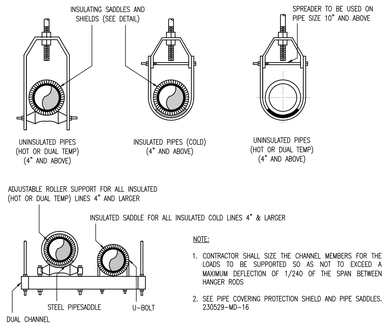
Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates, Inc.
223 West Jackson Boulevard
Suite 820
Chicago, IL 60606
312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MOM 5031)

Title
MECHANICAL DETAILS

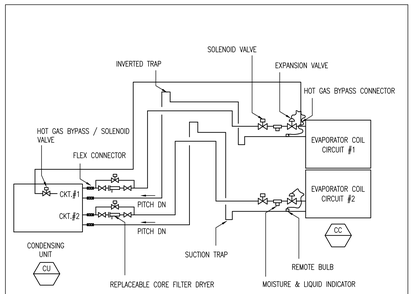
Sheet
M200-LNK



NOTE:

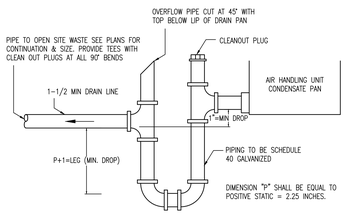
1. CONTRACTOR SHALL SIZE THE CHANNEL MEMBERS FOR THE LOADS TO BE SUPPORTED SO AS NOT TO EXCEED A MAXIMUM DEFLECTION OF 1/240 OF THE SPAN BETWEEN HANGER RODS
2. SEE PIPE COVERING PROTECTION SHIELD AND PIPE SADDLES. 230529-MD-16

1 PIPE SUPPORT AND HANGER DETAIL
M200-MEP Scale: None

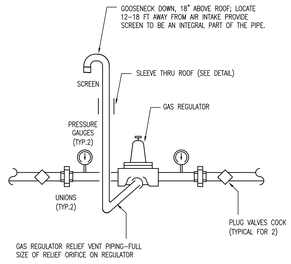


PIPE SIZING:
SEE PLANS FOR PRELIMINARY PIPE SIZING.
PIPE CONFIGURATION & SIZING TO BE VERIFIED BY EQUIPMENT MANUFACTURER.
USE ONLY LONG RADIUS ELBOWS.

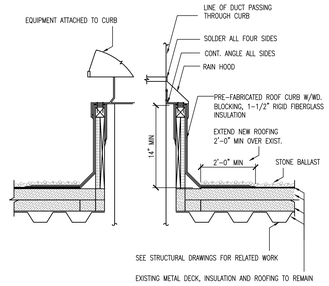
2 SPLIT SYSTEM REFRIGERANT PIPING DETAIL
M200-MEP Scale: None



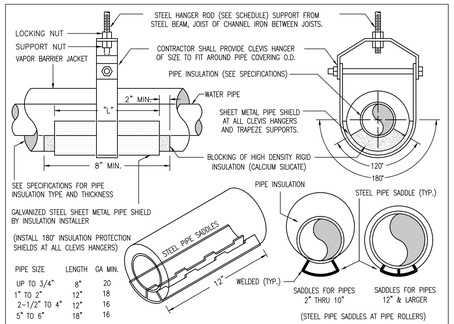
3 CONDENSATE DRIP PAN PIPING DTL FOR INDOOR USE
M200-MEP Scale: None



4 N.G. PRESSURE REDUCING STATION DETAIL
M200-MEP Scale: None



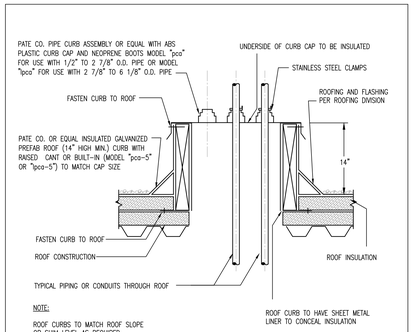
5 ROOF CURB DETAIL
M200-MEP Scale: None



PIPE SIZE	LENGTH	GA MIN.
UP TO 3/4"	8"	20
1" TO 2"	12"	18
2-1/2" TO 4"	12"	16
5" TO 6"	18"	16

INSTALL 360° INSULATION PROTECTION SHIELDS AT ALL PIPING SECURED WITH U-BOLTS AND U-CLAMPS. PROVIDE HIGH DENSITY INSULATION SUPPORTS AT ALL CLEVIS HANGERS, SUPPORTS AND TRAPEZE HANGERS. PROVIDE STEEL PIPE INSULATION SADDLES ON ALL PIPES SUPPORTED BY ROLLERS.

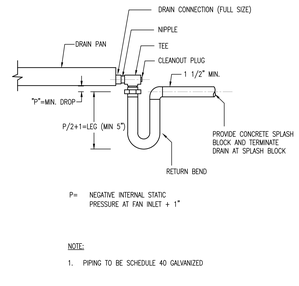
6 PIPE COVERING PROTECTION SHIELD & PIPE SADDLES
M200-MEP Scale: None



NOTE:

ROOF CURBS TO MATCH ROOF SLOPE OR SHIM LEVEL AS REQUIRED

7 PIPE PORTAL DETAIL
M200-MEP Scale: None

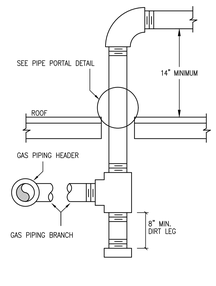


P= NEGATIVE INTERNAL STATIC PRESSURE AT FAN INLET + 1"

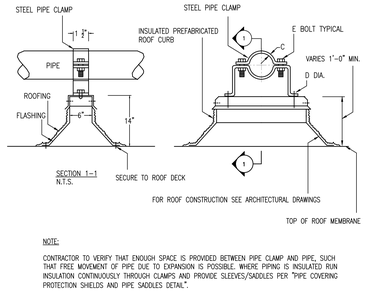
NOTE:

1. PIPING TO BE SCHEDULE 40 GALVANIZED

8 ROOF MOUNTED AHU CONDENSATE PAN SEALANT PIPING DTL
M200-MEP Scale: None



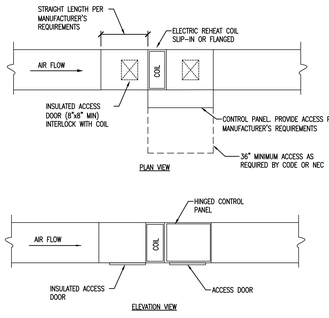
9 GAS PIPING AT ROOF EQUIPMENT DETAIL
M200-MEP Scale: None



NOTE:

CONTRACTOR TO VERIFY THAT ENOUGH SPACE IS PROVIDED BETWEEN PIPE CLAMP AND PIPE, SUCH THAT FREE MOVEMENT OF PIPE DUE TO EXPANSION IS POSSIBLE. WHERE PIPING IS INSULATED RUN INSULATION CONTINUOUSLY THROUGH CLAMPS AND PROVIDE SLEEVES/SADDLES PER "PIPE COVERING PROTECTION SHIELDS AND PIPE SADDLES DETAIL".

10 ROOF PIPING SUPPORT DETAIL
M200-MEP Scale: None



NOTE:
COORDINATE BOTTOM OR SIDE MOUNTED PANEL WITH FIELD CONDITIONS.

11 TYPICAL DUCT CONNECTION TO ELECTRIC REHEAT COIL
M200-MEP Scale: None

VENTILATION SCHEDULE

ROOM NO.	ROOM NAME	FLOOR AREA (SF)	ORDINANCE MECHANICAL VENTILATION SUPPLY AIR (CFM)	ORDINANCE MECHANICAL VENTILATION EXHAUST AIR (CFM)	ACTUAL PROVIDED MECHANICAL VENTILATION SUPPLY AIR (CFM)	ACTUAL PROVIDED MECHANICAL VENTILATION EXHAUST AIR (CFM)	EQUIPMENT SUPPLY	EQUIPMENT EXHAUST	REMARKS/ROOM FUNCTION
KENWOOD									
C-101	POOL	3113	6226	4670	6500	6650	RTU-8	RTU-8	DECK AREA
C-101A	STORAGE	178	NR	NR	--	100	--	(E)E-26	INACTIVE STORE
RTU-8 SYSTEM TOTALS			6226	4670	6500	6750			
			2075	CFM MIN OA					
ZONE 1									
C-107	BOY'S LOCKER	2308	692	2770	3820	2770	AHU-9	(E)E-26	LOCKER ROOM
C-107A	OFFICE	280	168	84	280	230	AHU-9	(E)E-26	OFFICE
C-107C	STORAGE	11	NR	NR	--	50	--	(E)E-26	INACTIVE STORE
C-107E	TOWEL	50	NR	NR	50	--	AHU-9	--	INACTIVE STORE
C-107F	DRYING	201	NR	NR	--	105	--	(E)E-26	INACTIVE STORE
C-107H	TOILET	180	NR	360	--	360	--	(E)E-26	TOILET
C-107J	SHOWER	524	NR	NR	--	480	--	(E)E-26	SHOWER
C-107K	DRYING	201	NR	NR	--	105	--	(E)E-26	INACTIVE STORE
ZONE 2									
C-108	CORRIDOR	1100	NR	NR	250	0	AHU-9	--	CORRIDOR
C-112	GIRL'S LOCKER	2200	660	2640	3350	2640	AHU-9	(E)E-25	LOCKER ROOM
C-112A	OFFICE	136	82	50	100	XFER	AHU-9	--	OFFICE, 100 CFM XFER TO C-112
C-112B	SHOWER	90	NR	NR	50	100	AHU-9	(E)E-25	SHOWER
C-112D	JANITOR'S CLOSET	11	NR	NR	--	50	--	(E)E-25	JANITOR'S CLOSET
C-112E	TOWELS	80	NR	NR	50	0	AHU-9	--	INACTIVE STORE
C-112F	TOILET	165	NR	330	--	330	--	(E)E-25	TOILET
C-112G	SHOWER	165	NR	NR	--	160	--	(E)E-25	SHOWER
C-112J	SHOWER	125	NR	NR	--	100	--	(E)E-25	SHOWER
C-112K	STORAGE	64	NR	NR	--	60	--	(E)E-25	INACTIVE STORE
C-112L	SHOWER	165	NR	NR	--	160	--	(E)E-25	SHOWER
C-114	TOILET	100	NR	200	--	200	--	(E)E-25	TOILET
C-115	TOILET	112	NR	224	--	240	--	(E)E-25	TOILET
ZONE 3									
C-108	CORRIDOR	630	NR	NR	100	--	AHU-9	--	CORRIDOR
C-109	ELECTRIC ROOM	175	NR	NR	165	165	AHU-9	E-35	
C-109A	TRAINER	247	148	74	200	XFER	AHU-9	--	OFFICE, 100 CFM XFER TO C-109C
C-109C	TOILET	39	NR	78	--	100	--	(E)E-26	TOILET
C-111	LOCKER	550	165	660	560	660	AHU-9	(E)E-25 & 26	LOCKER
C-111A	DRYING	105	50	126	200	XFER	AHU-9	--	LOCKER, 150 CFM XFER TO 111B
C-111B	SHOWER	144	NR	NR	--	150	--	(E)E-25	SHOWER
C-111C	TOILET	40	NR	80	--	80	--	(E)E-25	TOILET
ZONE 4									
C-200	CORRIDOR	1080	NR	NR	440	0	AHU-9	--	CORRIDOR
C-201	DRIVER'S ED / HEALTH	900	1350	675	1350	1250	AHU-9	(E)E-9	CLASSROOM
C-201A	STORAGE	56	NR	NR	--	50	--	(E)E-26	INACTIVE STORE
C-202	TOILET	198	NR	396	--	400	--	(E)E-26	TOILET
C-203	TOILET	198	NR	396	--	400	--	(E)E-26	TOILET
C-206A	PE STORAGE	436	NR	NR	190	190	AHU-9	(E)E-26	INACTIVE STORE
C-237	DRIVER'S ED / HEALTH	885	1328	664	1350	1250	AHU-9	(E)E-9	CLASSROOM
ZONE 5									
C-100	CORRIDOR	1080	NR	NR	250	0	AHU-9	--	CORRIDOR
C-101B	LAUNDRY	80	120	120	120	120	AHU-9	DRYER	LAUNDRY
C-102	BOY'S LOCKER	535	161	642	820	XFER	AHU-9	--	LOCKER, 820 CFM XFER TO 102C,E,F
C-102A	VESTIBULE	112	NR	NR	0	60	AHU-9	(E)E-26	CORRIDOR
C-102B	OFFICE	71	50	50	60	XFER	AHU-9	--	OFFICE, 60 CFM XFER TO 102A
C-102C	TOILET	51	NR	102	--	120	--	(E)E-26	TOILET
C-102E	SHOWER	173	NR	NR	--	650	--	(E)E-26	SHOWER
C-102F	TOILET	14	NR	50	--	50	--	(E)E-26	TOILET
C-105	OFFICE	100	60	50	60	XFER	AHU-9	--	OFFICE, 60 CFM XFER TO CORRIDOR
C-105	GIRL'S LOCKER	535	161	642	820	XFER	AHU-9	--	LOCKER, 520 CFM XFER TO 105C,E
C-105A	VESTIBULE	112	NR	NR	0	60	AHU-9	(E)E-26	CORRIDOR
C-105B	OFFICE	71	50	50	60	XFER	AHU-9	--	OFFICE, 60 CFM XFER TO 105A
C-105C	TOILET	51	NR	102	--	120	--	(E)E-26	TOILET
C-105E	GIRL'S SHOWER	173	173	173	XFER	700	--	(E)E-26	SHOWER, 700 CFM XFER FROM 105
AHU-9 SYSTEM TOTALS			5417	11837	14695	14715			
			12195	CFM MIN OA					
C-116	GIRL'S GYM	6776	5421	--	10000	10000	AHU-10	(E)E-10	GYMNASIUM, NOTE 1
C-200A	CORRIDOR EAST	1080	NR	NR	440	--	AHU-10	--	
C-207B	PE EQUIPMENT	514	NR	NR	50	50	AHU-10	(E)E-25	INACTIVE STORAGE
C-208	STORAGE	241	NR	NR	50	--	AHU-10	--	INACTIVE STORAGE
C-210	JANITOR'S CLOSET	130	NR	260	--	260	--	(E)E-25	JANITOR'S CLOSET
AHU-10 SYSTEM TOTALS			5421	0	10540	10050			
			2860	CFM MIN OA					
C-206	BOY'S GYM	9050	18100	13575	20000	20000	AHU-11	(E)E-11	GYMNASIUM
AHU-11 SYSTEM TOTALS			18100	13575	20000	20000			
			6033	CFM MIN OA					
TOILET EXHAUST TOTALS						4470	(E)E-25		
						7560	(E)E-26		

NOTE 1 EXISTING TO REMAIN GYMNASIUM AIR HANDLING SYSTEM COMPLIES WITH 1968 CODES IN EFFECT AT THAT TIME. (MINIMUM SUPPLY AIR = 0.8 CFM / SF)

ROOFTOP HVAC UNIT SCHEDULE (GAS HEATING)

TAG	SERVICE TYPE CAV	VAV	MULTI-ZONE NO. OF ZONES	LOCATION	AREA AND/OR BLDG SERVED	NOMINAL TONS	MIN O.A. CFM.	COOLING SECTION MIN TOTAL MBH	MIN SENS MBH	MIN SEER/EER	EAT Db °F	EAT Wb °F	LAT Db °F	LAT Wb °F	HEATING CAPACITY MIN. OUTPU T MBH	STAGES	GAS INPUT MBH	GAS PRESSURE INCH W.C.	EVAPORATOR FAN CFM	HP	TSP IN. W.C.	ESP IN. W.C.	EXHAUST/PURGE FAN CFM	HP	TSP IN. W.C.	ESP IN. W.C.	COMPRESSOR QTY	TONS	CONDENSER FANS QTY	HP	UNIT ELECTRICAL DATA FLA	MCA	MOCP	SCCR	V/PH/HZ	OPERATING WT (LBS)	BASED DESIGN ON DECTRON MODEL NUMBER	REMARKS
RTU-8	X			PENTHOUSE ROOF	NATATORIUM	16	2100	203.6	113.8		82	71.4	58.1	57.5	400	MODULATING	500	7 TO 14	6500	5.4		1.5	2310/ 4340	3.2/ 3.9		0.5	2	16 TOTAL	2	1.5	39.3	43	50	65 KA	480/3/60	6850 W/CURB	DS-080-NB-X-P4FB2602G2E5AD0H	ALL

REMARKS:

1. PROVIDE UNIT SPECIFICALLY DESIGNED FOR POOL DEHUMIDIFICATION W/ HOT GAS REHEAT (254 MBH). DEHUMIDIFICATION SEQUENCE CONTROLS AND AIR ECONOMIZER. 83.2 LBS / HR MOISTURE REMOVAL CAPACITY.
2. PROVIDE 2" MERV 13 PLEATED FILTERS ON RETURN & OUTSIDE AIR. FAN SOUND POWER LEVELS dB IN OCTAVE BANDS 1-8: SUPPLY DISCHARGE 77.81,89,86,83,78,73,71; MIN EXHAUST INLET 65,75,72,67,62,63,56,52; PURGE EXHAUST INLET 80,80,83,81,74,71,68,77
3. PROVIDE SINGLE POINT MAIN POWER CONNECTION AND WEATHER PROOF NON FUSED DISCONNECT. PROVIDE TERMINALS FOR SEPARATE 120 V, 1 PH CONNECTION FOR LIGHTS AND CONVENIENCE RECEPTACLE. CHICAGO CODE COMPLIANT REFRIGERANT RELIEFS.
4. PROVIDE ROOF CURB WITH TOP 14" MINIMUM ABOVE ROOF SURFACE. PROVIDE SWITCHED LED SERVICE LIGHTS IN ACCESSIBLE SECTIONS OF THE UNIT.
5. EVAPORATOR COIL AIRFLOW = TOTAL SUPPLY - OUTSIDE AIR. OUTSIDE AIR IS INTRODUCED DOWNSTREAM OF EVAPORATOR COIL. DURING PURGE MODE BOTH EXHAUST & PURGE FAN OPERATE SIMULTANEOUSLY.
6. PROVIDE GLYCOL HEAT RECOVERY LOOP ON OA / EA. 1/4 HP RECIRCULATING LOOP PUMP, 33% PROPYLENE GLYCOL, ASSOCIATED VALVES, EXPANSION TANK, ETC. PERFORMANCE: 2310 CFM EA, 2100 CFM OA, HEATING: OA -5.7 EAT / 41.6 LAT, 107 MBH

AIR COOLED CONDENSING UNIT SCHEDULE

TAG	LOCATION	UNIT SERVED	AMB. TEMP. DEG F	REJECTION CAPACITY BTUH	COMPRESSOR DATA TYPE	COMPRESSOR DATA QTY/ TONS	COMPRESSOR DATA REFRIG	COMPRESSOR DATA STEPS	CONDENSER FAN QTY	CONDENSER FAN FLA EA.	CONDENSER FAN CFM TOTAL	ELECTRICAL DATA MCA	MOCP	SCCR	VOLT	PH	HZ	UNIT WEIGHT (LBS)	MANUFACTURER	MODEL	EER	REMARKS
CU-9	PENTHOUSE ROOF	AHU-9	95	942840	SCROLL	6 / 13	R454B	5% HGB	4	2		160.4	175	65 KA	480	3	60	4000	YORK	YLUA0078ZJA6	11.36	1-4
CU-10	PENTHOUSE ROOF	AHU-10	95	468800	SCROLL	2 / 20	R410A	5% HGB	4	2.9		82.6	90	65 KA	480	3	60	2500	YORK	YD480A4GAB2	11.05	1-3,5
CU-11	PENTHOUSE ROOF	AHU-11	95	942840	SCROLL	6 / 13	R454B	5% HGB	4	2		160.4	175	65 KA	480	3	60	4000	YORK	YLUA0078ZJA6	10.8	1-3,6

REMARKS:

1. PROVIDE "PATE" TYPE CURB & CAP WITH TOP AT 14" ABOVE ROOF SURFACE FOR ROUTING OF REFRIGERANT PIPING, POWER AND CONTROL WIRING.
2. PROVIDE EQUIPMENT CURBS WITH TOPS AT 14" ABOVE ROOF SURFACE WITH WEATHERPROOF CAPS COORDINATED WITH ROOFING AND SECURE UNIT TO CURBS. SCHEDULED UNIT WEIGHT INCLUDES CURBS.
3. PROVIDE WITH SINGLE POINT CIRCUIT BREAKER POWER CONNECTION, BACNET INTERFACE, CHICAGO CODE COMPLIANT RELIEFS, HOT GAS BYPASS, (2) INDEPENDENT REFRIGERANT CCTS, ACOUSTIC SOUND BLANKETS & LOW SOUND FANS.
4. CU-9: 12.3 EER MINIMUM. MAXIMUM SOUND POWER LEVELS AT OCTAVE BANDS 1 THROUGH 8: 97,96,92,93,89,87,83,78
5. CU-10: 9.8 EER MINIMUM. MAXIMUM SOUND POWER LEVELS AT OCTAVE BANDS 1 THROUGH 8: 90,93,91,89,87,84,80,75
6. CU-11: 9.5 EER MINIMUM. MAXIMUM SOUND POWER LEVELS AT OCTAVE BANDS 1 THROUGH 8: 99,96,97,96,90,87,82,79

DX COOLING COIL SCHEDULE

TAG	AHU SERVING	LOCATION	CFM	FACE AREA SQ FT	COIL DATA QTY	COIL DATA TYPE	COIL DATA H (IN.)	COIL DATA L (IN.)	COIL DATA MIN ROWS	COIL DATA MAX FPI	COIL DATA REFRIG	MAX FACE VEL. (FPM)	MAX AIR PD (IN. WC.)	EAT Db °F	EAT Wb °F	LAT Db °F	LAT Wb °F	SUCTION TEMP °F	TOTAL CAP MBH	SENS CAP MBH	MANUFACTURER AND MODEL NUMBER	REMARKS
CC-9	LOCKER RMS	PENTHOUSE	12000	29.8	1	DX	48.25	89	5	12	R-410A	402.4	0.66	81.9	77	56.7	56.5	45	873.6	326.6	YORK BDX	ALL
CC-10	GIRL'S GYM	PENTHOUSE	9250	20.3	1	DX	37.5	78	6	12	R-410A	455.4	0.70	82.6	69.8	53.3	52.6	45	494.9	292.7	YORK BDX	ALL
CC-11	BOY'S GYM	PENTHOUSE	16250	37.2	1	DX	51.5	104	6	12	R-410A	436.9	0.60	80.1	68.3	54.9	54.1	45	718.2	442.3	YORK BDX	ALL

REMARKS:

1. COIL SIZED TO FIT IN EXISTING AHU. FIELD VERIFY ALL DIMENSIONS. TWO CIRCUITS TO MATCH CONDENSING UNIT, INTERTWINED ARRANGEMENT..

ELECTRIC HEATING COIL SCHEDULE

TAG	LOCATION	CFM	AIR TEMP DEG F ENT.	AIR TEMP DEG F LVG.	KW	VOLT	PH	HZ	CONTROL DATA STAGES REQ'D	CONTROL DATA CIRCUIT VOLTAGE	COIL DATA W	COIL DATA H	COIL DATA MAX AIR PD	MANUFACTURER	MODEL	REMARKS
EDH-9.1	BLDG C WEST PENTHOUSE	4150	55	70.2	20	480	3	60	SCR	24	16	30	0.05	INDEECO	QUA	1,2,3,5,6
EDH-9.2	BLDG C WEST PENTHOUSE	3800	55	71.6	20	480	3	60	SCR	24	44	12	0.05	INDEECO	QUA	1,2,3,5,6
EDH-9.3	BLDG C WEST PENTHOUSE	1225	55	70.5	6	480	3	60	SCR	24	12	16	0.05	INDEECO	QUA	1,2,3,5,6
EDH-9.4	BLDG C WEST PENTHOUSE	3330	55	70.2	16	480	3	60	SCR	24	18	20	0.05	INDEECO	QUA	1,2,4,5,6
EDH-9.5	BLDG C WEST PENTHOUSE	2190	55	69.4	10	480	3	60	SCR	24	26	12	0.05	INDEECO	QUA	1,2,3,5,6

1. HEATERS ARE TO BE INSTALLED WITHIN EXISTING DUCTWORK. FIELD VERIFY ALL SIZES AND LOCATION TO ACHIEVE 3' MINIMUM SERVICE CLEARANCE.
2. MINIMUM COIL FACE VELOCITY PER MANUFACTURER REQUIREMENTS.
3. SLIP TYPE HEATER W/ INTEGRAL SIDE MOUNTED CONTROL PANEL.
4. SLIP TYPE HEATER W/ INTEGRAL BOTTOM MOUNTED CONTROL PANEL.
5. SILENT CONTROLS SHALL BE PROVIDED. VERIFY CONTROL VOLTAGE W/ BAS CONTRACTOR. PROVIDE PROOF OF AIRFLOW CONTROL.
6. HEATER SHALL BE PROVIDED WITH BUILT-IN DISCONNECT SWITCH TO BE INTERLOCKED WITH THE HEATER TERMINAL BOX COVER AND HAVE LABELED "ON" AND "OFF" POSITIONS TO RESULT IN A "DEAD FRONT" DESIGN TO PROTECT SERVICE PERSONNEL.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates, Inc.
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312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 10311)

Title
MECHANICAL SCHEDULES AND DETAILS

Sheet
M200-MEP

DDC FUNCTION BLOCK LOGIC SYMBOLS

SYMBOL	DESCRIPTION
POINT NAME AO ADDRESS	OUTPUT POINT - TRANSMITS A VALUE FROM THE FB TO A PHYSICAL OUTPUT CHANNEL ON THE CONTROLLER. DESCRIPTOR - CONTROLLER ADDRESS, POINTNAME AND POINT TYPE AO - ANALOG OUTPUT DO - DIGITAL OUTPUT
ADDRESS AI POINT NAME	INPUT POINT - READS A VALUE FROM A PHYSICAL INPUT ON THE CONTROLLER AND CONVERTS FOR USE INSIDE THE FB. DESCRIPTOR - CONTROLLER ADDRESS, POINTNAME AND POINT TYPE AI - ANALOG INPUT DI - DIGITAL INPUT
POINT-NAME VP	VIRTUAL POINT - ANALOG OR DIGITAL VALUE USED WITHIN A FB OR BROADCAST ACROSS THE LAN.
	DIGITAL WIRE - DIGITAL LOGIC CONNECTION BETWEEN FB'S
	ANALOG WIRE - ANALOG LOGIC CONNECTION BETWEEN FB'S
CONST	CONSTANT - CONSTANT VALUE INPUTS
G	GRAPHIC INTERFACE - VALUE APPEARS ON GRAPHIC SCREEN
A#	ALARM & PRIORITY - TRANSMITS AN ALARM AND ALARM PRIORITY TO APPROPRIATE DEVICES.
M#	MESSAGE AND NUMBER - TRANSMITS A MESSAGE AND MESSAGE NUMBER TO APPROPRIATE DEVICES.
T	TREND - ESTABLISHES TREND IN CONTROLLER.
RESET RTM	RUN TIME MONITOR - ACCUMULATES RUNTIME FOR DIGITAL OUTPUT AND CONVERTS TIME TO HOURS.
REF#	REFERENCE FLAG - USED AS CONNECTION TO FB'S BY REFERENCE INSTEAD OF WIRES. SEE TABLE FOR TYPICAL REFERENCE FLAG NAME REPRESENTATIONS.
AND	DIGITAL AND GATE- OUTPUT IS ON IF ALL INPUTS ARE TRUE
OR	DIGITAL OR GATE - OUTPUT IS ON IF ANY INPUT IS TRUE.
XOR	DIGITAL EXCLUSIVE OR GATE - OUTPUT IS ON IF ONLY ONE INPUT IS TRUE.
N	INVERSE (NOT)- IF INPUT = ON, OUTPUT = OFF; CONVERSELY IF INPUT =OFF, OUTPUT =ON
SET LATCH1 RST	LATCH OFF- OUTPUT IS OFF WHENEVER INPUT IS ON. OUTPUT REMAINS OFF UNTIL RESET CHANGES FROM OFF TO ON.
SET LATCH1 RST	LATCH ON- OUTPUT IS ON WHENEVER INPUT IS ON. OUTPUT REMAINS ON UNTIL RESET CHANGES FROM OFF TO ON.
ON/OFF DELAY	ON/OFF DELAY TIMER- AFTER INPUT IS ON, OUTPUT IS ON/OFF AFTER A PREDETERMINED TIME (#) HAS ELAPSED.
CYCLE DELAY	CYCLE DELAY TIMER - WHEN SET TIME HAS ELAPSED, THE FIRST TIME INPUT IS ON, OUTPUT IS ON AND TIMER RESETS. BEFORE SET TIME HAS ELAPSED, OUTPUT IS OFF WHEN INPUT IS OFF. IF INPUT GOES FROM OFF TO ON BEFORE SET TIME HAS ELAPSED, OUTPUT WILL REMAIN OFF.
PWR	POWER FLAG - ON WHEN CONTROLLER IS INITIALLY POWERED ON AND NO PHASE LOSS IS DETECTED
FF	FLIP FLOP - CHANGE STATE OF OUTPUT WHEN INPUT CHANGES FROM OFF TO ON: OUTPUT SET TO OFF WHEN RESET (R) GOES CHANGES FROM OFF TO ON
OPTIMUM ON HI I O INC LO	SETPOINT OPTIMIZATION - RESET OF OUTPUT FROM A MAXIMUM VALUE TO A MINIMUM VALUE BASED ON VALUES OR REQUESTS) DB - DEAD BAND INC - INCREMENT/DECREMENT VALUE HI - MAXIMUM RESET VALUE LO - MINIMUM RESET VALUE
SP INTVL MX > +100=10 O I S & B < -100-10 MN	SAMPLE & BUMP - CHANGE IN OUTPUT (WITH DEFINED MINIMUM & MAXIMUM VALUES) BY A DEFINED AMOUNT WHEN INPUT DEVIATES FROM SETPOINT (SP) BY A DEFINED AMOUNT AT A DEFINED INTERVAL. I - INPUT O - OUTPUT MX - MAXIMUM OUTPUT MN - MINIMUM OUTPUT INTVL - INTERVAL > =IE, =OA - WHEN INPUT RISES ABOVE SETPOINT BY AMOUNT '=E', OUTPUT IS INCREASED BY AMOUNT '=OA' < =IE, =OA - WHEN INPUT FALLS BELOW SETPOINT BY AMOUNT '=E', OUTPUT IS REDUCED BY AMOUNT '=OA'

SYMBOL	DESCRIPTION
PID	PID CONTROLLER - PROPORTIONAL, INTEGRAL, DERIVATIVE LOOPS USE STANDARD ALGORITHMS TO CALCULATE AN OUTPUT BASED ON A VARIABLE INPUT. PROPORTIONAL IS BASED ON THE DIFFERENCE BETWEEN THE INPUT AND THE SETPOINT. INTEGRAL IS BASED ON THE TIME THE INPUT DEVIATES FROM THE SETPOINT. DERIVATIVE IS BASED ON THE TIME THE INPUT IS APPROACHING THE SETPOINT. THE PID CAN BE EITHER DIRECT ACTING (DA) OR REVERSE ACTING (RA). IN A DA PID WHEN THE INPUT INCREASES THE OUTPUT INCREASES. IN A RA PID WHEN THE INPUT INCREASES THE OUTPUT DECREASES.
FLOAT	FLOATING CONTROLLER - OUTPUT WILL INCREASE OR DECREASE INCREMENTALLY AS INPUT DEVIATES FROM SETPOINT. IN A DA CONTROLLER WHEN THE INPUT INCREASES THE OUTPUT INCREASES. IN A RA CONTROLLER WHEN THE INPUT INCREASES THE OUTPUT DECREASES.
RESET	RESET CONTROLLER - USER DEFINED OUTPUT VALUE WILL RESET IN A LINEAR RELATIONSHIP BASED ON USER DEFINED INPUT VALUE.
SR	SWITCHING RELAY - SWITCHES OUTPUT BETWEEN TWO INPUTS WHEN DIGITAL PILOT INPUT IS ON. SWITCH SHOWN IN NORMAL POSITION
DSR	DEADBAND SWITCHING RELAY - DIGITAL OUTPUT CHANGES WHEN INPUT VALUE RISES/FALLS ABOVE/BELOW SETPOINT (SP). DIGITAL OUTPUT RESTORES TO NORMAL WHEN INPUT RISES/FALLS ABOVE/BELOW DEADBAND(DB). SWITCH SHOWN IN NORMAL POSITION
IF > SP	LOGICAL IF EXPRESSION - THE OUTPUT IS ON IF THE INPUT MEETS THE CONDITION OF THE SETPOINT.
RAMP	RAMP CONTROLLER - LIMITS THE RATE OF CHANGE OF AN OUTPUT ON AN INCREASE IN VALUE OR A DECREASE IN VALUE. CHNG% - % OF TOTAL MAXIMUM OUTPUT VALUE ALLOWED FOR OUTPUT CHANGE # = TIME IN SECONDS MAX = MAXIMUM OUTPUT VALUE MIN = MINIMUM OUTPUT VALUE
TMR	TIMER - OUTPUT IS ON FOR A USER SPECIFIED TIME AFTER INPUT CHANGES FROM OFF TO ON
ATS	AUTOMATIC TIME SCHEDULER - INCLUDES SCHEDULES ENTERED INTO CONTROLLER FOR 7 DAY SCHEDULING WITH HOLIDAYS AND OVERRIDE SCHEDULES. INCLUDES OVERRIDE INPUT FOR UNSCHEDULED OVERRIDE. OUTPUTS REFERENCE FLAGS CAN INCLUDE : HEATING SETBACK, COOLING SETBACK, AND UNOCCUPIED
OS/S	OPTIMUM START/STOP TIME SCHEDULER - INCLUDES SCHEDULES ENTERED INTO CONTROLLER FOR 7 DAY SCHEDULING WITH HOLIDAYS AND OVERRIDE SCHEDULES. INCLUDES OPTIMUM START STOP ROUTINE. OUTPUTS REFERENCE FLAGS CAN INCLUDE : WARM-UP, COOL-DOWN, HEATING SETBACK, COOLING SETBACK, AND UNOCCUPIED. INCLUDES OVERRIDE INPUT (OVR) FOR UNSCHEDULED OVERRIDE
CALC	CALCULATION BLOCK - OUTPUT IS EQUAL TO CALCULATION USING INPUT(S). EQUATION CAN BE MATHEMATICAL OR A PREDEFINED INDUSTRY STANDARD ALGORITHM (ie. CFM, VELOCITY PRESSURE, ENTHALPY, DEW POINT ETC.)
HI	HIGH SELECTOR - SELECTS HIGHER OF INPUT VALUES
LO	LOW SELECTOR - SELECTS LOWER OF INPUT VALUES
AVE	AVERAGING BLOCK - MATHEMATICALLY AVERAGES INPUT VALUES.
PROOF	PROOFING MODULE - GENERATES VALUES BASED ON A COMPARISON OF COMMAND AND MONITORING INPUTS. DLY - PROOFING DELAY PERIOD MTR - MONITOR (INPUT FOR PROOF) COM - COMMAND (INPUT FOR PROOF) RST - RESET (IF LATCHING IS USED) ALM - (ON WHEN MONITOR INPUT IS NOT EQUAL TO COMMAND INPUT) NML - OUTPUT IS ON WHEN MONITOR AND COMMAND INPUTS ARE ON AND NORMAL CONDITIONS ARE MET
TIME AVG.	TIME AVERAGE BLOCK - OUTPUT IS EQUAL TO SUM OF INPUTS FROM USER SPECIFIED PREVIOUS TIME PERIOD (OR NUMBER OF SCANS) TO CURRENT TIME (OR SCAN) DIVIDED BY NUMBER OF DISCRETE POINTS IN THE SUMMATION PERIOD. OUTPUT IS A ROLLING TIME BASED AVERAGE OF THE INPUT VALUE.
REQUEST	STAGER BLOCK - OUTPUT IS EQUAL TO SUM OF REQUESTS FROM USER SPECIFIED INPUTS. ROTATION SHALL BE DETERMINED BY USER DEFINED PARAMETERS. EACH INDIVIDUAL OUTPUT CAN BE LOCKED OUT BY USER DEFINED INDIVIDUAL INPUTS. LOCKED OUT OUTPUTS SHALL BE SKIPPED IN ROTATION. (SEE SEQUENCE OF OPERATION FOR DETAILS)
INC/DEC	INCREMENT/DECREMENT BLOCK - OUTPUT IS EQUAL TO NUMBER OF INCREMENT AND DECREMENT SIGNALS RECEIVED FROM USER SPECIFIED INPUTS. A CHANGE FROM OFF TO ON OF THE INCREMENT/DECREMENT INPUT INCREASES/DECREASES THE OUTPUT BY A VALUE OF 1. AN ON SIGNAL ON RESET RESETS THE OUTPUT TO 0. BLOCK IS ACTIVE WHEN DIGITAL PILOT INPUT IS ON.

CONTROL SYMBOLS

SYMBOL	DESCRIPTION
AI POINT NAME POINT NAME AO	DDC POINT DESCRIPTOR WITH NAME AI - ANALOG INPUT DI - DIGITAL INPUT AO - ANALOG OUTPUT DO - DIGITAL OUTPUT
	TEMPERATURE SENSOR WITH AVERAGING ELEMENT
	TEMPERATURE SENSOR WITH SINGLE POINT ELEMENT
TSA	TEMPERATURE SENSOR WITH PIPE WELL
	HUMIDITY SENSOR
	LOW TEMPERATURE SWITCH (FREEZESTAT)
	HIGH TEMPERATURE SWITCH (FIRESTAT)
	SMOKE DETECTOR
	DIFFERENTIAL PRESSURE SWITCH
	ELECTRIC-PNEUMATIC RELAY
	PNEUMATIC-ELECTRIC SWITCH
	CURRENT TO PNEUMATIC TRANSDUCER
	TWO WAY CONTROL VALVE
N.C. N.O.	THREE WAY CONTROL VALVE
	DAMPER ACTUATOR
	MAIN AIR SUPPLY
	CURRENT SENSOR
PSI	PNEUMATIC TO CURRENT TRANSDUCER
	WATER FLOW SWITCH
	PNEUMATIC HIGH / LOW SIGNAL SELECTOR
	DUCT AIR QUALITY SENSOR
LS1	LIMIT SWITCH
	BUTTERFLY CONTROL VALVE WITH PNEUMATIC ACTUATOR
	AIR FLOW SWITCH
	HIGH LIMIT HUMIDISTAT

SYMBOL	DESCRIPTION
	DISCONNECT SWITCH
480V 120V	CONTROL TRANSFORMER
M S P	RELAY COILS
	FUSE
OL	THERMAL OVERLOAD
	NORMALLY OPEN AND NORMALLY CLOSED CONTACTS
HAND OFF AUTO	HAND-OFF-AUTO SELECTOR SWITCH
	WIRING DESIGNATION. (NO. OF YATCHES INDICATES NO. OF CONDUCTORS)
	WIRING CONNECTION
	ON-OFF SELECTOR SWITCH
	PNEUMATIC ACTUATOR PLAN VIEW
	ROOM TEMPERATURE SENSOR AS SHOWN ON FLOOR PLANS
	ROOM HUMIDITY SENSOR AS SHOWN ON FLOOR PLANS
DCS	NEW DIGITAL CONTROL STATION
PCS	EXISTING PNEUMATIC CONTROL STATION
FOI	FIBER OPTIC INTERFACE
	PNEUMATIC RESTRICTOR
	PILOT LIGHT (WITH LENS COLOR)
	REFRIGERANT DETECTOR
	AIR FLOW MONITORING STATION
FAR	FIRE ALARM RELAY
TDR	TIME DELAY RELAY DELAY ON MAKE OR BREAK
AHU OR EQUIPMENT NUMBER 10 ZONE NUMBER	ZONE DESCRIPTOR
	DUCT MOUNTED HUMIDISTAT

SYMBOL AND ABBREVIATION SCHEDULE

PIPING AND PIPE FITTINGS

SYMBOL	DESCRIPTION
CD	CONDENSATE DRAIN
CWS	CHILLED WATER SUPPLY
CWR	CHILLED WATER RETURN
SCWS	SECONDARY CHILLED WATER SUPPLY
SCWR	SECONDARY CHILLED WATER RETURN
CDS	CONDENSER WATER SUPPLY
CDR	CONDENSER WATER RETURN
	NEW PIPING (LABELED ACCORDINGLY)
	FUTURE PIPING
	EXISTING PIPING
	POINT OF CONNECTION (NEW TO OLD)
	REDUCER
	FLEXIBLE CONNECTOR
	THERMOMETER WITH WELL
	PRESSURE GAUGE
	TRIPLE DUTY VALVE
	BUTTERFLY VALVE
S	SOLENOID VALVE
	GATE VALVE
	GLOBE VALVE
	BALL VALVE
	SWING CHECK VALVE
	LIFT CHECK VALVE

TYPICAL REFERENCE FLAG NAME REPRESENTATIONS*

AMOA	Absolute minimum OA flow setpoint As determined by the Engineer of record
BOK	Pump HP-1 or HP-2 status proven on Typically Boiler OK to Run
BxALM	Boiler "x" Alarm"x" represents boiler number
BxRT	Boiler "x" Run Time"x" represents boiler number
CDN	Cool-down mode enabled
CHST	Chiller status proven on On=status proven
CHWR	Chilled water return temperature
CHWS	Chilled water supply temperature
CPCT	Chilled water valve position 0-100% open
DALM	Drive Alarm On=Alarm
DASP	Discharge air temperature setpoint
DMOA	Design minimum OA flow setpoint As determined by the Engineer of record
DPCTOA	Damper position 0-100% open
EPCT	Economizer position 0-100%
FLOW	Pump status proven on
GO	Unit "GO" Both the supply and return fans have been enabled by the BAS and the status of both has been proven ON
HOK	Heating Pump(s) status proven on
HPCT	HW reheat valve position 0-100% open
HST	Highest space temperature Pertains to zones served by the AHU only
HWR	Hot water return temperature
HWS	Hot water supply temperature
LZT	Low zone temperature flag On=zone temperature more than 2 deg F below setpoint
MAGO	Mixed air "GO" On when OA & RA conditions meet specified requirements to enable the economizer
MASP	Mixed air temperature setpoint
MAT	Mixed air temperature
MINOA	Minimum OA damper position 0-100% open
NDOA	Need for OA based on High Zone CO2 0-100%
NOFTR	FTR not allowed On=FTR not allowed based on OA conditions
OAFL	Outside air flow
Occ	Occupancy Mode Enabled
OCFM	Outside air flow
P1	Enable Pump-1 On=Run, typical for other pump numbers
P1A	Pump-1 Drive Alarm On=Alarm, typical for other pump numbers
P1FL	Pump-1 proof failed On=proof failure, typical for other pump numbers
P1PF	Pump-1 proof On=Status proven, typical for other pump numbers
P1RT	Pump-1 Run Time Typical for other pump numbers
PHT	Preheat Coil Discharge Temperature
PRS	Hi/Lo pressure switch in alarm On=Alarm
PURG	Night Purge mode enabled
PWR	Power ON Enabled continuously whenever controller is powered and enabled
RAH	Return air humidity
RAT	Return air temperature
RFAIL	Return fan proof failed
RFPR	Return Fan proof On=Status proven
RGO	Return Fan "GO" Fan enabled by BAS and Status has been proven ON
RUN	Unit enabled (FAN running)
SAT	Supply air temperature
SBC	Setback cooling mode enabled
SBH	Setback heating mode enabled
SCFM	Supply air flow
SFAIL	Supply fan proof failed On=proof failure
SFPR	Supply Fan proof On=Status proven
SGO	Supply Fan "GO" Fan enabled by BAS and Status has been proven ON
SMK	Smoke detector alarm On=Alarm
SP1	Secondary Pump-1 Enable On=Run, typical for other pump numbers
SP1A	Secondary Pump-1 Drive Alarm On=Alarm, typical for other pump numbers
SP1FL	Secondary Pump-1 proof failed On=proof failure, typical for other pump numbers
SP1PF	Secondary Pump-1 proof On=Status proven, typical for other pump numbers
SP1RT	Secondary Pump-1 Run Time Typical for other pump numbers
SPD	Supply fan speed 0-100%
SPD	Remote DP PID loop output 0-100%
SPID	Remote DP PID loop output 0-100%
SysGO	System Enable On whenever run conditions are met
Temp	Space Temperature
WUP	Warm-up mode enabled

Note:

This is a list of typical representations. This list is not not intended to be inclusive or definitive. Refer to actual logic diagram to ensure actual reference tag representation.

BAS SUMMARY

1. COORDINATE WITH EXISTING CONTROL SYSTEM THAT WAS PROVIDED BY AUTOMATIC BUILDING CONTROLS, LLC IN 2020. PROVIDE NEW CONTROLS FOR ALL NEW MECHANICAL EQUIPMENT INCLUDED WITHIN THE SCOPE OF THIS PROJECT. FULLY INTEGRATE ALL CONTROLS ASSOCIATED WITH THE WORK OF THIS PROJECT INTO THE EXISTING CONTROL SYSTEMS. PROVIDE GRAPHICS DISPLAYS AT THE EXISTING BAS FOR ALL NEW EQUIPMENT. NEW GRAPHICS DISPLAYS SHALL BE SIMILAR IN APPEARANCE AND FULLY INTEGRATED INTO THE EXISTING BAS PROGRAMMING.
2. APPROVED VENDORS AND THEIR PRODUCT LINES (NO SUBSTITUTIONS): AUTOMATIC BUILDING CONTROL, INC. - APPROVED FOR DISTECH TRIDIUM ONLY
3. SEE DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.

Mechanical and Electrical Coordination for Building Automation System

Work Activity	Furnish	Install	Low Voltage Wiring/Conduit	Line power
BAS low voltage and communications wiring	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS conduits and raceways	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
Automatic Control Dampers	Div. 23 based on BAS Specification and approved BAC submittal.	Div. 23	BAS Contractor	N/A
Automatic Control Damper Actuators	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
Automatic Control Valves	BAS Contractor	Div. 23	BAS Contractor	N/A
Automatic Control Valve Actuators	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
BAS Pipe mounted devices and taps, including thermowells, flow and pressure stations	Div. 23 furnish well, based on BAS Contractor control device. All other devices by BAS Contractor	Div. 23	BAS Contractor	BAS Contractor
BAS current switches	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS Control relays	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS Duct mounted devices	BAS Contractor	Div. 23	BAS Contractor	BAS Contractor
BAS Equipment Mounted Devices (MAT averaging sensors, freeze stats, AFMS mounted to fan inlet cone, etc.)	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
All BAS Nodes, equipment, housings, enclosures, and panels	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor to provide power to transformation for BAS Contractor supplied devices
Duct Smoke Detector	BAS Contractor to provide, coordinate with Div. 26 if Fire Protection interface required	Div. 23	BAS Contractor BAS Contractor wiring to BAS and Div. 26 to Fire Protection system.	BAS Contractor
Unit Ventilators	Div. 23 to provide Digital Ready unit. BAS Contractor to provide all control devices, except dampers. Coordinate with BAS Contractor on types of sensors to be used	Div. 23	BAS Contractor	Div. 26 power for unit. BAS Contractor to provide required transformation for BAS Contractor supplied devices
AHU & Fan Coil	BAS Contractor. For Factory mounted controls, Div. 23 to coordinate with BAS Contractor to supply controls for factory installation.	BAS Contractor	BAS Contractor	Div. 26 power for unit and its controls. BAS Contractor to provide required transformation for BAS Contractor supplied devices
Specialized Units with integrated controls (pool Dectron units, pkg RTU's, Boilers, Cooling Towers, Chillers, VFD's, etc.)	Div. 23, to provide an communication interface that is Native BacNet or allows direct control of all points required by the BAS drawing	Div. 23 to provide a compatible interface. BAS Contractor to interface with the equipment directly or through Div. 23 interface.	Div 23 for factory provided field installed devices. BAS Contractor to provide control wiring to interface device or to the directly controlled devices. Div. 26 power for unit	Div. 26 power for unit and its controls. BAS Contractor to provide required transformation for BAS Contractor supplied devices
Boiler Water treatment system	Div. 23 to provide pulse output for chemical treatment water meter and provide measurement constants to BAS Contractor	Div. 23	Div. 23 & BAS Contractor for makeup water meter interface	Div. 26
Cabinet Unit Heaters and Unit heater	Integral or remote thermostat Div. 23. Units controlled by BAS will have the valve and actuator supplied by the BAS Contractor	Div. 23 physical installation	Div. 26 except where devices are controlled by BAS. Then BAS Contractor responsible..	Div. 26
Power distribution monitoring relays	Div. 26	Div. 26	BAS Contractor	Div. 26
Starters, HOA switches	Div. 26	Div. 26	BAS Contractor control wiring to HOA	Div. 26
Control of 120V motors	BAS Contractor to provide HOA device	BAS Contractor	BAS Contractor	Div. 26
TAB work	Div. 23, coordinate with the BAS Contractor	N/A	N/A	N/A
Boiler room CO detector	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
Boiler emergency fuel burner switch	BAS Contractor	BAS Contractor, coordinate with Div. 23 on interface with Boiler	BAS Contractor	BAS Contractor

NOTES:

1. For any equipment with components that are part of the BAS, those components will comply with the requirements of the BAS specifications regardless of how they are purchased: BAS, Building Automation System refer to specifications. 23 09 21, 23 09 23, 23 09 26, & 23 09 27.
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3. BAS devices installed by Div. 23 shall follow all manufacturer and BAS specification requirements.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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Structural Engineer:
Milhouse Engineering, Inc.
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Suite 2901
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312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates, Inc.
223 West Jackson Boulevard
Suite 820
Chicago, IL 60606
312 663 3700

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PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCA# 5031)
Title
BAS GENERAL SYMBOLS
Sheet
M300-LNK

DDC FUNCTION BLOCK LOGIC SYMBOLS

SYMBOL	DESCRIPTION
POINT NAME AO ADDRESS	OUTPUT POINT - TRANSMITS A VALUE FROM THE FB TO A PHYSICAL OUTPUT CHANNEL ON THE CONTROLLER. DESCRIPTOR - CONTROLLER ADDRESS, POINTNAME AND POINT TYPE AO - ANALOG OUTPUT DO - DIGITAL OUTPUT
ADDRESS AI POINT NAME	INPUT POINT - READS A VALUE FROM A PHYSICAL INPUT ON THE CONTROLLER AND CONVERTS FOR USE INSIDE THE FB. DESCRIPTOR - CONTROLLER ADDRESS, POINTNAME AND POINT TYPE AI - ANALOG INPUT DI - DIGITAL INPUT
POINT-NAME VP	VIRTUAL POINT - ANALOG OR DIGITAL VALUE USED WITHIN A FB OR BROADCAST ACROSS THE LAN.
	DIGITAL WIRE - DIGITAL LOGIC CONNECTION BETWEEN FB'S
	ANALOG WIRE - ANALOG LOGIC CONNECTION BETWEEN FB'S
CONST	CONSTANT - CONSTANT VALUE INPUTS
G	GRAPHIC INTERFACE - VALUE APPEARS ON GRAPHIC SCREEN
A#	ALARM & PRIORITY - TRANSMITS AN ALARM AND ALARM PRIORITY TO APPROPRIATE DEVICES.
M#	MESSAGE AND NUMBER - TRANSMITS A MESSAGE AND MESSAGE NUMBER TO APPROPRIATE DEVICES.
T	TREND - ESTABLISHES TREND IN CONTROLLER.
RTM	RUN TIME MONITOR - ACCUMULATES RUNTIME FOR DIGITAL OUTPUT AND CONVERTS TIME TO HOURS.
REF.#	REFERENCE FLAG - USED AS CONNECTION TO FBS BY REFERENCE INSTEAD OF WIRES. SEE TABLE FOR TYPICAL REFERENCE FLAG NAME REPRESENTATIONS
AND	DIGITAL AND GATE- OUTPUT IS ON IF ALL INPUTS ARE TRUE
OR	DIGITAL OR GATE - OUTPUT IS ON IF ANY INPUT IS TRUE.
XOR	DIGITAL EXCLUSIVE OR GATE - OUTPUT IS ON IF ONLY ONE INPUT IS TRUE.
N	INVERSE (NOT)- IF INPUT = ON, OUTPUT = OFF; CONVERSELY IF INPUT =OFF, OUTPUT =ON
RST LATCH0	LATCH OFF- OUTPUT IS OFF WHENEVER INPUT IS ON. OUTPUT REMAINS OFF UNTIL RESET CHANGES FROM OFF TO ON.
RST LATCH1	LATCH ON- OUTPUT IS ON WHENEVER INPUT IS ON. OUTPUT REMAINS ON UNTIL RESET CHANGES FROM OFF TO ON.
ON/OFF DELAY	ON/OFF DELAY TIMER- AFTER INPUT IS ON, OUTPUT IS ON/OFF AFTER A PREDETERMINED TIME (#) HAS ELAPSED.
CYCLE DELAY	CYCLE DELAY TIMER - WHEN SET TIME HAS ELAPSED, THE FIRST TIME INPUT IS ON, OUTPUT IS ON AND TIMER RESETS. BEFORE SET TIME HAS ELAPSED, OUTPUT IS OFF WHEN INPUT IS OFF. IF INPUT GOES FROM OFF TO ON BEFORE SET TIME HAS ELAPSED, OUTPUT WILL REMAIN OFF.
PWR	POWER FLAG - ON WHEN CONTROLLER IS INITIALLY POWERED ON AND NO PHASE LOSS IS DETECTED
FF	FLIP FLOP - CHANGE STATE OF OUTPUT WHEN INPUT CHANGES FROM OFF TO ON. OUTPUT SET TO OFF WHEN RESET (R) GOES CHANGES FROM OFF TO ON
OPTIMUM DB H O INC LO	SETPOINT OPTIMIZATION - RESET OF OUTPUT FROM A MAXIMUM VALUE TO A MINIMUM VALUE BASED ON VALUES OR REQUESTS) DB - DEAD BAND INC - INCREMENT/DECREMENT VALUE HI - MAXIMUM RESET VALUE LO - MINIMUM RESET VALUE
SP INTVL MX > = 100 + 10 O | S & B | < -100 -10 MN	SAMPLE & BUMP - CHANGE IN OUTPUT (WITH DEFINED MINIMUM & MAXIMUM VALUES) BY A DEFINED AMOUNT WHEN INPUT DEVIATES FROM SETPOINT (SP) BY A DEFINED AMOUNT AT A DEFINED INTERVAL. - INPUT O - OUTPUT MX - MAXIMUM OUTPUT MN - MINIMUM OUTPUT INTVL - INTERVAL > =IE, =DA - WHEN INPUT RISES ABOVE SETPOINT BY AMOUNT =IE, OUTPUT IS INCREASED BY AMOUNT =DA < =IE, =DA - WHEN INPUT FALLS BELOW SETPOINT BY AMOUNT =IE OUTPUT IS REDUCED BY AMOUNT =DA

SYMBOL	DESCRIPTION
SP P I D O I D DA	PID CONTROLLER - PROPORTIONAL, INTEGRAL, DERIVATIVE LOOPS USE STANDARD ALGORITHMS TO CALCULATE AN OUTPUT BASED ON A VARIABLE INPUT. PROPORTIONAL IS BASED ON THE DIFFERENCE BETWEEN THE INPUT AND THE SETPOINT. INTEGRAL IS BASED ON THE THE TIME THE INPUT DEVIATES FROM THE SETPOINT. DERIVATIVE IS BASED ON THE THE RATE THE INPUT IS APPROACHING THE SETPOINT. THE PID CAN BE EITHER DIRECT ACTING (DA) OR REVERSE ACTING (RA). IN A DA PID WHEN THE INPUT INCREASES THE OUTPUT INCREASES. IN A RA PID WHEN THE INPUT INCREASES THE OUTPUT DECREASES.
SP F I T D DA O 0 100	FLOATING CONTROLLER - OUTPUT WILL INCREASE OR DECREASE INCREMENTALLY AS INPUT DEVIATES FROM SETPOINT. IN A DA CONTROLLER WHEN THE INPUT INCREASES THE OUTPUT INCREASES. IN A RA CONTROLLER WHEN THE INPUT INCREASES THE OUTPUT DECREASES.
RESET YES NO I O	RESET CONTROLLER - USER DEFINED OUTPUT VALUE WILL RESET IN A LINEAR RELATIONSHP BASED ON USER DEFINED INPUT VALUE.
SP SR I R	SWITCHING RELAY - SWITCHES OUTPUT BETWEEN TWO INPUTS WHEN DIGITAL PILOT INPUT IS ON. SWITCH SHOWN IN NORMAL POSITION
SP DSR DB SP	DEADBAND SWITCHING RELAY - DIGITAL OUTPUT CHANGES WHEN INPUT VALUE RISES/FALLS ABOVE/BELOW SETPOINT (SP). DIGITAL OUTPUT RESTORES TO NORMAL WHEN INPUT RISES/FALLS ABOVE/BELOW DEADBAND(DB). SWITCH SHOWN IN NORMAL POSITION
IF > SP O	LOGICAL IF EXPRESSION - THE OUTPUT IS ON IF THE INPUT MEETS THE CONDITION OF THE SETPOINT.
RAMP CHNG % MAX I O MIN # Sec MIN	RAMP CONTROLLER - LIMITS THE RATE OF CHANGE OF AN OUTPUT ON AN INCREASE IN VALUE OR A DECREASE IN VALUE. CHNG% - % OF TOTAL MAXIMUM OUTPUT VALUE ALLOWED FOR OUTPUT CHANGE # = TIME IN SECONDS MAX = MAXIMUM OUTPUT VALUE MIN = MINIMUM OUTPUT VALUE
TMR I O	TIMER - OUTPUT IS ON FOR A USER SPECIFIED TIME AFTER INPUT CHANGES FROM OFF TO ON
ATS ON/OFF	AUTOMATIC TIME SCHEDULER - INCLUDES SCHEDULES ENTERED INTO CONTROLLER FOR 7 DAY SCHEDULING WITH HOLIDAYS AND OVERRIDE SCHEDULES. INCLUDES OVERRIDE INPUT FOR UNSCHEDULED OVERRIDE. OUTPUTS REFERENCE FLAGS CAN INCLUDE : HEATING SETBACK, COOLING SETBACK, AND UNOCCUPIED
OS/S ON/OFF	OPTIMUM START-STOP TIME SCHEDULER - INCLUDES SCHEDULES ENTERED INTO CONTROLLER FOR 7 DAY SCHEDULING WITH HOLIDAYS AND OVERRIDE SCHEDULES. INCLUDES OPTIMUM START STOP ROUTINE. OUTPUTS REFERENCE FLAGS CAN INCLUDE : WARM-UP, COOL-DOWN, HEATING SETBACK, COOLING SETBACK, AND UNOCCUPIED. INCLUDES OVERRIDE INPUT (OVR) FOR UNSCHEDULED OVERRIDE
CALC I J K O	CALCULATION BLOCK - OUTPUT IS EQUAL TO CALCULATION USING INPUT(S). EQUATION CAN BE MATHEMATICAL OR A PREDEFINED INDUSTRY STANDARD ALGORITHM (ie. CFM, VELOCITY PRESSURE, ENTHALPY, DEW POINT ETC.)
H I	>HIGH SELECTOR - SELECTS HIGHER OF INPUT VALUES
L O	</>LOW SELECTOR - SELECTS LOWER OF INPUT VALUES
AVE	AVERAGING BLOCK - MATHEMATICALLY AVERAGES INPUT VALUES.
DLY MTR CNV RST PROOF ALM NML	PROOFING MODULE - GENERATES VALUES BASED ON A COMPARISON OF COMMAND AND MONITORING INPUTS. DLY - PROOFING DELAY PERIOD MTR - MONITOR (INPUT FOR PROOF) COM - COMMAND (INPUT FOR PROOF) RST - RESET (F LATCHING IS ENTERED) ALM - (ON WHEN MONITOR INPUT IS NOT EQUAL TO COMMAND INPUT) NML - OUTPUT IS ON WHEN MONITOR AND COMMAND INPUTS ARE ON AND NORMAL CONDITIONS ARE MET
I TIME AVGS CLEAR/LOCK O	TIME AVERAGE BLOCK - OUTPUT IS EQUAL TO SUM OF INPUTS FROM USER SPECIFIED PREVIOUS TIME PERIOD (OR NUMBER OF SCANS) TO CURRENT TIME (OR SCAN) DIVIDED BY NUMBER OF DISCRETE POINTS IN THE SUMMATION PERIOD. OUTPUT IS A ROLLING TIME BASED AVERAGE OF THE INPUT VALUE.
REQUEST BLKN BLKN CLOSE BLOCK ACKNOWLEDGE	STAGER BLOCK - OUTPUT IS EQUAL TO SUM OF REQUESTS FROM USER SPECIFIED INPUTS. ROTATION SHALL BE DETERMINED BY USER DEFINED PARAMETERS. EACH INDIVIDUAL OUTPUT CAN BE LOCKED OUT BY USER DEFINED INDIVIDUAL INPUTS. LOCKED OUT OUTPUTS SHALL BE SKIPPED IN ROTATION. (SEE SEQUENCE OF OPERATION FOR DETAILS)
INC/DEC INC DEC RESET	INCREMENT/DECREMENT BLOCK - OUTPUT IS EQUAL TO NUMBER OF INCREMENT AND DECREMENT SIGNALS RECEIVED FROM USER SPECIFIED INPUTS. A CHANGE FROM OFF TO ON OF THE INCREMENT/DECREMENT INPUT INCREASES/DECREASES THE OUTPUT BY A VALUE OF 1. AN ON SIGNAL ON RESET RESETS THE OUTPUT TO 0. BLOCK IS ACTIVE WHEN DIGITAL PILOT INPUT IS ON.

CONTROL SYMBOLS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
AI POINT NAME POINT NAME AO	DDC POINT DESCRIPTOR WITH NAME AI - ANALOG INPUT DI - DIGITAL INPUT AO - ANALOG OUTPUT DO - DIGITAL OUTPUT		DISCONNECT SWITCH
TE	TEMPERATURE SENSOR WITH AVERAGING ELEMENT	480V 120V	CONTROL TRANSFORMER
TE	TEMPERATURE SENSOR WITH SINGLE POINT ELEMENT	M S	RELAY COILS
TE	TEMPERATURE SENSOR WITH PIPE WELL		FUSE
HE	HUMIDITY SENSOR	OL	THERMAL OVERLOAD
TSL	LOW TEMPERATURE SWITCH (FREEZESTAT)		NORMALLY OPEN AND NORMALLY CLOSED CONTACTS
TSH	HIGH TEMPERATURE SWITCH (FIRESTAT)	HAND AUTO OFF	HAND-OFF-AUTO SELECTOR SWITCH
SD	SMOKE DETECTOR		WIRING DESIGNATION (NO. OF HATCHES INDICATES NO. OF CONDUCTORS)
DPS	DIFFERENTIAL PRESSURE SWITCH		WIRING CONNECTION
EP	ELECTRIC-PNEUMATIC RELAY	ON-OFF	ON-OFF SELECTOR SWITCH
PE SPST	PNEUMATIC-ELECTRIC SWITCH		PNEUMATIC ACTUATOR PLAN VIEW
IP	CURRENT TO PNEUMATIC TRANSDUCER	TE	ROOM TEMPERATURE SENSOR AS SHOWN ON FLOOR PLANS
VI	TWO WAY CONTROL VALVE	HE	ROOM HUMIDITY SENSOR AS SHOWN ON FLOOR PLANS
VI N.C. N.O.	THREE WAY CONTROL VALVE	DCS	NEW DIGITAL CONTROL STATION
		PCS	EXISTING PNEUMATIC CONTROL STATION
	DAMPER ACTUATOR	FOI	FIBER OPTIC INTERFACE
	MAIN AIR SUPPLY		PNEUMATIC RESTRICTOR
	CURRENT SENSOR		PILOT LIGHT (WITH LENS COLOR)
PI	PNEUMATIC TO CURRENT TRANSDUCER		REFRIGERANT DETECTOR
	WATER FLOW SWITCH		AIR FLOW MONITORING STATION
LSH LSL	PNEUMATIC HIGH / LOW SIGNAL SELECTOR	FAR	FIRE ALARM RELAY
AQ	DUCT AIR QUALITY SENSOR	TDR	TIME DELAY RELAY DELAY ON MAKE OR BREAK
LS1	LIMIT SWITCH	AHU OR EQUIPMENT NUMBER ZONE NUMBER	ZONE DESCRIPTOR
PE	BUTTERFLY CONTROL VALVE WITH PNEUMATIC ACTUATOR		
	AIR FLOW SWITCH		DUCT MOUNTED HUMIDISTAT
	HIGH LIMIT HUMIDISTAT		

SYMBOL AND ABBREVIATION SCHEDULE

PIPING AND PIPE FITTINGS

SYMBOL	DESCRIPTION
CD	CONDENSATE DRAIN
CWS	CHILLED WATER SUPPLY
CWR	CHILLED WATER RETURN
SCWS	SECONDARY CHILLED WATER SUPPLY
SCWR	SECONDARY CHILLED WATER RETURN
CDS	CONDENSER WATER SUPPLY
CDR	CONDENSER WATER RETURN
	NEW PIPING (LABELED ACCORDINGLY)
	FUTURE PIPING
	EXISTING PIPING
	POINT OF CONNECTION (NEW TO OLD)
	REDUCER
	FLEXIBLE CONNECTOR
	THERMOMETER W/ WELL
	PRESSURE GAUGE
	TRIPLE DUTY VALVE
	BUTTERFLY VALVE
	SOLENOID VALVE
	GATE VALVE
	GLOBE VALVE
	BALL VALVE
	SWING CHECK VALVE
	LIFT CHECK VALVE

TYPICAL REFERENCE FLAG NAME REPRESENTATIONS*

AMOA	Absolute minimum OA flow setpoint As determined by the Engineer of record
BOK	Pump HP-1 or HP-2 status proven on Typically Boiler OK to Run
BxALM	Boiler "x" Alarm"x" represents boiler number
BxRT	Boiler "x" Run Time"x" represents boiler number
CDN	Cool-down mode enabled
CHST	Chiller status proven on On=status proven
CHWR	Chilled water return temperature
CHWS	Chilled water supply temperature
CPCT	Chilled water valve position 0-100% open
DALM	Drive Alarm On=Alarm
DASP	Discharge air temperature setpoint
DMOA	Design minimum OA flow setpoint As determined by the Engineer of record
DPCTOA	Damper position 0-100% open
EPCT	Economizer position 0-100%
FLOW	Pump status proven on
GO	Unit "GO" Both the supply and return fans have been enabled by the BAS and the status of both has been proven ON
HOK	Heating Pump(s) status proven on
HPCT	HW reheat valve position 0-100% open
HST	Highest space temperature Pertains to zones served by the AHU only
HWR	Hot water return temperature
HWS	Hot water supply temperature
LZT	Low zone temperature flag On=zone temperature more than 2 deg F below setpoint
MAGO	Mixed air "GO" On when OA & RA conditions meet specified requirements to enable the economizer
MASP	Mixed air temperature setpoint
MAT	Mixed air temperature
MINOA	Minimum OA damper position 0-100% open
NDOA	Need for OA based on High Zone CO2 0-100%
NOFTR	FTR not allowed On=FTR not allowed based on OA conditions
OAFL	Outside air flow
Occ	Occupancy Mode Enabled
OCFM	Outside air flow
P1	Enable Pump-1 On=Run, typical for other pump numbers
P1A	Pump-1 Drive Alarm On=Alarm, typical for other pump numbers
P1FL	Pump-1 proof failed On=proof failure, typical for other pump numbers
P1PF	Pump-1 proof On=Status proven, typical for other pump numbers
P1RT	Pump-1 Run Time Typical for other pump numbers
PHT	Preheat Coil Discharge Temperature
PRS	HI/Lo pressure switch in alarm On=Alarm
PURG	Night Purge mode enabled
PWR	Power ON Enabled continuously whenever controller is powered and enabled
RAH	Return air humidity
RAT	Return air temperature
RFAIL	Return fan proof failed
RFPR	Return Fan proof On=Status proven
RGO	Return Fan "GO" Fan enabled by BAS and Status has been proven ON
RUN	Unit enabled (FAN running)
SAT	Supply air temperature
SBC	Setback cooling mode enabled
SBH	Setback heating mode enabled
SCFM	Supply air flow
SFAIL	Supply fan proof failed On=proof failure
SFPR	Supply Fan proof On=Status proven
SGO	Supply Fan "GO" Fan enabled by BAS and Status has been proven ON
SMK	Smoke detector alarm On=Alarm
SP1	Secondary Pump-1 Enable On=Run, typical for other pump numbers
SP1A	Secondary Pump-1 Drive Alarm On=Alarm, typical for other pump numbers
SP1FL	Secondary Pump-1 proof failed On=proof failure, typical for other pump numbers
SP1PF	Secondary Pump-1 proof On=Status proven, typical for other pump numbers
SP1RT	Secondary Pump-1 Run Time Typical for other pump numbers
SPD	Supply fan speed 0-100%
SPD	Remote DP PID loop output 0-100%
SPID	Remote DP PID loop output 0-100%
SysGO	System Enable On whenever run conditions are met
Temp	Space Temperature
WUP	Warm-up mode enabled

Note:

This is a list of typical representations. This list is not not intended to be inclusive or definitive. Refer to actual logic diagram to ensure actual reference tag representation.

BAS SUMMARY

1. COORDINATE WITH EXISTING CONTROL SYSTEM THAT WAS PROVIDED BY AUTOMATIC BUILDING CONTROLS, LLC IN 2020. PROVIDE NEW CONTROLS AND RECONFIGURE EXISTING CONTROLS AS REQUIRED TO ACCOMMODATE THE NEW & MODIFIED MECHANICAL EQUIPMENT INCLUDED WITHIN THE SCOPE OF THIS PROJECT. FULLY INTEGRATE ALL CONTROLS ASSOCIATED WITH THE WORK OF THIS PROJECT INTO THE EXISTING CONTROL SYSTEMS. PROVIDE GRAPHICS DISPLAYS AT THE EXISTING BAS FOR ALL NEW EQUIPMENT AND EXISTING EQUIPMENT WHERE CONTROL MODIFICATIONS ARE BEING MADE. NEW GRAPHICS DISPLAYS SHALL BE SIMILAR IN APPEARANCE AND FULLY INTEGRATED INTO THE EXISTING BAS PROGRAMMING.
2. REMOVE AND REPLACE ALL EXISTING ZONE TEMPERATURE SENSORS WITHIN THE BUILDING WITH NEW COMBINATION TEMPERATURE / SPACE CO2 SENSORS WITH INTEGRAL OCCUPANCY OVERRIDE BUTTON. INSTALL NEW COMBINATION SENSOR IN SAME LOCATION WHERE EXISTING SPACE TEMPERATURE SENSOR IS REMOVED AND INCLUDE WALL MOUNTING PLATES AS REQUIRED TO COMPLETELY COVER ANY EXISTING WALL OPENINGS.
   A. ZONE SENSOR QUANTITIES: AHU-8 = 5 ZONES (ZONE 3 INCLUDES (2) AVERAGING SENSORS), AHU-10 = 3 ZONES, AHU-11 = 2 ZONES.
3. APPROVED VENDORS AND THEIR PRODUCT LINES (NO SUBSTITUTIONS): AUTOMATIC BUILDING CONTROL, INC. - APPROVED FOR DISTECH TRIDIUM ONLY
4. SEE DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.

Mechanical and Electrical Coordination for Building Automation System

Work Activity	Furnish	Install	Low Voltage Wiring/Conduit	Line power
BAS low voltage and communications wiring	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS conduits and raceways	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
Automatic Control Dampers	Div. 23 based on BAS Specification and approved BAC submittal.	Div. 23	BAS Contractor	N/A
Automatic Control Damper Actuators	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
Automatic Control Valves	BAS Contractor	Div. 23	BAS Contractor	N/A
Automatic Control Valve Actuators	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
BAS Pipe mounted devices and taps, including thermowells, flow and pressure stations	Div. 23 furnish well, based on BAS Contractor control device. All other devices by BAS Contractor	Div. 23	BAS Contractor	BAS Contractor
BAS current switches	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS Control relays	BAS Contractor	BAS Contractor	BAS Contractor	N/A
BAS Duct mounted devices	BAS Contractor	Div. 23	BAS Contractor	BAS Contractor
BAS Equipment Mounted Devices (MAT averaging sensors, freeze stats, AFMS mounted to fan inlet cone, etc.)	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor
All BAS Nodes, equipment, housings, enclosures, and panels	BAS Contractor	BAS Contractor	BAS Contractor	BAS Contractor to provide power to transformation for BAS Contractor supplied devices
Duct Smoke Detector	BAS Contractor to provide, coordinate with Div. 26 if Fire Protection interface required	Div. 23	BAS Contractor BAS Contractor wiring to BAS and Div. 26 to Fire Protection system.	BAS Contractor
Unit Ventilators	Div. 23 to provide Digital Ready unit. BAS Contractor to provide all control devices, except dampers. Coordinate with BAS Contractor on types of sensors to be used	Div. 23	BAS Contractor	Div. 26 power for unit. BAS Contractor to provide required transformation for BAS Contractor supplied devices
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Power distribution monitoring relays	Div. 26	Div. 26	BAS Contractor	Div. 26
Starters, HOA switches	Div. 26	Div. 26	BAS Contractor control wiring to HOA	Div. 26
Control of 120V motors	BAS Contractor to provide HOA device	BAS Contractor	BAS Contractor	Div. 26
TAB work	Div. 23, coordinate with the BAS Contractor	N/A	N/A	N/A
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PUBLIC BUILDING COMMISSION — Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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312 663 3700

No.	Date	Description
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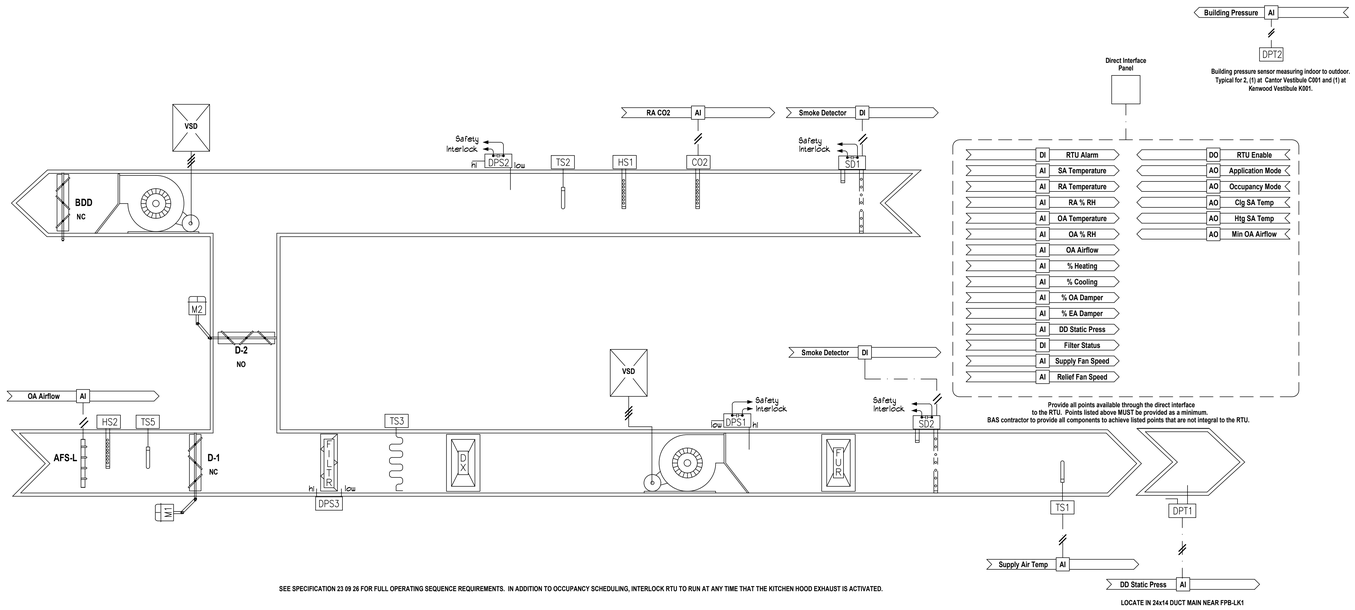
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: BAS GENERAL SYMBOLS

Sheet: M300-MEP



Building pressure sensor measuring indoor to outdoor. Typical for 2, (1) at Center Vestibule C001 and (1) at Kenwood Vestibule K001.

Provide all points available through the direct interface to the RTU. Points listed above MUST be provided as a minimum. BAS contractor to provide all components to achieve listed points that are not integral to the RTU.

SEE SPECIFICATION 23 09 26 FOR FULL OPERATING SEQUENCE REQUIREMENTS. IN ADDITION TO OCCUPANCY SCHEDULING, INTERLOCK RTU TO RUN AT ANY TIME THAT THE KITCHEN HOOD EXHAUST IS ACTIVATED.

LOCATE IN 24x14 DUCT MAIN NEAR FPB-LK1

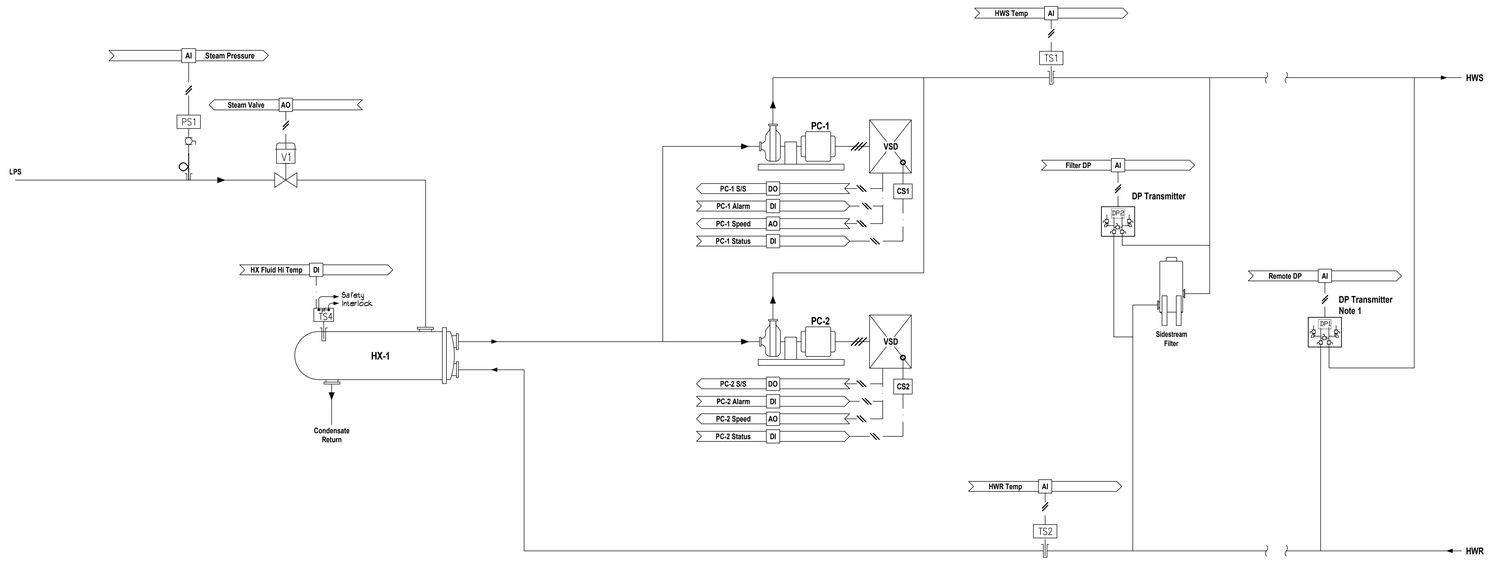
VAV RTU-L-Gas Heat and DX Cooling

POINTS LIST

ADDRESS	POINT DESCRIPTOR	DI	AI	DO	AO	VP	REMARKS
	Space CO2		•				typical for 2
	Smoke Detector	•					
	RTU Alarm	•					
	Supply Air Temp		•		•		typical for clg & htg
	Return Air Temp		•				
	Return Air %RH		•				
	Outside Air Temp		•				
	Outside Air %RH		•				
	SA Fan Speed		•				
	EA Fan Speed		•				
	OA Airflow		•				
	% Heating		•				
	% Cooling		•				
	% OA Damper		•				
	% EA Damper		•				
	DD Static Press		•				
	RTU S/S			•			
	Application Mode				•		
	Occupancy Mode				•		
	Clg SA Temp				•		
	Htg SA Temp				•		
	Min OA Airflow				•		
	Filter Status	•					

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TSI			Duct Temperature Sensor	
HSI			Duct Humidity Sensor	
CO2			Return Air CO2 Sensor	
SDI42			Smoke Detector	
DPTI			Differential Pressure Transmitter	
DPT2			Building Pressure Transmitter	(TYP FOR 2)
DPSI2			DP Switch (Manual Reset)	
AFS-L			OA Airflow Measuring Station	



Steam to Hot Water Heat Exchanger, VV Pumps

POINTS LIST

ADDRESS	POINT DESCRIPTOR	DI	AI	DO	AO	VP	REMARKS
	HX Steam Valve				•		
	PC-1 S/S			•			
	PC-1 Status	•					
	PC-1 Speed				•		
	PC-1 Alarm	•					
	PC-2 S/S			•			
	PC-2 Status	•					
	PC-2 Speed				•		
	PC-2 Alarm	•					
	HW Supply Temp		•				
	HW Return Temp		•				
	Remote DP		•				
	Sidestream Filt DP		•				
	Steam Pressure		•				
	HX Fluid Hi Temp	•					

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TSI-2			Immersion Temp Sensor	
DPI-2			Differential Pressure Transmitter	
CSI-2			Current Sensor (VFD Type)	
V1			HX Steam Valve	
T3			Immersion Temp Sensor	
PSI			Steam Pressure Sensor	
TS4			Immersion Hi Temp Switch	

DRAWING NOTES:

1. Locate downstream in the piping mains as located on the plans.
2. Provide hardwire interlock to close the HX steam supply valve closed if the HX temperature switch exceeds 200F

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

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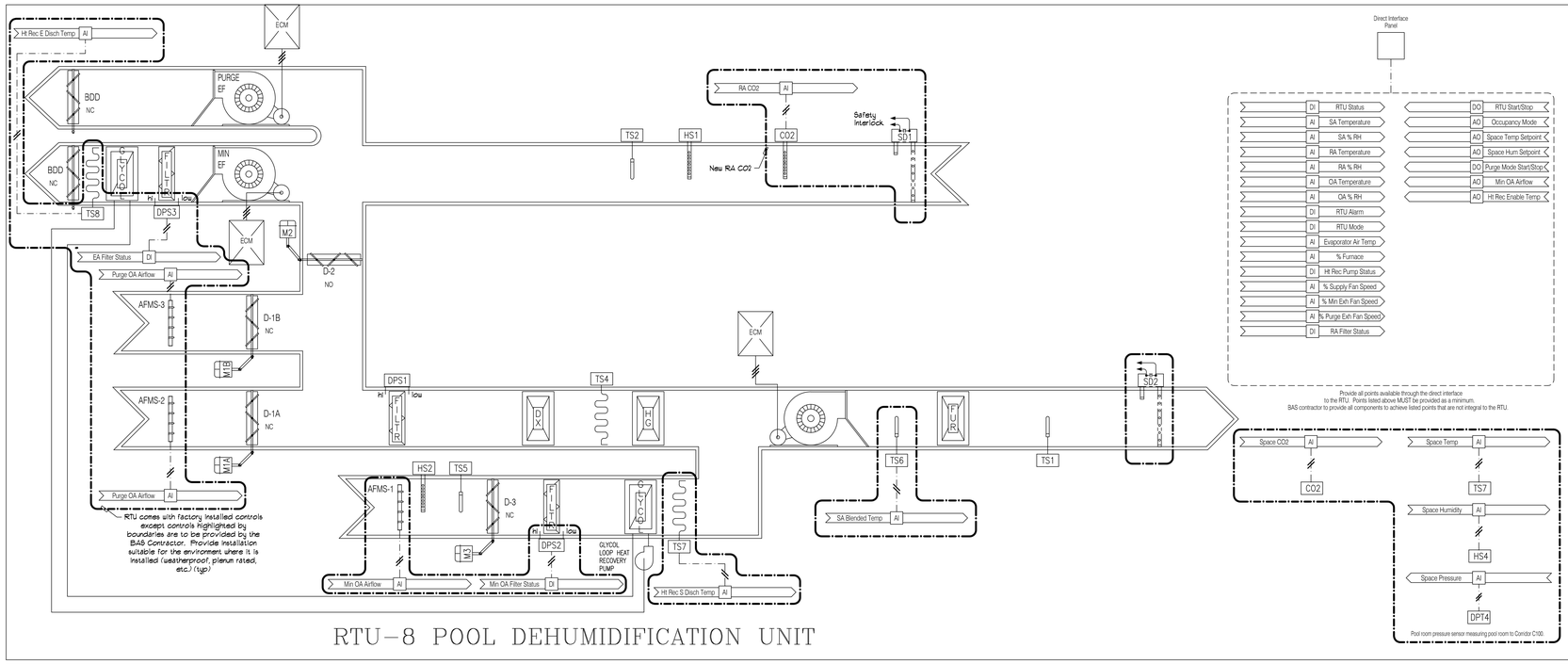
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)
Title
BAS CONTROL DIAGRAM
Sheet
M301-LNK



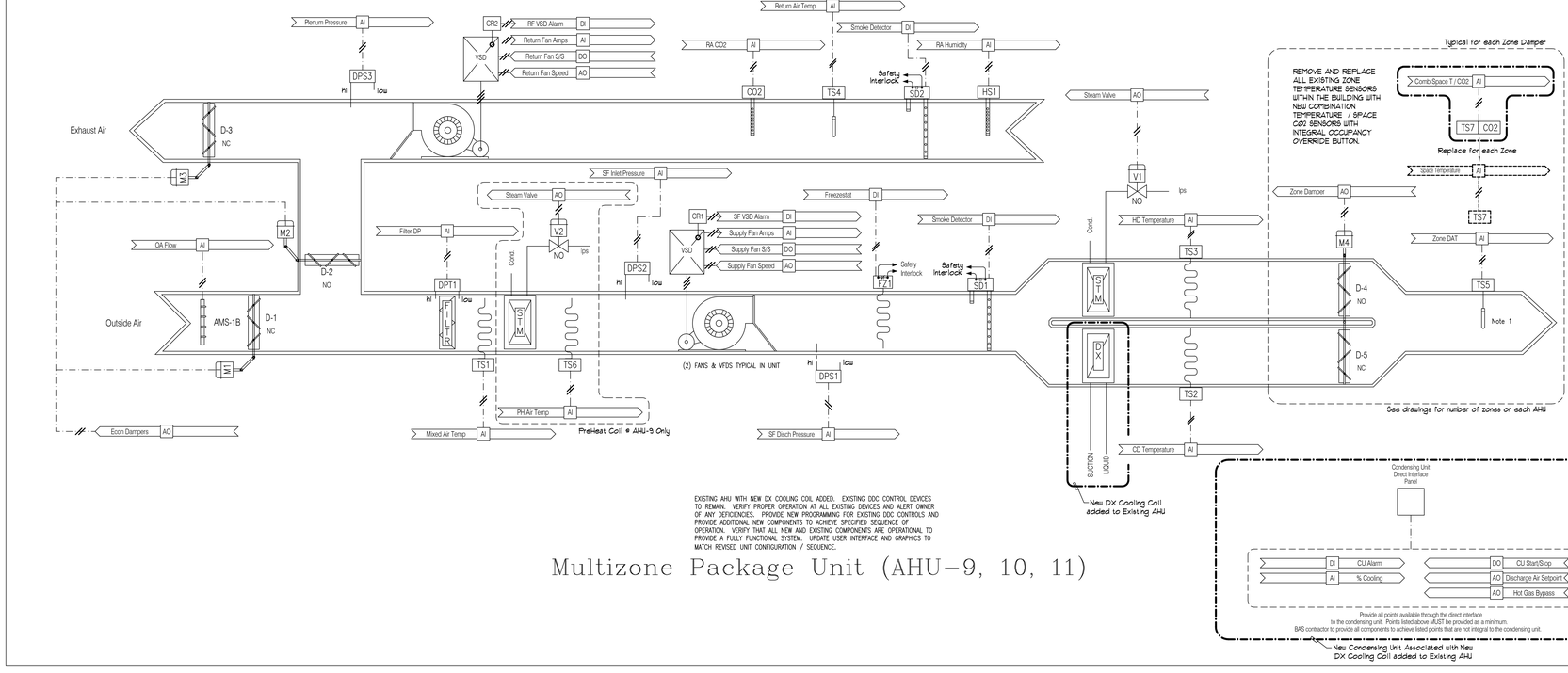
RTU-8 POOL DEHUMIDIFICATION UNIT

POINTS LIST

ADDRESS	POINT DESCRIPTOR	DI	AI	DO	AO	VP	REMARKS
	Smoke Detector	•					supply & return air
	RTU Alarm	•					Communication, sensor fault, compressor fault, freezestat, fan failure, power failure
	Supply Air Temp		•				
	SA Blend Air Temp		•				
	Return Air Temp		•				
	Return Air %RH		•				
	Return Air CO2		•				
	Outside Air Temp		•				
	Outside Air %RH		•				
	Min OA Airflow		•				
	Purge OA Airflow		•				Typical for 2
	RTU S/S			•			
	RTU Status	•					
	Supply Fan Speed		•				
	Exhaust Fan Speed		•				Typical for 2
	Occupancy Mode			•			Dehumidification, cooling, heating, economizer, purge
	Space Temp		•				
	Space Temp Setpoint				•		
	Space Humidity		•				
	Space Hum Setpoint				•		
	Space Pressure		•				
	Space CO2		•				
	Filter Status	•					Typical for 3 Banks
	Ht. Rec Pump Status	•					
	Ht. Rec S Disch T		•				
	Ht. Rec E Disch T		•				

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TS7			Space Temperature Sensor	
HS4			Space Humidity Sensor	
DPS-2,3			Filter DP Switch	
DPT4			Space Pressure Sensor	
CO2			Space & RA CO2 Sensors	
SD-12			SA & RA Smoke Detectors	
AFMS-1,2,3			OA Airflow Measuring Stations	



EXISTING AHU WITH NEW DX COOLING COIL ADDED. EXISTING DDC CONTROL DEVICES TO REMAIN. VERIFY PROPER OPERATION AT ALL EXISTING DEVICES AND ALERT OWNER OF ANY DEFICIENCIES. PROVIDE NEW PROGRAMMING FOR EXISTING DDC CONTROLS AND PROVIDE ADDITIONAL NEW COMPONENTS TO ACHIEVE SPECIFIED SEQUENCE OF OPERATION. VERIFY THAT ALL NEW AND EXISTING COMPONENTS ARE OPERATIONAL TO PROVIDE A FULLY FUNCTIONAL SYSTEM. UPDATE USER INTERFACE AND GRAPHICS TO MATCH REVISED UNIT CONFIGURATION / SEQUENCE.

Multizone Package Unit (AHU-9, 10, 11)

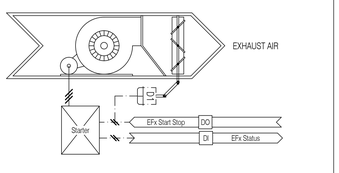
POINTS LIST

ADDRESS	POINT DESCRIPTOR	DI	AI	DO	AO	VP	REMARKS
	Supply Fan S/S			•			
	Supply Fan Speed				•		
	Supply Fan Amps		•				
	SF VSD Alarm	•					
	Return Fan S/S			•			
	Return Fan Speed				•		
	Return Fan Amps		•				
	RF VSD Alarm	•					
	Smoke Detector	•					Typical for SA & RA
	Freezestat	•					
	Mixed Air Temp		•				
	Return Air Temp		•				
	Return Air CO2		•				
	Filter DP		•				
	FH Temperature		•				AHU-9 only
	CD Temperature		•				
	HD Temperature		•				
	CD Temp Reset					•	to condensing unit
	FH Steam Valve					•	AHU-9 only
	HD Steam Valve					•	
	Econ Dampers					•	
	RA Humidity		•				
	OA Airflow		•				
	Plenum Pressure		•				Typical for (2)SA + RA
	CU Enable/Disable				•		
	CU Alarm	•					
	CU % Cooling		•				
	Hot Gas Bypass						
	Space Temp		•				Typical for each Zone
	Zone DAT		•				Typical for each Zone
	Zone CO2		•				Typical for each Zone
	Zone Damper				•		Typical for each Zone

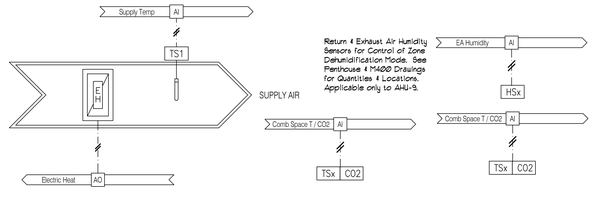
BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TS1,2,3,6			Averaging Duct Temperature Sensor	
TS4, 5			Duct Temperature Sensor	
DPT1			Differential Pressure Transmitter	
SD1,2			Smoke Detector	
CR1-2			Current Relay	
FZ1			Freezestat	
V1			Control Valve	
D1-3			Control Dampers	
D4,5			Zone Control Dampers	
M1-4			Damper Actuators	
R1			Safety Interlock Control Relay	
TS7/CO2			Comb Space Temp/CO2 Sensor	Typ for each Zone
HS1-x			Duct Humidity Sensor	
AMS1			OA Airflow Measuring Station	
DPS1,2,3			Pressure Switches	

DRAWING NOTES:
1. Locate each Zone Damper DAT sensor a sufficient distance downstream of the zone dampers to ensure adequate mixing of the airstreams.



Locker Rm Exhaust Fan with Motorized Damper (EF-36)



Duct Mounted Electric Reheat

POINTS LIST (PER MZ ZONE)

ADDRESS	POINT DESCRIPTOR	DI	AI	DO	AO	VP	REMARKS
	Space Temp		•				
	Supply Air Temp		•				
	Electric Reheat				•		
	Rset/Exh Humidity		•				
	TOTALS						

BILL OF MATERIAL

DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TSx			Zone Temp Sensor	
TS1			Duct Temp Sensor	
HSx			Zone RA/EA Humidity Sensor	See Plans for Qty
Dx			Damper Actuators	
TSx/CO2			Comb Zone Temp/CO2 Sensor	

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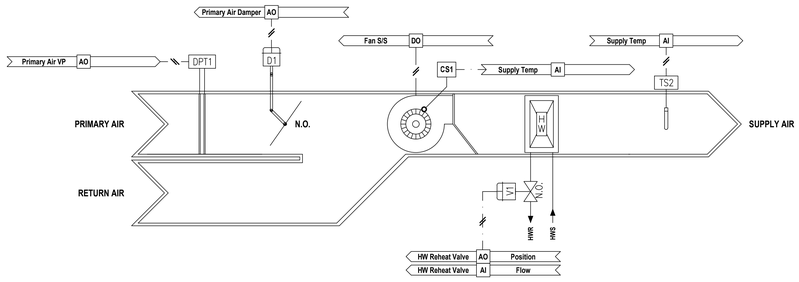
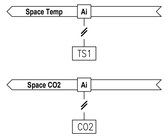
Project No.: 05326 (MCM 5031)
Title: BAS CONTROL DIAGRAM
Sheet: M301-MEP





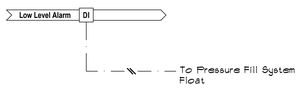
Series Fan Powered VAV Box

POINTS LIST

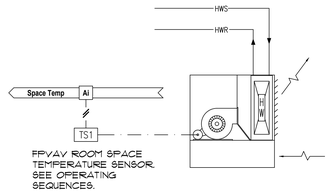
ADDRESS	POINT DESCRIPTOR	POINT TYPE DI	AI	DO	AO	VP	REMARKS
	Space Temp		•				
	Prim Air Damper				•		
	Primary Air VP		•				
	Supply Air Temp		•				
	HW Reheat Valve		•			•	
	Fan S/S			•			
	Fan Amps		•				
	Space CO2		•				
	TOTALS						

BILL OF MATERIAL

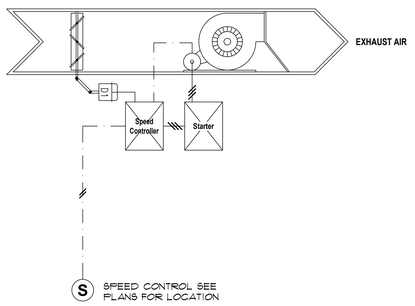
DESIG	QTY	MODEL NO.	DESCRIPTION	MFG / REMARKS
TS1			Room Temp Sensor	
CO2			Room CO2 Sensor	
TS2			Duct Temp Sensor	
D1			Primary Air Damper Actuator	
V1			HW Reheat Valve	
R1			S/S Relay	
CS1			Current Sensor	



Float Switch (Tank Level)



TYPICAL HW CABINET UNIT HEATER



Exhaust Fan with Wall Mtd Speed Control & associated EA Damper (E-34)

POINTS LIST

ADDRESS	POINT DESCRIPTOR	POINT TYPE DI	AI	DO	AO	VP	REMARKS
	EF-x Status	•					
	Low Level Alarm	•					Glycol Pressure Fill Sys.
	TOTALS						

Exhaust Fans

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Project No.: 05326 (MCM 5031)

Title
BAS CONTROL DIAGRAM

Sheet
M302-LNK

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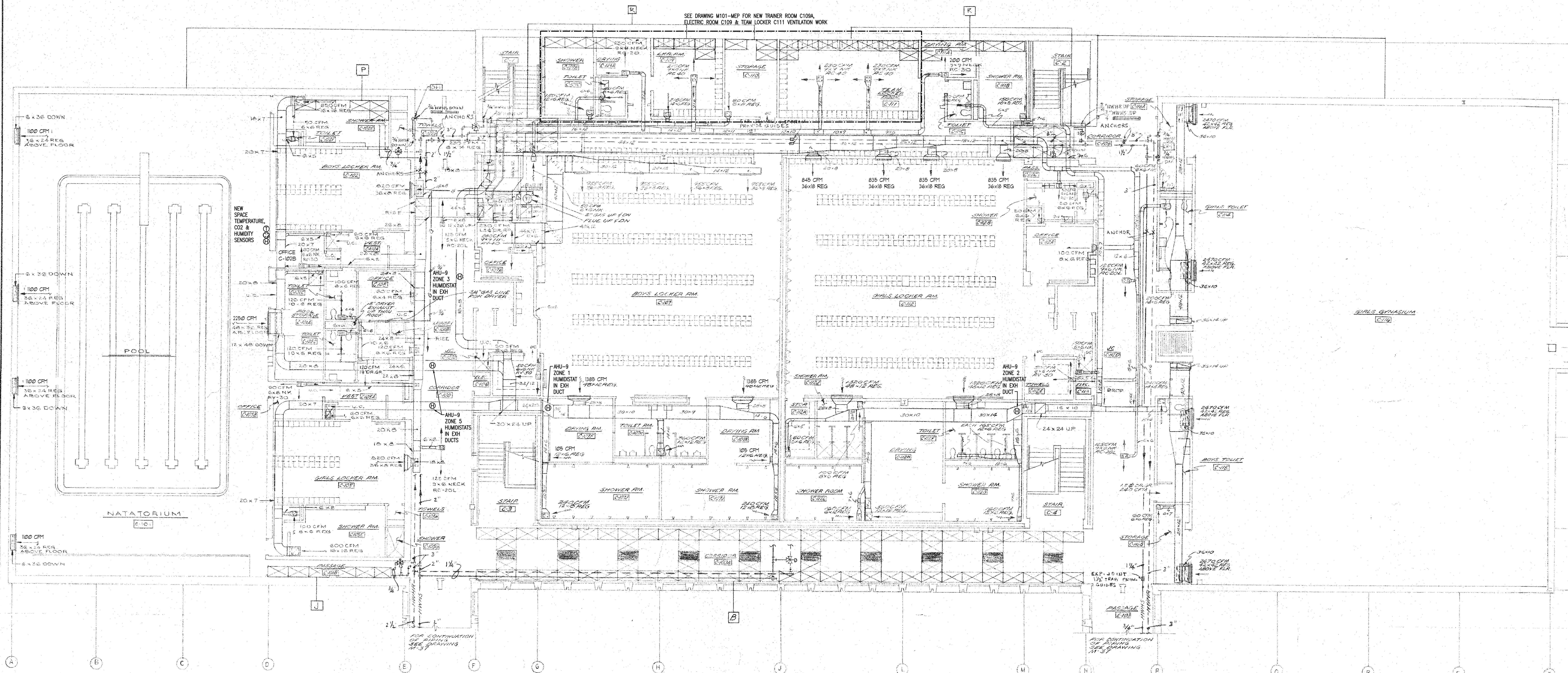
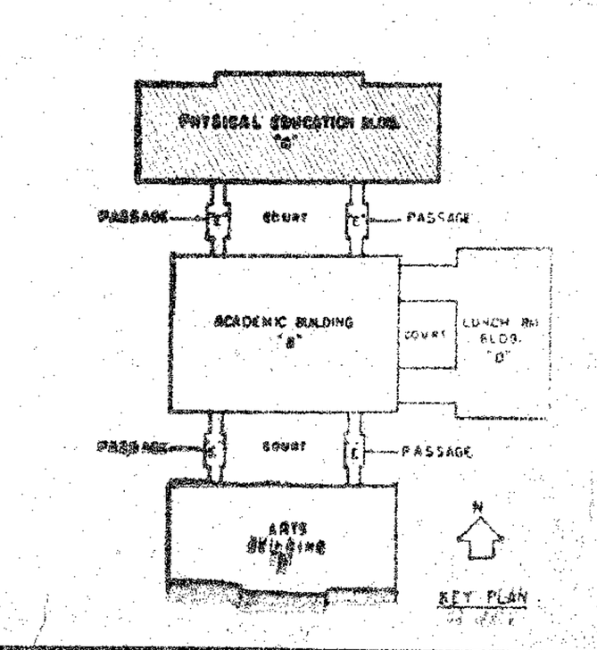


UNIT C PHYSICAL EDUCATION BLDG FIRST FL. HEATING & VENTILATING PLAN

SCALE 1/8"=1'-0"

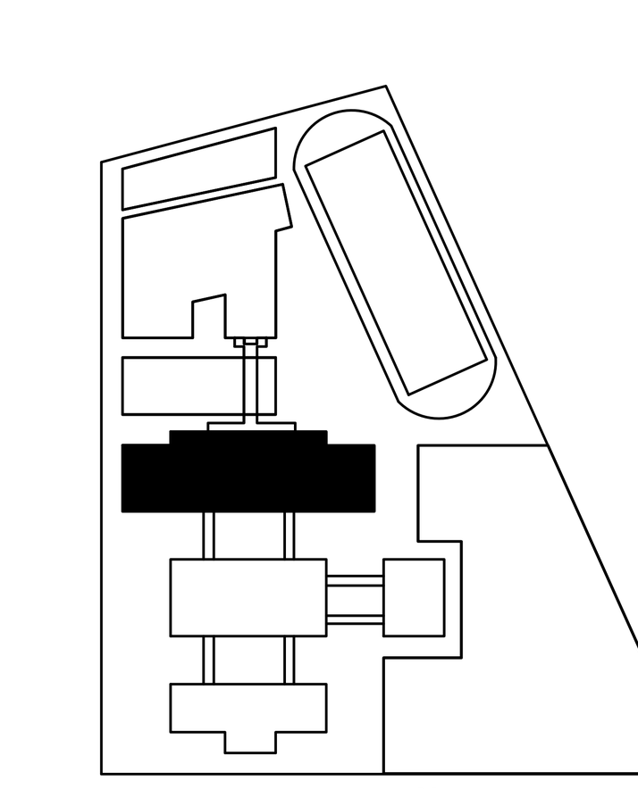


UNIT "C"

PHYSICAL ED. BLDG. FIRST FL. PLAN HEATING & VENTILATING	SHEET NO. M 35	DATE 1-15-68 ARCHTS. NO. 6738
KENWOOD HIGH SCHOOL • DISTRICT 14 BLACKSTONE AVENUE AND HYDE PARK BOULEVARD BOARD OF EDUCATION • CITY OF CHICAGO JAMES F. REDMOND GENERAL SUPERINTENDENT OF SCHOOLS	DRAWN BY R.T.C.W.J.D. CHECKED BY M.A.T. IN CHARGE P.D.M.C.	REVISIONS
SCHMIDT, GARDEN & ERIKSON 104 SOUTH MICHIGAN AVENUE, CHICAGO ARCHITECTS & ENGINEERS		

H-E 10 5156

LEGACY DRAWINGS FOR REFERENCE IN AIR BALANCING & HUMIDISTAT LOCATIONS ONLY



KEY PLAN

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KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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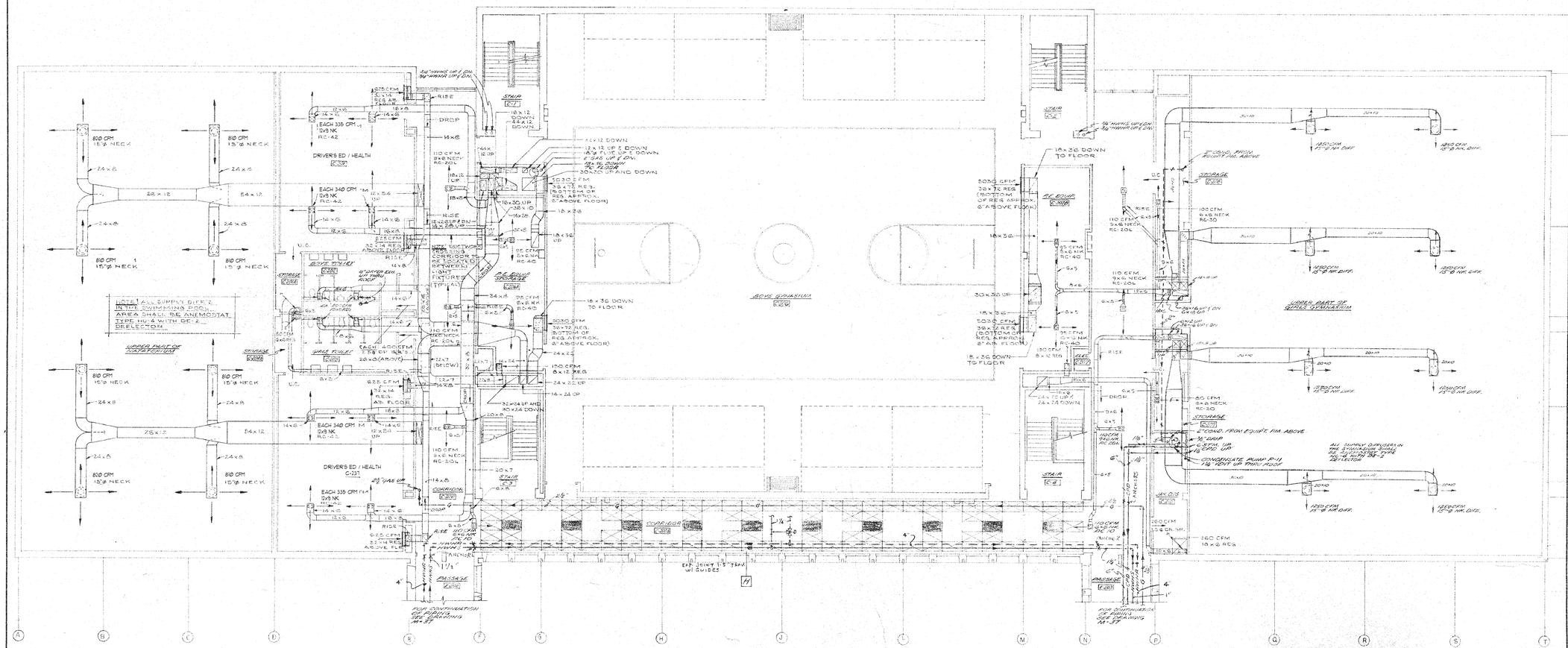
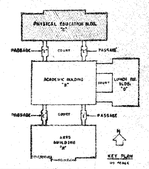
Project No.: 05326 (MCA# 5031)

Title: 1ST FLOOR LEGACY PLAN

Sheet: M401-MEP





UNIT "C"

PHYSICAL ED. BLDG. SECOND FL. PLAN HEATING & VENTILATING	SHEET NO. M-36	DATE 1-15-68 ARCHTS. NO. 67.59
KENWOOD HIGH SCHOOL • DISTRICT 14 BLACKSTONE AVENUE AND HYDE PARK BOULEVARD BOARD OF EDUCATION • CITY OF CHICAGO JAMES F. REDMOND GENERAL SUPERINTENDENT OF SCHOOLS	DRAWN BY R.T.O.W.J.P. CHECKED BY M. A. T. IN CHARGE P. D. M. C	REVISIONS
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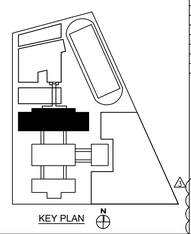
H-E 10 5156

LEGACY DRAWINGS FOR REFERENCE IN AIR BALANCING ONLY



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PUBLIC BUILDING COMMISSION
Chicago Public Schools

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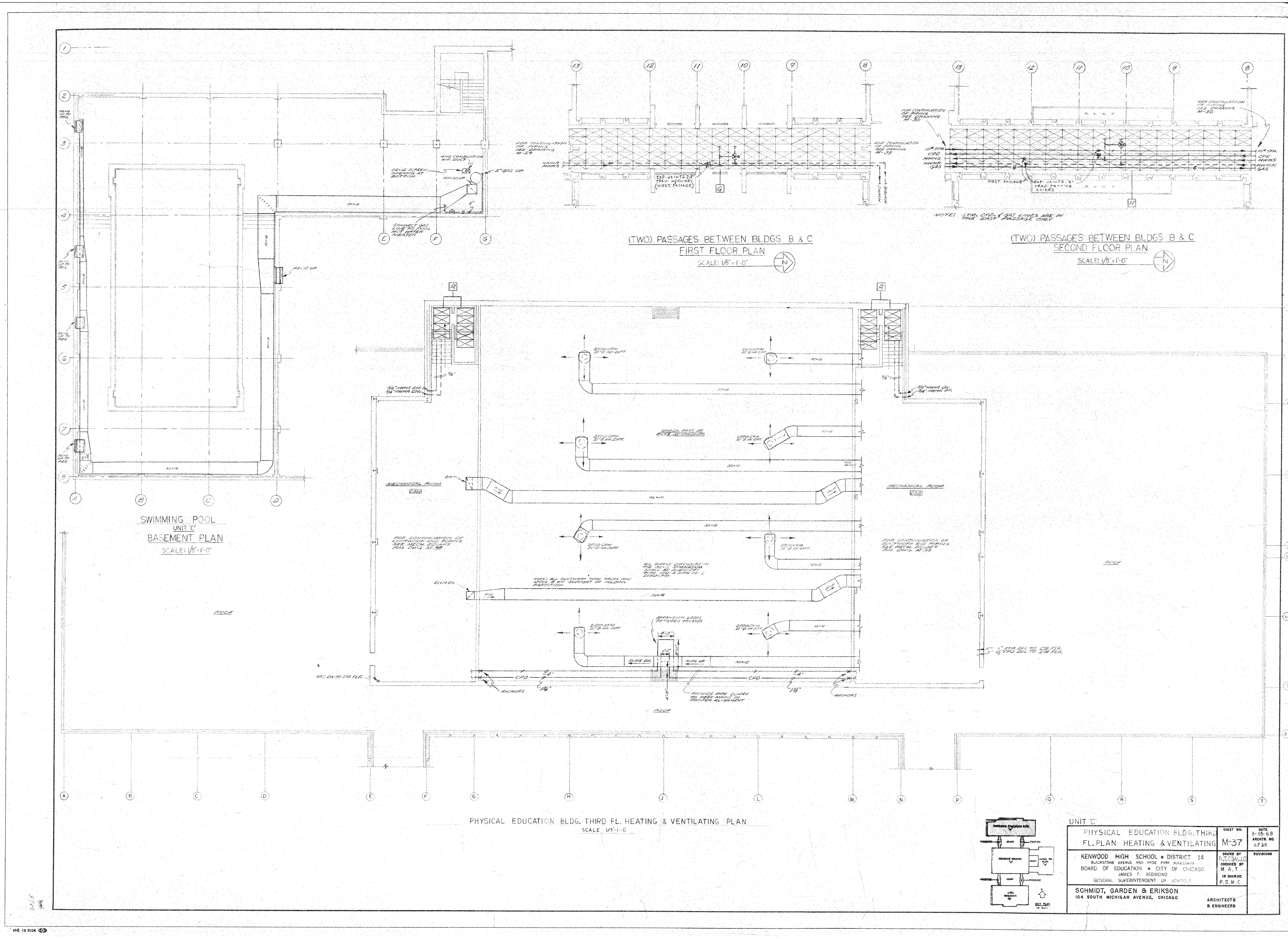
Title
2ND FLOOR LEGACY PLAN

Sheet
M402-MEP



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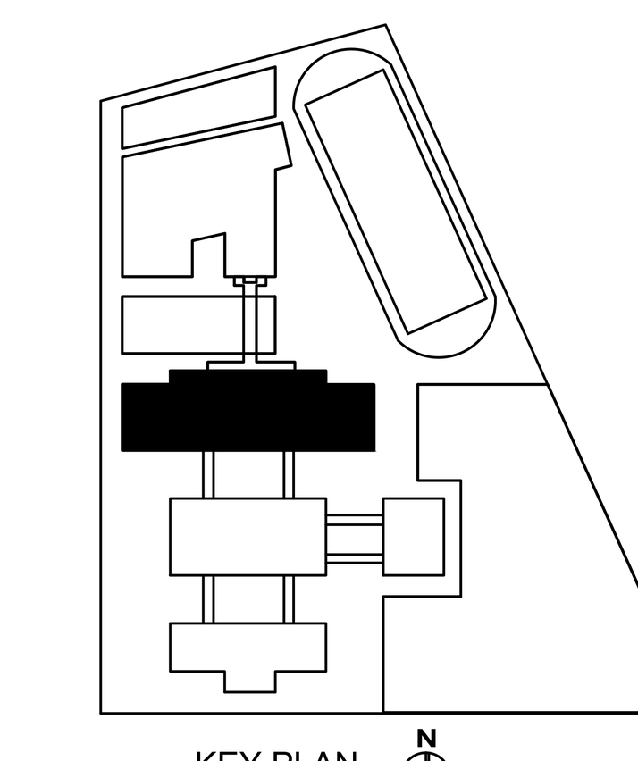

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LINK + MECHANICAL PROJECT
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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCA# 5031)

Title: 3RD FLOOR LEGACY PLAN

Sheet: M403-MEP

GENERAL ELECTRICAL NOTES: (APPLY TO ALL SHEETS)

1. ALL ELECTRICAL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATIONS AND ALL OTHER DRAWINGS RELATED TO THE PERFORMANCE OF THE WORK. THE CONTRACTOR SHALL VISIT THE JOB SITE AND FAMILIARIZE HIMSELF/HERSELF WITH ALL EXISTING AND PROPOSED EQUIPMENT LOCATIONS AND ROUTING REQUIREMENTS FOR NEW CONDUITS PRIOR TO SUBMITTING BID PROPOSAL.

2. GENERAL NOTES INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS SHALL BE CONSIDERED A PART OF THE CONTRACT.

3. ALL CONDUITS SHALL BE CONCEALED WHEREVER EXISTING OR NEW CONSTRUCTION, LAY-IN ACCESSIBLE CEILINGS, ETC. PERMIT.

4. THIS CONTRACTOR SHALL COORDINATE HIS WORK WITH ALL APPLICABLE TRADES.

5. BRANCH CIRCUIT WIRING IN EXCESS OF 75 FEET FOR 120V CIRCUITS SHALL BE #10 FROM PANEL TO MIDPOINT OUTLET OF THE CIRCUITS.

6. PROVIDE COVERPLATES FOR ALL JUNCTION BOXES, USED AND UNUSED, NEW OR EXISTING, FOR THIS WORK.

7. COORDINATE WITH ARCHITECTURAL DRAWINGS AND ALL APPLICABLE TRADES AND EXISTING CONDITIONS PRIOR TO INSTALLING CONDUITS, LIGHT FIXTURES, ETC.

8. CONDUIT RUNS SHOWN ON DRAWINGS ARE DIAGRAMMATIC ONLY. ACTUAL FIELD CONDITIONS SHALL BE VERIFIED AND CONDUITS SHALL BE ROUTED ACCORDINGLY.

9. ALL MEASUREMENTS AND DIMENSIONS SHALL BE FIELD VERIFIED BY THIS CONTRACTOR.

10. THIN WALL FITTINGS SHALL BE OF THE COMPRESSION TYPE. THE USE OF CRIMPING TYPE FITTINGS SHALL NOT BE ACCEPTABLE.

11. THE LOCATION OF ALL EQUIPMENT IS SHOWN DIAGRAMMATICALLY. THE EXACT LOCATION SHALL BE DETERMINED BY ACTUAL FIELD CONDITIONS. IF CONFLICT OCCURS WITH THE PLACEMENT OF EQUIPMENT SHOWN ON DRAWINGS AND EXISTING STRUCTURES AND APPURTENANCES, CONTRACTOR SHALL COORDINATE WITH DESIGN ENGINEER BEFORE FINAL INSTALLATION. CONTRACTOR SHALL OBTAIN AND VERIFY ALL DIMENSIONS AND CONDITIONS AT JOB SITE AND BE FULLY RESPONSIBLE FOR SAME.

12. THE CONTRACTOR SHALL FURNISH, INSTALL, AND CONNECT ALL EQUIPMENT IN ACCORDANCE WITH 2019 CHICAGO BUILDING CODE. AFTER EACH WORK DAY, CONTRACTOR SHALL CLEAN ALL WORK AREAS AND REMOVE ALL DEBRIS.

13. LOCATION OF ITEMS NOT FIXED BY DIMENSIONS ARE APPROXIMATE ONLY AND EXACT LOCATIONS NECESSARY TO SECURE THE BEST CONDITIONS AND RESULTS SHALL BE DETERMINED AT THE SITE AND SHALL BE SUBJECT TO REVIEW.

14. DO NOT SCALE FROM THESE DRAWINGS.

15. IDENTIFY ALL NEW RECEPTACLES WITH "BRADY" CLEAR VINYL POLYESTER TAPE WITH BLACK LETTERING. LABEL SHALL INDICATE RECEPTACLE PANEL AND CIRCUIT NUMBER AT BOTTOM OF COVER PLATE. (i.e.: RP-109:12)

16. PENETRATIONS OF FIRE RATED WALL AND FLOOR ASSEMBLIES SHALL BE PROTECTED WITH AN APPROVED THROUGH-PENETRATION SYSTEM AND SHALL BE A TESTED ASSEMBLY IN ACCORDANCE WITH ASTM E119. ALL CONDUIT PENETRATIONS THROUGH FLOORS AND WALLS SHALL BE FIRE SEALED. SEALANT RATING SHALL MEET OR EXCEED THE FIRE RATING OF FLOOR AND WALL CONSTRUCTION. REFER TO SECTION 07 84 00.

17. CPS RESERVES THE RIGHT TO RELOCATE ANY ELECTRICAL EQUIPMENT OR CONNECTION WITHIN FIVE FEET FROM THAT SHOWN ON THE DRAWINGS PRIOR TO INSTALLATION AT NO EXTRA COST TO CPS.

18. THIS CONTRACTOR RESPONSIBLE FOR THE EXECUTION OF THIS WORK SHALL BECOME THOROUGHLY FAMILIAR WITH THE PROJECT SPECIFICATIONS BEFORE COMMENCING ANY WORK. THE PROJECT SPECIFICATIONS AND DRAWINGS FORM THE BASIS OF THIS CONTRACT REQUIREMENTS AND INCLUDE THE TYPE AND GRADE OF MATERIALS TO BE INSTALLED, EQUIPMENT TO BE FURNISHED, THE MANNER BY WHICH TO BE INSTALLED AND WHERE TO BE LOCATED. IN THE EVENT OF A CONFLICT BETWEEN THE PROJECT SPECIFICATIONS AND DRAWINGS, SPECIFICATIONS GOVERN UNLESS THE ARCHITECT/ENGINEER DIRECTS OTHERWISE.

19. ALL BRANCH CIRCUIT FEEDERS SHALL BE PROVIDED WITH SEPARATE GROUNDING CONDUCTORS SIZED PER ARTICLE 250 OF THE CHICAGO BUILDING CODE.

20. PROVIDE PULL STRING IN ALL EMPTY CONDUITS.

21. CIRCUIT NUMBERS SHOWN ARE FOR CLARITY ONLY AND DO NOT REPRESENT ACTUAL CIRCUIT BREAKER NUMBERS IN EXISTING OR NEW PANELS. BRING ALL EXISTING PANEL DIRECTORIES UP TO DATE FOR ALL NEW AND EXISTING CIRCUITS, INCLUDING SPARES. PROVIDE NEW TYPEWRITTEN PANEL DIRECTORIES.

22. NO WIRING SHALL BE DONE PRIOR TO THIS CONTRACTOR'S REVIEW OF THE PROJECT EQUIPMENT SHOP DRAWINGS. COORDINATE FIELD CONDITIONS WITH THE CONTRACT DOCUMENTS. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ARCHITECT/ENGINEER'S ATTENTION FOR FINAL RESOLUTION. WORK THAT HAS TO BE REPLACED DUE TO LACK OF PROPER SHOP DRAWINGS COORDINATION SHALL BE DONE AT CONTRACTOR'S EXPENSE.

23. ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN DEMOLITION, REMOVAL, STORING, DISCONNECTING, RELOCATING, AND RECONNECTING OF EXISTING CONDUIT AND EQUIPMENT. ANY DISPUTE BETWEEN CONTRACTORS AS TO THEIR RESPECTIVE RESPONSIBILITY FOR THIS WORK SHALL BE RESOLVED BY THE ENGINEER AND HIS DECISION SHALL BE FINAL.

24. FURNISH AND INSTALL ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND APPURTENANCES FOR A COMPLETE ELECTRICAL SYSTEM. WHERE THERE IS NO MENTION OF THE RESPONSIBLE PARTY FOR A SPECIFIC ITEM TO BE FURNISHED, INSTALLED, OR WIRED ON THE ELECTRICAL DRAWINGS, THIS CONTRACTOR SHALL BE RESPONSIBLE COMPLETELY FOR A COMPLETE AND OPERATING SYSTEM FOR THIS ITEM.

25. LOCATION OF ITEMS NOT FIXED BY DIMENSIONS ARE APPROXIMATE ONLY AND EXACT LOCATIONS NECESSARY TO SECURE THE BEST CONDITIONS AND RESULTS SHALL BE DETERMINED AT THE SITE AND SHALL BE SUBJECT TO REVIEW.

26. THIS CONTRACTOR SHALL CHECK CAREFULLY ALL DRAWINGS AND SPECIFICATIONS THAT ARE PART OF THIS PROJECT TO INSURE THAT NO FIXTURE, OUTLET, PUSH PLATE OR CONTROL AND POWER WIRING IS OMITTED. THE CONTRACTOR SHALL CONSULT ALL TRADES FURNISHING EQUIPMENT AND OBTAIN FROM THEM ALL DATA. IN SOME CASES EQUIPMENT, FIXTURES AND DEVICES ARE SHOWN ONLY. ASCERTAIN AND PROVIDE THE WIRING AND CONTROL STATIONS REQUIRED FOR THE PROPER FUNCTION OF BUILDING EQUIPMENT.

27. ALL CONDUIT CONNECTIONS TO MOTORS SHALL BE SEALTIGHT FLEXIBLE CONDUIT; SAME CONDUIT SIZE AS CIRCUIT CONDUIT FROM MOTOR STARTER OR VARIABLE FREQUENCY DRIVE TO MOTOR.

28. PREPARE AND SUBMIT 1/4" SCALE COORDINATION DRAWINGS PRIOR TO ORDERING EQUIPMENT AND ROUGHING BRANCH CIRCUITS. LOCATE ALL ELECTRICAL EQUIPMENT, INDICATE CLEARANCES AND ROUTING OF ALL OVERHEAD BRANCH CIRCUITS.

29. CONTRACTOR SHALL COORDINATE EXACT LOCATIONS AND MOUNTING HEIGHTS OF ALL DEVICES WITH THE ARCHITECTURAL DRAWINGS INCLUDING BUT NOT LIMITED TO ARCHITECTURAL DETAILS, ELEVATIONS, AND CASEWORK DETAILS.

30. THE GENERAL CONTRACTOR SHALL SUBMIT MECHANICAL AND ELECTRICAL CONSTRUCTION AND COORDINATION DRAWINGS TO A SCALE OF 1/4"=1'-0" FOR 'REVIEW OF DESIGN INTENT' INDICATING COORDINATION OF ALL TRADES PRIOR TO INSTALLATION OF MECHANICAL AND ELECTRICAL WORK. PROVIDE MECHANICAL AND ELECTRICAL COORDINATION DRAWINGS, AT MINIMUM, FOR ALL CORRIDORS, LINK, CLASSROOMS, ELECTRICAL ROOMS, AND MECHANICAL ROOMS. GENERAL CONTRACTOR SHALL DETAIL MAJOR ELEMENTS, COMPONENTS, AND SYSTEMS OF MECHANICAL AND ELECTRICAL EQUIPMENT AND MATERIALS IN RELATIONSHIP WITH OTHER SYSTEMS AND BUILDING COMPONENTS.

31. WHERE THERE IS A CONFLICT BETWEEN THE DRAWINGS AND SPECIFICATIONS, BID SHALL BE BASED ON THAT ITEM WHICH IS GREATER IN QUANTITY OR QUALITY. VERIFY WITH THE ENGINEER WHICH ITEM SHALL TAKE PRECEDENCE PRIOR TO THE INSTALLATION OF THIS ITEM.

32. PROVIDE A DEDICATED NEUTRAL FOR EACH 120 VOLT CIRCUIT.

DEMOLITION/REMOVAL NOTES:

D1. VERIFY EXISTING CONDITIONS AND LOCATIONS IN FIELD PRIOR TO SUBMITTING BID PROPOSAL. FAILURE TO DO SO SHALL NOT RELIEVE THIS CONTRACTOR FROM PERFORMING THE WORK UNDER THIS CONTRACT.

D2. MAKE NECESSARY MODIFICATIONS AND ADJUSTMENTS TO ALL ELECTRICAL ITEMS AND EQUIPMENT, BOTH NEW AND EXISTING, AS MAY BE REQUIRED BY THESE ALTERATIONS.

D3. DISCONNECT AT SOURCE AND REMOVE EXISTING ELECTRICAL MATERIALS AND EQUIPMENT, INCLUDING BUT NOT LIMITED TO: LIGHTING FIXTURES, WIRING DEVICES, FIRE ALARM DEVICES, MOTION SENSORS, SPEAKERS, DOOR CONTACTS, SURFACE STEEL RACEWAY, CONDUIT AND WIRES, AND ALL OTHER ELECTRICAL ITEMS WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS. THESE ARE THE PROPERTY OF CPS AND SHALL EITHER BE REMOVED FROM THE SITE LEGALLY OR RETURNED TO THE OWNER'S STOCK AT THE DISCRETION OF CPS.

D4. IT SHALL BE THIS CONTRACTOR'S RESPONSIBILITY TO MAINTAIN THE ELECTRICAL CONTINUITY AND CONTINUITY OF EXISTING MISCELLANEOUS SYSTEMS DURING THE ENTIRE CONSTRUCTION PERIOD. IF IT IS ABSOLUTELY NECESSARY TO SHUT DOWN ANY FEEDER OR SERVICE OR DISTRIBUTION EQUIPMENT AT ANY TIME, THIS CONTRACTOR SHALL CONSULT WITH CPS TO MAKE ARRANGEMENTS TO DO SO ON SUNDAYS OR OFF-HOUR PERIODS AT THE CONVENIENCE OF CPS. PRIOR WRITTEN NOTICE SHALL BE GIVEN TO THE CPS (3) CALENDAR DAYS IN ADVANCE OF THE DESIRED SHUTDOWN TIME. ANY PREMIUM OR OVERTIME COSTS NECESSARY TO ACCOMPLISH THE ABOVE SHALL BE INCLUDED IN BID PROPOSAL. CONTRACTOR SHALL PROVIDE ALL TEMPORARY WIRING, OVER DEVICES, CONDUITS, PULLBOXES, IN ORDER TO MAINTAIN CONTINUITY OF ELECTRICAL SERVICES IN THE EXISTING BUILDING.

D5. DISCONNECT, REMOVE, AND REINSTALL EXISTING ELECTRICAL MATERIALS AND EQUIPMENT INCLUDING BUT NOT LIMITED TO LIGHTING FIXTURES, WIRING DEVICES, CONDUIT, SURFACE STEEL RACEWAY, AND ALL OTHER ELECTRICAL ITEMS WHICH INTERFERE OR ARE INTERFERED WITH, OBSTRUCT OR ARE OBSTRUCTED BY, THESE ALTERATIONS. PERMANENTLY REINSTALL SUCH ITEMS. PROVIDE NEW OUTLETS, CONDUITS, SURFACE STEEL RACEWAY, WIRING, ETC., AS REQUIRED TO EXTEND SERVICE TO NEW LOCATIONS. RECONNECT SUCH ITEMS IN PROPER OPERATING CONDITION AT NEW OR EXISTING LOCATIONS AS REQUIRED.

D6. ANY EQUIPMENT THAT IS TO BE REINSTALLED AND RECONNECTED SHALL BE CAREFULLY EXAMINED FOR ANY DEFECTS AND TESTED FOR ELECTRICAL CONTINUITY AND PROPER OPERATION PRIOR TO REMOVAL. ANY DEFECTS OR MALFUNCTIONS DETECTED SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ARCHITECT AND CPS. AFTER EQUIPMENT HAS BEEN CERTIFIED TO BE IN GOOD ELECTRICAL/MECHANICAL CONDITION, THE EQUIPMENT MAY BE REMOVED, BOXED, STORED, AND PROTECTED BY THE CONTRACTOR. CONTRACTOR SHALL BEAR ALL EXPENSES FOR ANY EQUIPMENT REINSTALLED THAT IS NOT OPERATING PROPERLY. CONTRACTOR SHALL REPLACE WITH NEW EQUIPMENT OR PROPERLY REPAIR ANY DAMAGED OR NON-WORKING EQUIPMENT TO THE SATISFACTION OF CPS.

D7. WHERE EXISTING CONDUITS HAVE BEEN MADE OBSOLETE BY THESE ALTERATIONS AND IT IS IMPRACTICAL TO REMOVE SAME, THIS CONTRACTOR SHALL:
- a). PULL OUT ALL WIRE AND CABLE.
- b). CUT CONDUIT OFF AT SLAB OR WALL LINE.
- c). BLANK-UP ALL OBSOLETE CONDUIT ENTRIES INTO EXISTING JUNCTION BOXES, PANELBOARD, PULL BOXES, ETC.
- d). CAP CONDUIT AND PATCH SURFACE TO MATCH EXISTING.

D8. REFER TO ARCHITECTURAL AND MECHANICAL DEMOLITION DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL ELECTRICAL DEMOLITION/REMOVAL WORK REQUIRED.

D9. WHERE THE CONTINUITY OF CIRCUITS OR CONDUITS SERVING ANY EXISTING ELECTRICAL EQUIPMENT IN AREAS OF THE EXISTING BUILDING NOT BEING ALTERED IS INTERFERED WITH, THIS CONTRACTOR SHALL REROUTE AND RECONNECT ALL SUCH CIRCUITS OR CONDUITS.

D10. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES FOR LIGHT FIXTURES AND MOTORS WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS.

D11. REMOVE ALL CONDUITS INCLUDING ALL CONDUITS ABOVE THE CEILING AND ALL EXPOSED CONDUITS AND ASSOCIATED HANGERS AND MISCELLANEOUS AND INCIDENTAL HARDWARE WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS.

D12. LIGHT FIXTURES. REMOVE LIGHT FIXTURES, STEMS, LAMPS, ACCESSORIES, JUNCTION BOXES, CONDUITS AND WIRING. WHERE PARTIAL LIGHTING IS REMOVED, REWIRE EXISTING LIGHTING TO REMAIN TO THE EXISTING CIRCUIT OR OVERCURRENT DEVICE.

D13. HVAC MOTORS. REMOVE EXISTING MOTORS, MOTOR STARTERS, PUSH BUTTONS, DISCONNECT SWITCHES, CONDUITS, WIRING, FITTINGS, AND BOXES. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES. REFER TO MECHANICAL DEMOLITION DRAWINGS FOR EXACT LOCATIONS.

D14. LIGHTING FIXTURES, SWITCHES, RECEPTACLES, MISCELLANEOUS DEVICES, AND MISCELLANEOUS WIRING DEVICES SHOWN TO BE REMOVED DO NOT REPRESENT THE EXACT QUANTITY OF ELECTRICAL MATERIALS, WIRING DEVICES, EQUIPMENT TO BE REMOVED. CONTRACTOR SHALL PROVIDE FOR THE FOLLOWING:
- a). REMOVE ALL EXISTING LIGHT FIXTURES WHERE NEW LIGHTING IS SHOWN AND SPECIFIED. MAINTAIN CONTINUITY OF ALL EXISTING LIGHTING FIXTURES TO REMAIN.
- b). REMOVE ALL UNUSED WIRING BACK TO OVERCURRENT DEVICE.

D15. CAREFULLY REMOVE AND REINSTALL EXISTING CEILING OR WALL MOUNTED EQUIPMENT AS REQUIRED FOR INSTALLATION OF NEW WORK, INCLUDING DISCONNECTING, REMOVAL, REINSTALLATION AND RECONNECTING OF EXISTING CEILING OR WALL MOUNTED DEVICES.

D16. CAREFULLY REVIEW THE ARCHITECTURAL AND MECHANICAL DRAWINGS FOR ADDITIONAL ITEMS TO BE REMOVED AND/OR RELOCATED. INCLUDE ALL COSTS IN BID PROPOSAL FOR REMOVAL, DISCONNECTING, OR RELOCATION OF EQUIPMENT AFFECTED BY DEMOLITION OF OTHER TRADES.

DEMOLITION/REMOVAL NOTES: (CONT'D)

D17. ALL EXISTING CONDUIT AND WIRING INTERFERING WITH THE NEW WORK SHALL BE REROUTED AND CONCEALED IN THE NEW CONSTRUCTION WHERE POSSIBLE.

D18. EXISTING ELECTRICAL EQUIPMENT NOT SHOWN ON THIS DRAWING; HOWEVER, REQUIRED TO BE REMOVED AND/OR RELOCATED BY DEMOLITION, SHALL BE INCLUDED BY THIS CONTRACTOR IN HIS/HER BID PROPOSAL.

D19. REFER TO MECHANICAL DEMOLITION DRAWINGS FOR EXACT LOCATIONS OF ALL MOTORS SHOWN TO BE REMOVED. PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES FOR DISCONNECTION AND REMOVAL OF ALL RELATED ELECTRICAL EQUIPMENT AND DEVICES INCLUDING, BUT NOT LIMITED TO THE FOLLOWING:
- a). REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES.
- b). REMOVE ALL CONDUITS, HANGERS, BOXES, ANCHORS, CHANNELS, ETC. FOR A COMPLETE REMOVAL.
- c). UPDATE DISTRIBUTION PANEL, PANELBOARD, NAMEPLATES, AND DIRECTORIES. WHERE A CIRCUIT BREAKER OR FUSIBLE BRANCH SWITCH IS NOW SPARE; PROVIDE ENGRAVED NAMEPLATE "SPARE".
- d). REMOVE DISCONNECT MEANS.
- e). DISCONNECT MOTORS FROM SUPPLY SOURCE.
- f). REMOVE ALL CONTROL CONDUITS AND ASSOCIATED WIRING.
- g). REMOVE MOTOR STARTER

D20. CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN CLEANUP THROUGHOUT THE COURSE OF THE DEMOLITION WORK.

D21. FLOOR SLABS MAY CONTAIN CONDUIT SYSTEMS. THIS CONTRACTOR IS RESPONSIBLE FOR TAKING ANY MEASURES REQUIRED TO ENSURE NO CONDUITS OR OTHER SERVICES ARE DAMAGED. THIS INCLUDES X-RAY OR SIMILAR NON-DESTRUCTIVE MEANS.

D22. THIS CONTRACTOR IS RESPONSIBLE FOR ALL COSTS INCURRED IN REPAIR, RELOCATIONS, OR REPLACEMENT OF ANY CABLES, CONDUITS, OR OTHER SERVICES IF DAMAGED WITHOUT PROPER INVESTIGATION.

D23. PERFORM ALL CUTTING, CORING, AND PATCHING REQUIRED TO COMPLETE THE WORK. PERFORM ALL DEMOLITION AND REMOVAL OF DEBRIS RESULTING THEREFROM AND REQUIRED TO COMPLETE THE WORK. PATCH AND PAINT EXISTING FINISHED SURFACES AND BUILDING COMPONENTS USING NEW MATERIALS MATCHING EXISTING MATERIALS AND TEXTURE USING EXPERIENCED INSTALLERS. REFER TO SPECIFICATIONS AND ARCHITECTURAL DRAWINGS.

D24. WHERE EXISTING SURFACE MOUNTED RACEWAY IS BEING REMOVED, THIS CONTRACTOR SHALL VERIFY THAT NO SERVICE INTERRUPTIONS HAVE OCCURRED ONCE RACEWAY HAS BEEN REMOVED.

D25. ALL EQUIPMENT SPECIFIED TO BE REMOVED, STORED, RE-INSTALLED, AND REWIRED, INCLUDING BUT NOT LIMITED TO LIGHT FIXTURES, MOTION SENSORS, AND FIRE ALARM DEVICES SHALL BE PRE-VERIFIED FOR PROPER OPERATION PRIOR TO REMOVAL IN THE PRESENCE OF CPS. ALL INOPERATIVE DEVICES SHALL BE RECORDED. ALL PARTIES, INCLUDING CPS, ARCHITECT, AND CONTRACTOR, SHALL RECEIVE DOCUMENTATION OF ANY EXISTING DEFECTIVE EQUIPMENT. CONTRACTOR SHALL BEAR ALL COST AND RESPONSIBILITY FOR ALL EQUIPMENT SCHEDULED TO BE REMOVED, STORED, REINSTALLED, AND REWIRED BY THE CONTRACTOR. CONTRACTOR AGREES TO REPAIR OR REPLACE TO THE SATISFACTION OF CPS ALL MATERIALS AND EQUIPMENT FOUND TO BE INOPERATIVE AFTER REINSTALLATION AT NO ADDITIONAL OR EXTRA COST TO THE CONTRACT. ALL EQUIPMENT NOT PRE-VERIFIED BY THE CONTRACTOR FOR PROPER OPERATION PRIOR TO EQUIPMENT REMOVAL SHALL AUTOMATICALLY ASSUME FULL RESPONSIBILITY FOR PROPER OPERATION UPON REINSTALLATION OF EQUIPMENT.

D26. MAINTAIN CONTINUITY FOR EXIT DIRECTIONAL SIGNS AND EMERGENCY LIGHTING FOR MEANS OF EGRESS. PROVIDE TEMPORARY WIRING FOR REMOVING, RELOCATING, RE-INSTALLING, REWIRING EXISTING EXIT SIGNS AND LIGHT FIXTURES AS REQUIRED TO MAINTAIN EXIT DIRECTIONAL SIGNAGE AND EMERGENCY LIGHTING DURING THE ENTIRE CONSTRUCTION PERIOD.

D27. EXISTING SCHOOL INTRUSION DETECTION SYSTEM, CCTV CAMERAS, AND INTERCOM SYSTEM HEAD END EQUIPMENT, LOCAL DEVICES, ASSOCIATED CONDUIT AND WIRING TO REMAIN. PRESERVE DURING ENTIRE CONSTRUCTION PERIOD AND MAINTAIN OPERATIONAL AT ALL TIMES. COORDINATE ANY DOWNTIME REQUIRED WITH CPS.

D28. IT SHALL BE THIS CONTRACTOR'S RESPONSIBILITY TO MAINTAIN ALL LOW VOLTAGE SYSTEM CABLING CONTINUITY DURING THE ENTIRE CONSTRUCTION PERIOD. IF IT IS ABSOLUTELY NECESSARY TO SHUT DOWN ANY ELECTRONIC EQUIPMENT AT ANY TIME, THIS CONTRACTOR SHALL CONSULT WITH CPS TO MAKE ARRANGEMENTS TO DO SO ON SUNDAYS OR OFF-HOUR PERIODS AT THE CONVENIENCE OF CPS. PRIOR WRITTEN NOTICE SHALL BE GIVEN TO CPS (3) CALENDAR DAYS IN ADVANCE OF THE DESIRED SHUTDOWN TIME. ANY PREMIUM OR OVERTIME COSTS NECESSARY TO ACCOMPLISH THE ABOVE SHALL BE INCLUDED IN BID PROPOSAL. CONTRACTOR SHALL PROVIDE ALL TEMPORARY CABLING, CONDUITS, IN ORDER TO MAINTAIN CONTINUITY OF ALL LOW VOLTAGE SYSTEM CABLING IN THE EXISTING BUILDING.

D29. WHERE EXISTING DATA OUTLETS ARE BEING REMOVED, CONTRACTOR SHALL REMOVE ALL CABLES BACK TO THE CLASSROOM CONCENTRATOR ENCLOSURE OR MDF ROOM AS REQUIRED.

INTERCOM AND PAGING SYSTEM NOTES:

A. PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES TO REMOVE THE EXISTING TELECOR #ACP-2B INTERCOM AND PAGING SYSTEM HEADEND EQUIPMENT LOCATED IN MAIN OFFICE 201 OF CANTER MIDDLE SCHOOL AND REPLACE WITH NEW INTERCOM AND PAGING SYSTEM HEADEND EQUIPMENT COMPATIBLE WITH EXISTING RAULAND TELECENTER LOCATED IN THE MAIN OFFICE OF KENWOOD ACADEMY. RECONNECT ALL EXISTING INTERCOM CABLES TO NEW HEADEND EQUIPMENT. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION. ANY ITEMS OR ITEM OF MATERIAL AND/OR EQUIPMENT NOT SHOWN ON THE DRAWINGS OR SPECIFIED, BUT REQUIRED FOR SATISFACTORY OPERATION, SHALL BE FURNISHED AND INSTALLED AS THOUGH COMPLETELY SPECIFIED HEREIN AND SHOWN ON THE DRAWINGS AT NO EXTRA COST TO THE CONTRACT.

B. IN GENERAL, THIS SECTION INCLUDES, BUT IS NOT NECESSARILY LIMITED TO THE FURNISHING, INSTALLING, AND/OR PERFORMANCE OF THE FOLLOWING:
1. FURNISH AND INSTALL ALL EQUIPMENT, ACCESSORIES, AND MATERIALS TO PROVIDE A COMPLETE AND OPERATING SOUND INTERCOM AND PAGING SYSTEM FOR CANTER MIDDLE SCHOOL.
2. THE NEW INTERCOM AND PAGING SYSTEM HEADEND EQUIPMENT SHALL INTERFACE TO THE EXISTING RAULAND TELECENTER INTERCOM AND PAGING SYSTEM LOCATED IN KENWOOD ACADEMY SUCH THAT EACH SCHOOL SHALL HAVE "ALL CALL" PAGING CAPABILITIES INCLUDING OUTSIDE SPEAKERS.
3. THE SYSTEM PROVIDED UNDER THIS CONTRACT SHALL INTERFACE TO ALL EXISTING INTERCOM SYSTEM DEVICES AND WIRING.
4. TESTING, CORRECTING, AND RETESTING FOR SOUND INTERCOM AND PAGING SYSTEM.
5. SHOP DRAWINGS AND RECORD DRAWINGS.
6. ALL GUARANTEES AND WARRANTIES.
7. MISCELLANEOUS HANGERS, CHANNELS, BRACKETS, BACK-BOXES, HARDWARE, CONDUITS.
8. FIRE SEALS FOR ALL WALL AND FLOOR SYSTEM PENETRATIONS.
9. MAINTAIN CONTINUITY OF ALL SERVICES FOR ALL EXISTING INTERCOM SPEAKERS AND CALL SWITCHES DURING ENTIRE CONSTRUCTION PERIOD.
10. ALL EQUIPMENT PROVIDED BY THIS CONTRACTOR SHALL BE INSTALLED IN STRICT CONFORMANCE TO MANUFACTURER'S INSTRUCTIONS AND WIRING DIAGRAMS. PROVIDE ALL REQUIRED COMPONENTS AND MISCELLANEOUS AND INCIDENTAL HARDWARE FOR A COMPLETE INSTALLATION READY FOR OPERATION.
11. IT IS INTENDED THAT ALL ITEMS OF WORK AND SYSTEMS BE FURNISHED AND INSTALLED COMPLETE IN ALL DETAILS READY FOR SATISFACTORY OPERATIONS AND SERVICE AND ALL REQUIRED APPARATUS SHALL BE FURNISHED EVEN THOUGH NOT SPECIFICALLY MENTIONED HEREIN.
12. PROVIDE ALL REQUIRED WIRING, SURFACE METAL RACEWAY, JUNCTION BOXES, TESTING, CORRECTING AND RETESTING AND ALL FINAL CONNECTIONS FOR COMPLETE SYSTEMS CERTIFIED READY FOR OPERATION IN ALL RESPECTS.
13. ALL PROGRAMMING, TESTING, REPROGRAMMING.
14. THE SYSTEMS PROVIDED SHALL INTERFACE TO ALL EXISTING COMMUNICATION SYSTEM DEVICES AND WIRING.

C. WIRING METHODS AND INSTALLATION OF PATHWAYS
1. WIRING METHOD: INSTALL WIRING IN DEDICATED RACEWAY SYSTEM FOR SCHOOL INTERCOM SYSTEM EQUIPMENT. CONCEAL RACEWAYS IN NEW CONSTRUCTION.
   - a. COMPLY WITH REQUIREMENTS FOR RACEWAYS AND BOXES AND THEIR INSTALLATION SPECIFIED IN DIVISION 26 SECTION "RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS."
   - b. COMPLY WITH TIA/EIA-569-A FOR PULL-BOX SIZING AND LENGTH OF CONDUIT AND NUMBER OF BENDS BETWEEN PULL POINTS.
2. WIRING WITHIN ENCLOSURES: BUNDLE, LACE, AND TRAIN CABLES TO TERMINAL POINTS WITHOUT EXCEEDING MANUFACTURER'S LIMITATIONS ON BENDING RADII. USE LACING BARS IN CABINETS.

D. FIELD QUALITY CONTROL
1. MANUFACTURER'S FIELD SERVICE: ENGAGE A FACTORY-AUTHORIZED SERVICE REPRESENTATIVE TO INSPECT FIELD-ASSEMBLED COMPONENTS AND EQUIPMENT INSTALLATION, INCLUDING CONNECTIONS AND INITIAL SYSTEM PROGRAMMING. REPORT RESULTS IN WRITING.
2. RETESTING: CORRECT DEFICIENCIES AND RETEST. PREPARE A WRITTEN RECORD OF TESTS.
3. INSPECTION: VERIFY THAT UNITS AND CONTROLS ARE PROPERLY LABELED AND INTERCONNECTING WIRES AND TERMINALS ARE IDENTIFIED. PREPARE A LIST OF FINAL TAP SETTINGS OF PAGING AND INDEPENDENT ROOM SPEAKER-LINE MATCHING TRANSFORMERS.
4. PREPARE WRITTEN TEST REPORTS. INCLUDE A RECORD OF FINAL SPEAKER-LINE MATCHING TRANSFORMER-TAP SETTINGS, AND SIGNAL GROUND-RESISTANCE MEASUREMENT CERTIFIED BY INSTALLER.

E. EQUIPMENT AND MATERIALS
1. SPEAKER ENCLOSURE SHALL BE ROUND RECESSED STEEL HOUSING WITH BAKED WHITE EPOXY FINISH, ACOUSTICALLY DAMPENED, WITH FRONT FACE AT LEAST 0.03 INCH STEEL COMPLETE WITH MOUNTING ASSEMBLY SUITABLE FOR FLUSH CEILING MOUNTING.
   - a. ROUND SPEAKER RECESSED BACKBOX – RAULAND #ACC1101
   - b. SPEAKER/BAFFLE SUPPORT BRIDGE – RAULAND #ACC1104
   - c. 8" SPEAKER ASSEMBLY (WHITE) – RAULAND #ACC1401
   - d. RAULAND TELECENTER OVERLAY ONTO TELECENTER ICS INCLUDING BUT NOT LIMITED TO ZONE PAGE MODULE AND THREE RAULAND PoE IP AUX I/O MODULES TO CONNECT THE EXISTING RAULAND ICS LOCATED IN KENWOOD ACADEMY TO THE NEW CANTER MIDDLE SCHOOL TCU FOR ALL CALL AND WEB BASED BELL MANAGEMENT. PROVIDE ALL PROGRAMMING AS REQUIRED.
   - e. TELECENTER CAMPUS CONTROLLER – RAULAND #TCC2000
   - f. TELECENTER ZONE PAGING MODULE – RAULAND #TCC2022
   - g. TELECENTER AUXILIARY INPUT/OUTPUT MODULE – RAULAND #TCC2033
   - h. TELECENTER ADMINISTRATIVE CONSOLE – RAULAND #TCC2045
   - i. TELECENTER MICROPHONE INPUT MODULE – RAULAND #TCC2077
   - j. IP-ADDRESSABLE 24-PORT GATEWAYS – RAULAND #TCC2024
2. CABLE: SHIELDED TWISTED NOT SMALLER THAN NO. 22 AWG.

F. REFER TO SECTION 27 53 15 FOR ADDITIONAL INFORMATION.

LIGHTING FIXTURE SCHEDULE

SYMBOL & TYPE	MANUFACTURER AND CATALOG NUMBER	WATTAGE	LOCATION	MOUNTING	SHIELDING	REMARKS	ALTERNATE MANUFACTURER SUBJECT TO THE APPROVAL OF THE ENGINEER
LL2	2" APERTURE RECESSED LINEAR LED LUMINAIRE FINELITE # HP-2-R-D-xx-H-835-F-96LG-120-SC-FC-10%-SF-xx-12' LENSES-CP	LED MODULE (9.2 WATTS/FT) (639 LUMENS/FT) (3500°K)	SEE PLANS	RECESSED	FLUSH FROSTED WHITE DIFFUSER	120 VOLT LED 0-10V DIMMING DRIVER. CHICAGO PLENUM RATED. FINISH AS SELECTED BY ARCHITECT. VERIFY CEILING CONSTRUCTION PRIOR TO ORDERING. NOTE 1.	LEDALITE FOCAL POINT
LT1	2' x 4' RECESSED LED LUMINAIRE WITH ACRYLIC BASKET METALUX (CRUZE) # ATW-SW4-24CZ2-50-UNV-L835-CD1-CZ2-EQCLIP-U-PK	LED MODULE (40 WATTS) (5049 LUMENS) (3500°K)	SEE PLANS	RECESSED	RIBBED ACRYLIC FROSTED LENS	120 VOLT LED 0-10V DIMMING DRIVER. CHICAGO PLENUM RATED. PROVIDE UL APPROVED SAFETY CLIPS TO SECURE RECESSED TROFFERS TO T-BAR. USE FOUR PER FIXTURE. NOTE 1.	DAY-BRITE LITHONIA COLUMBIA
LT6	4' LOW PROFILE LED WRAPAROUND METALUX # 4WPLD4035C	LED MODULE (39 WATTS) (4460 LUMENS) (3500°K)	ELECTRIC ROOM	SURFACE	ACRYLIC LENS WITH END CAPS	120 VOLT LED 0-10V DIMMING DRIVER. NOTE 1.	DAY-BRITE LITHONIA
LX8	3.5" APERTURE RECESSED WET LOCATION LINEAR LED LUMINAIRE PRECISION ARCHITECTURAL LIGHTING # ML3WL65-D-MO-3000-80-8-R-VR-XX-TF-UNV-DIM1	LED MODULE (4.25 WATTS/FT) (428 LUMENS/FT) (3000°K)	EXTERIOR-UNDERSIDE OF LINK	RECESSED IN METAL PANEL SOFFIT	0.100" THICK VANDAL RESISTANT ACRYLIC LENS (IP65 RATED)	120 VOLT LED 0-10V DIMMING DRIVER. WET LABEL. FINISH AS SELECTED BY ARCHITECT. NOTE 1.	LEDALITE FOCAL POINT
LX10	POLE MOUNTED LED AREA LUMINAIRE LITHONIA (RADEAN) # RAD1 LED-P3-30K-SYM-120-RPA-DBLBXD ON A 14'-0" ROUND STRAIGHT STEEL POLE #RSS 14 4B DM19RAD DBLBXD	LED MODULE (54 WATTS) (7382 LUMENS) (3000°K)	PARKING LOT	POLE MOUNTED LUMINAIRE. SEE BASE DETAIL 4/E011-LNK.	DIE CAST ALUMINUM HOUSING	120 VOLT LED DRIVER. ASYMMETRIC TYPE IV DISTRIBUTION. TEXTURED BLACK FINISH. NOTE 1.	GARDCO McGRAW-EDISON KIM
LX12	WALL MOUNTED LED AREA LUMINAIRE LITHONIA (RADEAN) # RAD1 LED-P1-30K-ASY-120-WBA-DBLBXD	LED MODULE (25 WATTS) (3214 LUMENS) (3000°K)	EXTERIOR (NORTH WALL OF BUILDING C)	WALL MOUNTED. MATCH EXISTING MOUNTING HEIGHT.	DIE CAST ALUMINUM HOUSING	120 VOLT LED DRIVER. ASYMMETRIC TYPE IV DISTRIBUTION. TEXTURED BLACK FINISH. NOTE 1.	GARDCO McGRAW-EDISON KIM
X2	EXIT DIRECTIONAL SIGN WITH INTEGRAL LED DRIVER RED LETTERS WITH WHITE BACKGROUND SURE-LITES # CHX SERIES	LONG LIFE WHITE LED'S	SEE PLANS	RECESSED/ SURFACE CEILING OR WALL MOUNTED AS REQUIRED	STEEL HOUSING	120/277 VOLT. EXACT WORDING, ARROWS, SINGLE OR DOUBLE FACE AS APPROVED BY LOCAL CODE AUTHORITY. EXIT SIGNS SHALL NOT EXCEED 5 WATTS PER SIDE OF SIGN. CITY OF CHICAGO APPROVED. ALL EXIT SIGNS SHALL BE MOUNTED TO BE VISIBLE BELOW ALL CEILING PLANES AND SOFFITS.	LITHONIA CHLORIDE
EBU WP	CITY OF CHICAGO APPROVED EMERGENCY BATTERY UNIT SURE-LITES# SELM60R4SD WITH METAL WEATHERPROOF SINGLE REMOTE HEAD SURE-LITES# SRM25WH AS SHOWN ON DRAWINGS	300 LUMENS/HEAD	SEE PLANS	WALL MOUNTED	STEEL HOUSING WITH METAL HEADS	120/277 VOLT. EXACT LOCATIONS/QUANTITIES OF EMERGENCY BATTERY UNIT SHALL BE PROVIDED AS PER CITY OF CHICAGO BUREAU OF FIRE PREVENTION. WHITE FINISH. 90 MINUTE SEALED NICKEL CADMIUM BATTERY.	CHLORIDE

LIGHTING FIXTURE SCHEDULE NOTES:

1. REFER TO THE SPECIFICATIONS FOR ADDITIONAL LIGHTING FIXTURE REQUIREMENTS.

2. ANY MANUFACTURERS SUBMITTED TO QUALIFY UNDER AN "ALTERNATE" LISTING IN THE LIGHTING FIXTURE SCHEDULE SHALL MEET ALL REQUIREMENTS OF THE BASE MANUFACTURER(S) INCLUDING PHOTOMETRIC PERFORMANCE.

3. MINIMUM LENS THICKNESS TO BE .125 INCHES, WHERE LENSES ARE USED.

4. THE FIXTURE SCHEDULE AND CATALOG NUMBER DOES NOT NECESSARILY REFLECT ALL FIXTURES REQUIREMENTS OR LIST ALL ACCESSORIES AND HARDWARE NECESSARY FOR THE COMPLETION OF INSTALLATION, NOR DOES IT DETAIL THE CEILING CONSTRUCTION TO BE ENCOUNTERED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROPERLY DETERMINE AND PROVIDE CORRECT FLANGE TYPES, FITTINGS, AND HARDWARE REQUIRED FOR THE INSTALLATION OF LIGHTING FIXTURES INTO CEILING GRIDS, DRYWALL CEILINGS, AND OTHER CONSTRUCTION MATERIALS AS REQUIRED.

5. ALL LIGHTING FIXTURES ARE TO BE LOCATED AS REQUIRED ON THE JOB TO CLEAR DUCTS, STRUCTURAL MEMBERS, PIPING, EQUIPMENT, AND/OR MECHANICAL EQUIPMENT.

6. ALL LIGHTING FIXTURES INSTALLED IN A CEILING AIR PLENUM SHALL BE CITY OF CHICAGO PLENUM APPROVED AND SHALL BE MARKED CCEA.

7. ALL CONDUIT SERVING EXTERIOR LIGHTING SHALL BE CONCEALED WITHOUT EXCEPTIONS.

8. REFER TO ARCHITECTURAL ROOM FINISH SCHEDULE. THIS CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ORDERING RECESSED FIXTURES WITH CORRECT TRIM TO PROVIDE EXACT FIT REQUIRED FOR THE TYPE OF CEILING AND CEILING SUPPORTING SYSTEM SPECIFIED. BEFORE PLACING ORDER FOR FIXTURES, CONTRACTOR SHALL EXAMINE FINAL APPROVED CEILING SHOP DRAWINGS TO VERIFY COMPATIBILITY BETWEEN LIGHT FIXTURES AND CEILING CONSTRUCTION.

9. ALL PENDANT MOUNTED LIGHT FIXTURES, REGARDLESS OF WEIGHT, SHALL BE SUPPORTED FROM THE STRUCTURE ABOVE AT EACH SUSPENSION POINT AND SHALL NOT BE SUPPORTED DIRECTLY FROM A SUSPENDED CEILING SYSTEM OR DRYWALL CEILING SYSTEM. CONTRACTOR SHALL COORDINATE EXACT MOUNTING HARDWARE NECESSARY FOR INSTALLATION BASED ON THE SPECIFIED CEILING SYSTEMS AND SELECTED LIGHT FIXTURE MANUFACTURER. SHOP DRAWINGS SHALL BE SUBMITTED FOR ALL PENDANT MOUNTED LIGHT FIXTURE LENGTHS CLEARLY NOTING EXACT SUSPENSION POINTS TO THE CEILING AND PROPOSED SUSPENSION COMPONENTS.

10. RECESSED LUMINAIRES SHALL BE SUPPORTED WITH 12 GAUGE WIRE HANGERS, (2) PER LUMINAIRE, AT DIAGONALLY OPPOSITE CORNERS. LUMINAIRES SHALL BE ATTACHED TO CEILING GRID TO RESIST HORIZONTAL FORCE EQUAL TO WEIGHT OF LUMINAIRE.

11. ALL EXIT SIGNS SHALL BE SUPPORTED AND FED FROM CADDY SNAP ON BOX HANGER, ELECTRICAL BOX HANGER, OR SUPPORT FROM LUMINAIRE MANUFACTURER, AND ADDITIONAL 12 GAUGE WIRE INSTALLED FROM BOX TO STRUCTURE.

12. GRID-TYPE LIGHT FIXTURES SHALL BE SUPPORTED BY A MINIMUM OF 4 RODS OR WIRES SECURED TO THE CEILING SUPPORT SYSTEM WITHIN 6 INCHES OF THE FIXTURE CORNERS.

13. INSTALL FLUSH MOUNTED LUMINAIRES PROPERLY TO ELIMINATE LIGHT LEAKAGE BETWEEN LUMINAIRE FRAME AND FINISHED SURFACE.

14. WHERE DIMMING OR INTEGRAL LIGHT FIXTURE CONTROLS ARE SPECIFIED, COMPATIBILITY OF FIXTURE AND CONTROLS SHALL BE VERIFIED PRIOR TO ORDERING ANY EQUIPMENT.

15. FRAMING MEMBERS OF SUSPENDED CEILING SYSTEMS USED TO SUPPORT LUMINAIRES SHALL BE SECURELY FASTENED TO EACH OTHER AND SHALL BE SECURELY ATTACHED TO THE BUILDING STRUCTURE AT APPROPRIATE INTERVALS. LUMINAIRES SHALL BE SECURELY FASTENED TO THE CEILING FRAMING MEMBERS BY MECHANICAL MEANS SUCH AS BOLTS, SCREWS, OR RIVETS. LISTED CLIPS IDENTIFIED FOR USE WITH THE TYPE OF CEILING FRAMING MEMBERS AND LUMINAIRES SHALL ALSO BE PERMITTED.

CHICAGO FIRE PREVENTION BUREAU EXIT SIGN SYMBOLS

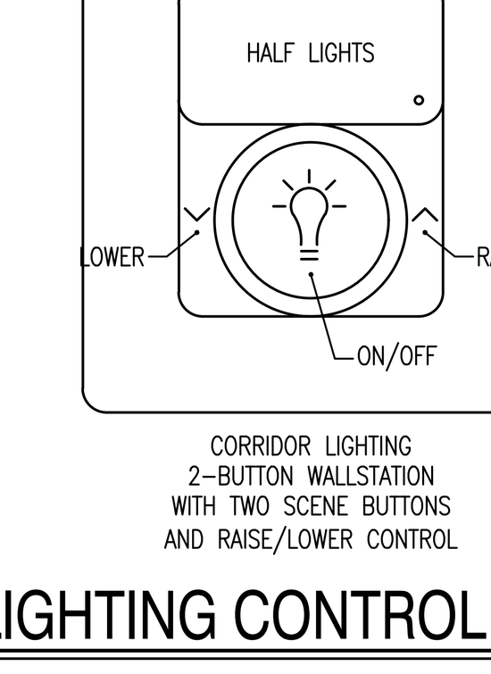
SINGLE FACE SIGNS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
1	FIRE ESCAPE	2	STAIR(S)/STAIRWAY	3	EXIT
4	FIRE ESCAPE	5	STAIR(S)	6	EXIT
7	FIRE ESCAPE	8	STAIR(S)	9	EXIT
10	FIRE ESCAPE	11	STAIR(S)	12	EXIT

DOUBLE FACE SIGNS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
14	14-3G SHOW THE FACES WITH THE PROPER ANGLE OF THE FACE AND FACE NUMBER (1, 2, OR 3)				
16	FIRE ESCAPE	17	STAIR(S)	18	EXIT
19	FIRE ESCAPE	20	STAIR(S)	21	EXIT
22	FIRE ESCAPE	23	STAIR(S)	24	EXIT

NOTE E11, DRAWING E000-LNK



CORRIDOR LIGHTING
2-BUTTON WALLSTATION
WITH TWO SCENE BUTTONS
AND RAISE/LOWER CONTROL

2 LIGHTING CONTROL STATIONS

NOT TO SCALE

NOTES
1. ALL PROGRAMMING AND CUSTOM ENGRAVING SHALL BE CONFIRMED WITH CPS TO MEET SCHOOL'S REQUIREMENTS. CONFIRM ENGRAVINGS FOR EACH BUTTON/SWITCH WITH CPS. ALL COVER PLATES SHALL BE SATIN STAINLESS STEEL.
2. ALL COOPER LIGHTING SOLUTIONS WALLSTATIONS FIT IN A STANDARD SINGLE GANG BACKBOX.
3. EACH WALLSTATION SHALL BE PROGRAMMED IN THE FIELD WITH CUSTOM ENGRAVED BUTTONS.

LIGHTING CONTROL SYSTEM – SEQUENCE OF OPERATIONS:

A. CORRIDORS
CORRIDOR LIGHTING SHALL BE PROGRAMMED FOR TIME CLOCK ON-TIME CLOCK OFF DURING SCHOOL HOURS (AS DETERMINED BY THE SCHOOL). WALLSTATIONS SHALL BE PROVIDED TO OVERRIDE TIME CLOCK. WALLSTATIONS SHALL BE LOCATED IN CLOSETS AS SHOWN ON PLANS. VERIFY EXACT LOCATION OF WALLSTATIONS WITH SCHOOL PRIOR TO DOING ANY WORK.

OCCUPANCY SENSOR NOTES

OS-1. LIGHT FIXTURES IN AREAS WITH OCCUPANCY SENSORS SHALL BE TIME CLOCK ON-TIME CLOCK OFF WITH OVERRIDE SWITCH.

OS-2. REFER TO MANUFACTURER'S DATA SHEETS AND INSTALLATION INSTRUCTIONS PRIOR TO INSTALLATION.

OS-3. THE DELAYED-OFF TIME FOR ALL CEILING MOUNTED OCCUPANCY SENSORS SHALL BE SET WITH 20 MINUTE MAXIMUM DELAY AFTER THE LAST MOTION IS SENSED.

OS-4. PROVIDE ALL OCCUPANCY SENSORS WITH APPROPRIATE POWER PACKS.

OS-5. ALL OCCUPANCY SENSORS SHALL BE INSTALLED AS PER MANUFACTURER'S WIRING DIAGRAMS, RECOMMENDATIONS, AND ALL APPLICABLE CODES.

OS-6. ALL OCCUPANCY SENSORS SHALL BE LOCATED AT LEAST 6 FEET FROM AIR SUPPLY/RETURN REGISTERS.

OS-7. CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER SENSITIVITY AND TIME DELAY SETTINGS AND MANUFACTURERS RECOMMENDED PLACEMENT, FIELD VERIFICATION OF CIRCUITS WITH RESPECT TO POWER PACK PLACEMENT.

OS-8. CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFICATION OF REQUIRED NUMBER OF POWER PACKS.

OCCUPANCY SENSOR NOTES (CONT'D)

OS-9. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES REQUIRED TO INSTALL A COMPLETE AND OPERATING LIGHTING CONTROL SYSTEM. THIS WORK SHALL INCLUDE BUT NOT NECESSARILY BE LIMITED TO WIRING, CONDUIT, JUNCTION BOXES, BRACKETS, AND HARDWARE COMPLETE WITH ALL ACCESSORIES AND INCIDENTALS AND ALL FINAL CONNECTIONS FOR A COMPLETE INSTALLATION READY FOR OPERATION. CONTRACTOR SHALL INCLUDE STARTUP AND DEMONSTRATION TO OWNER IN BID PROPOSAL.

OS-10. ALL OCCUPANCY SENSORS SHALL BE MOUNTED ON A VIBRATION FREE SURFACE.

OS-11. OCCUPANCY SENSOR INSTALLATION SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, MANUFACTURER'S WIRING DIAGRAMS, MANUFACTURER'S RECOMMENDATIONS, AND ALL APPLICABLE CODES.

OS-12. CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING MANUFACTURER FOR PROPER PLACEMENT AND ADJUSTING OF ALL OCCUPANCY SENSORS.

OS-13. DO NOT MOUNT SENSORS CLOSER THAN 10 FEET FROM EACH OTHER.

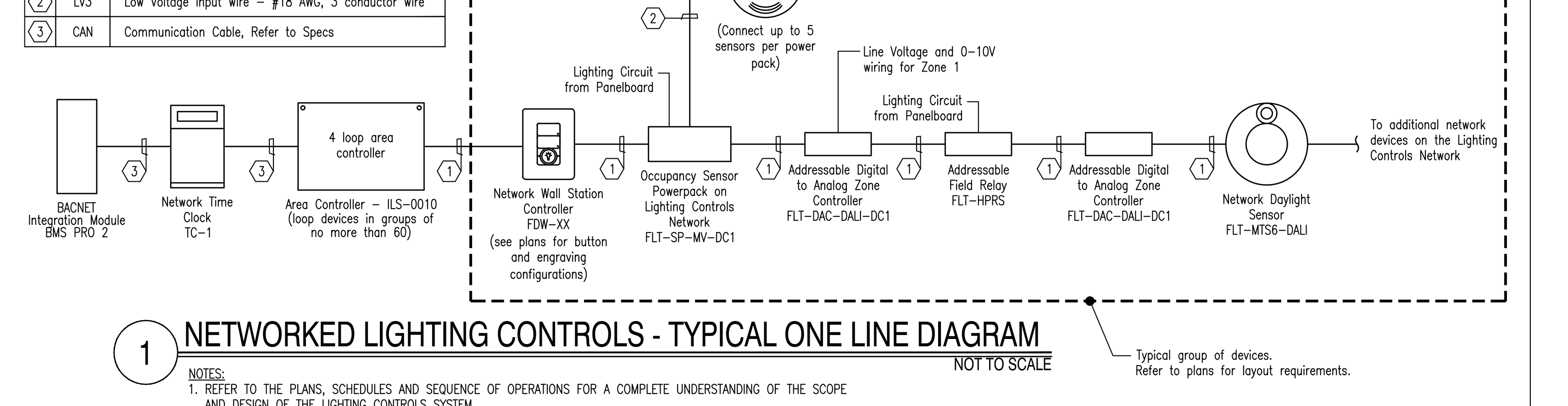
OS-14. ALL OCCUPANCY SENSORS SHALL BE MOUNTED A MINIMUM 3 FEET AWAY FROM ALL SUSPENDED LIGHT FIXTURES.

OS-15. ALL OCCUPANCY SENSORS SHALL BE MOUNTED A MINIMUM 2 FEET AWAY FROM ALL RECESSED LIGHT FIXTURES.

OS-16. CONTRACTOR SHALL SUBMIT A FACTORY GENERATED SHOP DRAWING INDICATING ALL OCCUPANCY SENSOR LOCATIONS AND PATTERN ARRAYS.

Cables

1	TF	Topology Free 2-conductor (2#16 AWG)
2	LV3	Low Voltage Input wire – #18 AWG, 3 conductor wire
3	CAN	Communication Cable, Refer to Specs



1 NETWORKED LIGHTING CONTROLS - TYPICAL ONE LINE DIAGRAM

NOT TO SCALE

NOTES:
1. REFER TO THE PLANS, SCHEDULES AND SEQUENCE OF OPERATIONS FOR A COMPLETE UNDERSTANDING OF THE SCOPE AND DESIGN OF THE LIGHTING CONTROLS SYSTEM.
2. BACNET CONNECTIONS TO THE BMS PRO 2 SHALL BE PROVIDED AND SETUP BY THE BAS CONTRACTOR.
3. USE LAYOUT FOR DEVICES AS SPECIFIED IN THE MANUFACTURER'S COMPLETE AND CUSTOM PROJECT LAYOUT AND LOOP CONFIGURATION SO THAT MAXIMUM RUNS AND PROGRAMMING CONCEPTS WILL BE MAINTAINED.
4. ONE-LINE DIAGRAM IS DIAGRAMMATIC AND IS SHOWN TO PROVIDE A GENERAL OVERVIEW OF MAJOR SYSTEM COMPONENTS AND THEIR INTERCONNECTIONS. THIS DIAGRAM IS NOT TO BE USED FOR FIELD INSTALLATION PURPOSES.
5. PROVIDE ALL CONDUIT AND WIRING AS REQUIRED FOR A COMPLETE AND OPERATIONAL LIGHTING CONTROL SYSTEM.
6. REFER TO LIGHTING CONTROL STATION DETAILS ON THIS DRAWING.
7. THE BASIS OF DESIGN IS COOPER LIGHTING SOLUTIONS WAVELINX WIRED AS INDICATED BY THEIR CATALOG NUMBERS AND ESTABLISHES THE QUALITY REQUIRED FOR ALTERNATE APPROVED MANUFACTURERS. REFER TO SPECIFICATIONS.

GENERAL SYMBOLS

(NOT ALL SYMBOLS ARE USED ON THIS PROJECT)

SYMBOL	DESCRIPTION
	BRANCH CIRCUIT PANELBOARD
	DISTRIBUTION PANELBOARD
T	DRY TYPE TRANSFORMER
	FUSED HEAVY DUTY DISCONNECT SWITCH
	NON-FUSED HEAVY DUTY DISCONNECT SWITCH
	MAGNETIC MOTOR STARTER WITH HAND-OFF-AUTO SWITCH AND RED & GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (4 NORMALLY OPEN, 4 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
	COMBINATION STARTER/DISCONNECT SWITCH (NON-FUSED) WITH HAND-OFF-AUTO SWITCH AND RED AND GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (2 NORMALLY OPEN, 2 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
	COMBINATION STARTER/DISCONNECT SWITCH (FUSED) WITH HAND-OFF-AUTO SWITCH AND RED AND GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (2 NORMALLY OPEN, 2 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
M	MOTOR. SEE DRAWINGS FOR HP RATINGS.
	MOTOR/EQUIPMENT TAG
	FUSIBLE SWITCH
	CIRCUIT BREAKER
F / Na	1' x 4' LED FIXTURE WHERE: 'F' IS THE FIXTURE TAG 'N' IS THE CIRCUIT NUMBER 'a' IS THE SWITCH DESIGNATION
EM	HATCHING INDICATES LIGHT FIXTURE CONNECTED TO EMERGENCY LIGHTING SYSTEM
X	EXISTING LIGHT FIXTURE TO REMAIN
$a	SINGLE POLE WALL SWITCH. REFER TO ARCHITECTURAL DRAWINGS FOR MOUNTING HEIGHT. WHERE: 'a' IS THE DESIGNATION INDICATING WHAT LIGHTS ARE CONTROLLED BY THAT SWITCH
$P	ILLUMINATED AND PILOT LIGHT CLEAR TOGGLE SWITCH (LIGHT ON WITH LOAD OFF) (HUBBELL #HBL1221ILC).
$T-P	SINGLE POLE MANUAL FRACTIONAL MOTOR STARTER WITH RED PILOT LIGHT AND THERMAL OVERLOAD PROTECTION (TYPE T-P).
	DUPLEX CONVENIENCE TAMPER-RESISTANT RECEPTACLE
GFI	GROUND FAULT INTERRUPTING DUPLEX CONVENIENCE TAMPER-RESISTANT RECEPTACLE
X-N	REMOTE EXISTING RECEPTACLE, WIRING, AND COVERPLATE. PROVIDE NEW RECEPTACLE, WIRING, AND COVERPLATE. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.
	GROUND
	GREEN GROUNDING WIRE CONDUCTOR INSTALLED WITH CIRCUIT CONDUCTORS
DC	NEW ADDRESSABLE DOOR CONTACT (HONEYWELL #4959SN) TO BE ELECTRICALLY COMPATIBLE IN ALL RESPECTS WITH EXISTING BUILDING INTRUSION DETECTION SYSTEM (KENWOOD ACADEMY/CANTER AS REQUIRED). PROVIDE NEW WIRING IN NEW SURFACE STEEL RACEWAY. PROGRAM ALL NEW DEVICES TO SUIT CPS SAFETY AND SECURITY REQUIREMENTS. READJUST OR REPLACE SYSTEM DEVICES WHEN FALSE ALARMS OCCUR.
MD	NEW WALL MOUNTED MOTION DETECTOR (+9'-6" A.F.F. – DO NOT MOUNT WITHIN 6" OF CEILING) TO BE ELECTRICALLY COMPATIBLE WITH EXISTING BUILDING INTRUSION DETECTION SYSTEM. PROVIDE NEW WIRING IN NEW SURFACE STEEL RACEWAY. PROGRAM ALL NEW DEVICES TO SUIT CPS SAFETY AND SECURITY REQUIREMENTS.
CCTV	CLOSED CIRCUIT TELEVISION CAMERA – PROVIDE (1) 4-PAIR CATEGORY 6 UTP CABLE (PURPLE JACKET COVER) FROM CAMERA TO CATEGORY 6 PATCH PANEL LOCATED IN MDF ROOM 204 (CANTER). PROVIDE 3/4"C (PURPLE). THIS CONTRACTOR SHALL TERMINATE ALL PAIRS OF CATEGORY 6 CABLE AT BOTH ENDS. PROVIDE PURPLE PATCH CORD. MAKE ALL FINAL CONNECTIONS FOR A COMPLETE AND OPERATIONAL DIGITAL VIDEO SURVEILLANCE SYSTEM. REFER TO SECTION 28 23 07.
S	RECESSED CEILING MOUNTED SPEAKER TO BE ELECTRICALLY COMPATIBLE IN ALL RESPECTS WITH INTERCOM SYSTEM HEADEND EQUIPMENT. SPEAKER SHALL BE CENTERED IN CEILING TILE. REFER TO SECTION 27 53 15.
S	FLUSH WALL MOUNTED SPEAKER TO BE ELECTRICALLY COMPATIBLE IN ALL RESPECTS WITH INTERCOM SYSTEM HEADEND EQUIPMENT. REFER TO SECTION 27 53 15.
DS	CEILING-MOUNTED DAYLIGHT SENSOR – COOPER LIGHTING SOLUTIONS (OR EQUIVALENT) #FLT-MTS6-DALI. REFER TO OCCUPANCY SENSOR NOTES ON THIS DRAWING.
	DATA OUTLET – PROVIDE DATA DROP TO CONSIST OF ONE 4-PAIR CATEGORY 6 CABLE (BLUE) TO NEAREST CONCENTRATOR ENCLOSURE OR MDF ROOM. PROVIDE 3/4"C. FROM BACKBOX TO NEAREST CONCENTRATOR OR MDF ROOM. PROVIDE 4" SQUARE EXTRA DEEP SINGLE GANG BACKBOX. PROVIDE VERTICALLY MOUNTED SINGLE GANG PLASTER RING AND COVERPLATE. THIS CONTRACTOR SHALL TERMINATE ALL PAIRS OF CATEGORY 6 CABLES AT BOTH ENDS. MAKE ALL FINAL CONNECTIONS FOR A COMPLETE AND OPERATIONAL DATA SYSTEM. REFER TO DIVISION 27 SPECIFICATION SECTIONS.
CCE	CLASSROOM CONCENTRATOR ENCLOSURE
PP	MOTORIZED HANDICAP DOOR PUSH PLATE
B	SIGNAL BELL
	TIME CLOCK

PANELBOARD WIRING CONVENTION

- NORTH OR SOUTH PORTION OF BLDG.
- LEVEL
- PANEL TYPE

e.i. – 'L2S' (LIGHTING PANEL, 2ND FLOOR, SOUTH)

TYPE
- LM – LIGHTING/GENERAL MAINTENANCE PANELBOARD
- PP – POWER PANELBOARD
- ACP – AIR CONDITIONING PANELBOARD (BEING REUSED AS GENERAL PANELBOARD FOR FAN COIL BOXES)

RACEWAYS & WIRING

SYMBOL	DESCRIPTION
	CONDUIT HOMERUN – PHASE, NEUTRAL, GROUND
	CONDUIT – SURFACE MOUNTED OR CONCEALED
	CONDUIT UNDERFLOOR OR UNDERGROUND
	CONDUIT TURNED UP
	CONDUIT TURNED DOWN
	FLEXIBLE CONDUIT
J	JUNCTION BOX
J	JUNCTION BOX – WALL MOUNTED
J	JUNCTION BOX UNDER FLOOR
PB	PULLBOX
A	ALTERNATOR

GENERAL SYMBOLS (CONT'D)

SYMBOL	DESCRIPTION
S	INTELLIGENT DUAL ACTION MANUAL PULL STATION TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
D	INTELLIGENT ADDRESSABLE HEAT DETECTOR TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
SD	INTELLIGENT ADDRESSABLE SYSTEM SMOKE DETECTOR TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
V	ADA STROBE TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER) – 75 CANDELA STROBE
AV	ADA HORN/STROBE TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER) – 15 Db OVER AMBIENT NOISE
H	MAGNETIC/ELECTRONIC DOOR HOLDER AND RELEASING DEVICE (FLUSH WALL MOUNT) WITH RECESSED MAGNET. VERIFY VOLTAGE PRIOR TO ROUGH-IN. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.
CO	NEW INTELLIGENT CARBON MONOXIDE (CO) DETECTOR TO COMPLY WITH UL 2075 AND EQUIPPED WITH A DISTINCT ALARM SIGNAL FROM THE FIRE ALARM SIGNAL, END OF LIFE TIMER, AND TEST/HUSH BUTTON AS REQUIRED BY THE CITY OF CHICAGO BUILDING CODE AND ILLINOIS STATE FIRE MARSHALL FOR SCHOOLS. CONNECT TO EXISTING NOTIFIER FIRE ALARM AND DETECTION SYSTEM FOR GENERAL ALARM SIGNAL. A TROUBLE SIGNAL SHALL BE SENT TO THE FACP UPON CO CELL TROUBLE OR CELL END OF LIFE. MOUNT AND WIRE ACCORDING TO MANUFACTURER'S INSTRUCTIONS.
X	EXISTING ELECTRICAL EQUIPMENT (DEVICE) TO REMAIN
XR	EXISTING ELECTRICAL EQUIPMENT (DEVICE) TO BE REMOVED. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES, OR DISCONNECT AND RECONNECT NEW EQUIPMENT USING EXISTING WIRING AS INDICATED ON DRAWINGS.
XRR	EXISTING EQUIPMENT (DEVICE) TO BE REMOVED, STORED, RELOCATED, REINSTALLED, AND REWIRED, COMPLETE IN PLACE, READY FOR OPERATION.
H	INDICATES DEVICE MOUNTED ABOVE COUNTER
W	INDICATES DEVICE MOUNTED AT SWITCH HEIGHT (+48" A.F.F.)
WP	INDICATES DEVICE IN WEATHERPROOF ENCLOSURE
PROVIDE	FURNISHED, INSTALLED, AND WIRED BY ELECTRICAL CONTRACTOR

ABBREVIATIONS

A – AMPS	CU – COPPER	F – FUSE	J/B – JUNCTION BOX	NIC – NOT IN CONTRACT	SW – SWITCH
AFF – ABOVE FINISHED FLOOR	CT – CURRENT TRANSFORMER	FDR – FEEDER	LTG – LIGHTING	NO – NORMALLY OPEN	SWBD – SWITCHBOARD
A/C – AIR CONDITIONING	DIA – DIAMETER	FLA – FULL LOAD AMPS	JPC – JOCKEY PUMP CONTROLLER	NTS – NOT TO SCALE	SWGR – SWITCHGEAR
AHU – AIR HANDLING UNIT	D/S – DISCONNECT SWITCH	FLR – FLOOR	M – MOTOR	O/H – OVERHEAD	TR – TRANSFORMER
ATS – AUTOMATIC TRANSFER SWITCH	DIV – DIVISION	FPC – FIRE PUMP CONTROLLER	MCB – MAIN CIRCUIT BREAKER	OL – OVERLOAD	TTC – TELEPHONE TERMINAL CABINET
BSMT – BASEMENT	DWG – DRAWING	FIXT – FIXTURE	MCC – MOTOR CONTROL CENTER	PB – PUSHBUTTON	TVSS – TRANSIENT VOLTAGE SURGE SUPPRESSOR
BPS – BOLTED PRESSURE SWITCH	EC – ELECTRICAL CONTRACTOR	FVNR – FULL VOLTAGE, NON REVERSING (MAGNETIC STARTER)	MCP – MAXIMUM CIRCUIT PROTECTION	P/N – PART NUMBER	UPS – UNINTERRUPTIBLE POWER SUPPLY
C – STEEL CONDUIT	EQUIP – EQUIPMENT	GFI – GROUND FAULT INTERRUPTER	MLO – MAIN LUGS ONLY	PNL – PANEL	V – VOLTS
CCT – CIRCUIT	ELECT – ELECTRIC, ELECTRICAL	GFP – GROUND FAULT PROTECTION	MECH – MECHANICAL	PRI – PRIMARY	VFD – VARIABLE FREQUENCY DRIVE
C/B – CIRCUIT BREAKER	EM – / EMERG– EMERGENCY	GRD – GROUND	MOCP – MAIN OVERCURRENT PROTECTION	PT – POTENTIAL TRANSFORMER	W – WATTS
CLG – CEILING	EXIST– EXISTING	HP – HORSEPOWER	N – NEUTRAL	R – RELOCATED	WG – WIRE GUARD
CO – CARBON MONOXIDE DETECTOR	F&I – FURNISH AND INSTALL	HOA – HAND-OFF-AUTO	N/A – NOT APPLICABLE	S – SWITCH	WP – WEATHERPROOF
CP – CONTROL PANEL	FCU – FAN COIL UNIT	IG – ISOLATED GROUND	NC – NORMALLY CLOSED	SEC – SECONDARY	
				SPD – SURGE PROTECTIVE DEVICE	

ELECTRICAL KEY PLAN NOTES

E1. ALL CONDUITS SHALL BE CONCEALED WHEREVER EXISTING CONSTRUCTION OR NEW CONSTRUCTION, LAY-IN ACCESSIBLE CEILINGS, ETC. PERMIT, OR BE SURFACE METAL RACEWAY. RACEWAY SIZE AS REQUIRED TO ACCOMMODATE WIRING CAPACITY PER 2018 CITY OF CHICAGO ELECTRICAL CODE.

E2. CONTRACTOR MAY REUSE EXISTING CONDUIT SYSTEM WHERE EXISTING CONDUIT SYSTEMS MEET OR EXCEED THE APPLICABLE CODES IN ALL RESPECTS. ALL EXISTING CONDUITS SHALL BE CLEANED PRIOR TO CABLE INSTALLATION. PROVIDE GROUNDING CONDUCTOR IN ALL EXISTING CONDUITS REUSED. HOWEVER, WHERE EXISTING CONDUIT SYSTEM IS NOT REUSED, CONTRACTOR SHALL FURNISH AND INSTALL NEW CONDUIT SYSTEM FOR NEW FEEDERS AS SPECIFIED.

E3. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVAL, STORAGE, AND RE-INSTALLATION OF ALL LAY-IN CEILING TILES FOR INSTALLATION OF NEW CONDUITS. TAKE PRECAUTIONS SO AS NOT TO DAMAGE TILES. STORE CEILING TILES IN A CLEAN DRY LOCATION AS INDICATED BY THE SCHOOL. CONTRACTOR IS RESPONSIBLE FOR PROVIDING NEW CEILING TILES TO MATCH EXISTING FOR ANY TILES DAMAGED AT NO ADDITIONAL COST TO THE CONTRACT.

E4. PROVIDE NEW 2#10-3/4"C. CONNECT TO NEAREST EXISTING EXIT SIGN CIRCUIT. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUIT, WIRING, ETC. MAKE ALL FINAL CONNECTIONS.

E5. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, ETC. TO PROVIDE AIR TIGHT KNOCKOUT SEALS TO PLUG ALL UNUSED OPEN BOX KNOCKOUTS ON ALL EXISTING JUNCTION BOXES AND PULL BOXES ABOVE EXISTING PLENUM CEILINGS. PROVIDE NEW GASKETED COVERS ON ALL JUNCTION BOXES AND PULL BOXES WHICH DO NOT HAVE COVERS. CONTRACTOR SHALL PROVIDE SUPPORTS FOR ALL EXISTING LOW VOLTAGE CABLE TO REMAIN. ALL CABLING SHALL BE SUPPORTED ON A SPACING OF 4 TO 5 FEET UTILIZING STEEL J-HOOKS UL LISTED FOR USE IN PLENUM CEILINGS. J-HOOKS SHALL INCLUDE A RETAINING MEANS FOR CLOSING THE HOOK SO THE CABLES DO NOT FALL OUT. CONTRACTOR SHALL REMOVE ALL OBSOLETE LOW VOLTAGE CABLING LAYING ON EXISTING SPLINE CEILING SYSTEM.

E6. PROVIDE NEW 2#10-3/4"C. (OR SURFACE STEEL RACEWAY IN ALL FINISHED AREAS) CONNECT TO EXISTING NEAREST EMERGENCY LIGHTING CIRCUIT IN CORRIDOR. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUIT, WIRING, ETC. MAKE ALL FINAL CONNECTIONS.

E7. VARIABLE FREQUENCY DRIVE – CONTRACTOR SHALL FURNISH, INSTALL, AND WIRE ALL VARIABLE FREQUENCY DRIVES IN CONFORMANCE TO THE MANUFACTURER'S WIRING DIAGRAMS AND INSTRUCTIONS INCLUDING BUT NOT LIMITED TO ALL REQUIRED CABLE, WIRE, CONDUITS, SUPPORTS, PROPER PHASE ROTATION, TESTING, CORRECTING AND RETESTING AND ALL FINAL CONNECTIONS. PROVIDE CONDUIT ENTRANCE KIT WITH MULTIPLE KNOCKOUT SIZES AS REQUIRED. VERIFY EXACT LOCATION OF VARIABLE FREQUENCY DRIVES WITH MECHANICAL CONTRACTOR PRIOR TO DOING ANY WORK. ALL VARIABLE FREQUENCY DRIVES SHALL BE BY A SINGLE MANUFACTURER. REFER TO SECTION 26 29 23.

E8. PROVIDE ALL REQUIRED LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES TO REMOVE EXISTING EXTERIOR LUMINAIRE AND REPLACE WITH NEW EXTERIOR LUMINAIRE. THIS CONTRACTOR SHALL DISCONNECT EXISTING LUMINAIRE FROM SUPPLY SOURCE AND CONNECT NEW LUMINAIRE TO EXISTING OVERCURRENT DEVICE WITH NEW OR EXISTING WIRING AS REQUIRED. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUITS, WIRING, AND SPLICES IN ORDER TO MAINTAIN CONTINUITY OF EXISTING LIGHTING BRANCH CIRCUITS TO REMAIN WHICH ARE AFFECTED BY NEW CONSTRUCTION. NO CONDUIT SHALL BE EXPOSED ON THE EXTERIOR OF THE BUILDING. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

E9. KENWOOD AND CANTER MDF ROOM CONNECTIONS. THIS CONTRACTOR SHALL PROVIDE (3) CONDUITS BETWEEN KENWOOD MDF ROOM 221B AND CANTER MDF ROOM 204A:
- (1) 2" CONDUIT WITH (1) 12-STRAND MULTIMODE FIBER OPTIC CABLE AND (2) 6-STRAND SINGLE MODE FIBER OPTIC CABLES;
- (1) 2" CONDUIT WITH (1) 50 PAIR UTP CATEGORY 5e BACKBONE CABLE;
- (1) SPARE 2" CONDUIT WITH PULL LINE.

COMPLY WITH CHICAGO ELECTRICAL CODE, ARTICLE 300.22. PROVIDE CONDUIT BUSHINGS AT BOTH ENDS OF ALL CONDUITS. VERIFY EXACT ROUTING IN FIELD. ALL CABLES SHALL BE TERMINATED, TESTED, AND LABELED PER CONTRACT DOCUMENTS. REFER TO DIVISION 27 SPECIFICATIONS.

E10. PROVIDE COOPER LIGHTING SOLUTIONS WAVELINX WIRED AREA CONTROLLER PANEL #ILS-0010 FOR CENTRALIZED COORDINATION OF MULTIPLE AREAS FOR TIME CLOCK SCHEDULING FOR FIRST AND SECOND FLOOR CORRIDORS.

E11. PROVIDE 2-BUTTON COOPER LIGHTING SOLUTIONS WAVELINX WIRED WALLSTATION #FDW-2TLB-RL-W. WALLSTATION SHALL SET FULL (100%) LIGHTS, HALF (50%) LIGHTS, RAISE AND LOWER LIGHTING LEVELS, AND TURN LIGHTS OFF. PROVIDE CUSTOM ENGRAVED BUTTONS. PROVIDE METAL DECORATOR STYLE COLOR MATCHING WALLPLATE. VERIFY COLOR WITH ARCHITECT. PROVIDE COOPER LIGHTING SOLUTIONS DIGITAL TO ANALOG CONVERTOR #FLT-DAC-DALI-DC1 WITH BUILT-IN LATCHING RELAY AND 0-10V CURRENT SINKING INTERFACE TO INTEGRATE INDIVIDUAL OR A GROUP OF DIMMABLE 0-10V DRIVERS VIA A TWO WIRE COMMUNICATIONS BUS USED WITH COOPER LIGHTING SOLUTIONS. PROVIDE ONE DIGITAL TO ANALOG CONVERTOR FOR EACH SWITCH LEG (i.e. PROVIDE ONE PER LIGHTING CIRCUIT). REFER TO DETAIL 2 ON THIS DRAWING.

E12. PROVIDE NETWORK CONNECTION TO EXISTING COOPER LIGHTING SOLUTIONS WAVELINX WIRELESS CONTROLS WHICH CONTROL THE EXISTING CORRIDOR LIGHTING.

E13. EMERGENCY BATTERY BACKUP LIGHTING SHALL HAVE A MINIMUM 90 MINUTE DURATION AND BE PERMANENTLY WIRED IN PLACE (NEW 2#8-3/4"C.) THE BRANCH CIRCUIT FEEDING EMERGENCY BATTERY UNITS SHALL BE THE SAME BRANCH CIRCUIT AS THAT SERVING THE NIGHT LIGHTING OR NORMAL ILLUMINATION IN THE AREA AND CONNECTED AHEAD OF ANY LOCAL SWITCHES (ARTICLE 700.66).

E14. EXISTING EMERGENCY LIGHTING CONTROL STATION WITH PILOT LIGHT TO BE REMOVED, STORED, RELOCATED, REINSTALLED, AND REWIRED. VERIFY EXACT LOCATION WITH ARCHITECT PRIOR TO DOING ANY WORK. PROVIDE ALL REQUIRED NEW CONDUIT, WIRING, JUNCTION BOXES, ETC. TO EXISTING EMERGENCY PANEL LOCATED IN JANITOR CLOSET 109. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION. THIS CONTRACTOR SHALL RESTORE EXPOSED FINISHES OF PATCHED AREAS AND EXTEND FINISH RESTORATION INTO RETAINED ADJOINING CONSTRUCTION IN A MANNER THAT SHALL ELIMINATE EVIDENCE OF PATCHING AND REFINISHING.

E15. PROVIDE NEW TIME CLOCK TO CONTROL EXTERIOR LIGHTS LOCATED UNDER THE LINK. PROVIDE NEW 365 DAY ASTRONOMIC TIME SWITCH (2) CIRCUIT ELECTRONIC CONTROL WITH DAYLIGHT SAVINGS ADJUSTMENT, MANUAL OVER-RIDE, 30A RATED CONTACTS, BATTERY BACK-UP, LEAP YEAR, COMPATIBLE WITH MECHANICAL HELD, ELECTRONICALLY OPERATED CONTACTOR WITH 2 WIRE AUXILIARY RELAY – NEMA 1 ENCLOSURE. EXTERIOR LIGHTING TO BE CONTROLLED VIA TIME CLOCK ON-TIME CLOCK OFF. SET TIME SWITCH ON-OFF TIME PERIODS AS DIRECTED BY CPS. INTERMATIC ET90215CR SERIES OR ENGINEER APPROVED EQUIVALENT. PROVIDE ALL REQUIRED CONTROL WIRING IN NEW 3/4"C. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

E16. OMIT

E17. PROVIDE ELECTRIFIED DOOR CLOSER/HOLDER FOR FIRE RATED DOORS. UNITS SHALL BE FAIL SAFE AND RELEASE UPON AN INITIATION SIGNAL FROM EXISTING FIRE ALARM CONTROL PANEL. REFER TO ARCHITECTURAL DOOR HARDWARE SCHEDULE. PROVIDE ALL NEW WIRING AS REQUIRED. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

E18. PROVIDE (1) NEW 3/4"C. FOR PARKING LOT CCTV CAMERA IN THE SAME TRENCH AS NEW BRANCH CIRCUIT CONDUIT SERVING NEW PARKING LOT LIGHT STANDARDS. PROVIDE (1) 4-PAIR CATEGORY 6 UTP CABLE (PURPLE JACKET COVER) FROM CAMERA TO CCE LOCATED IN CLASSROOM 106 (CANTER). PROVIDE 3/4"C (PURPLE) WITHIN BUILDING. THIS CONTRACTOR SHALL TERMINATE ALL PAIRS OF CATEGORY 6 CABLE AT BOTH ENDS. PROVIDE PURPLE PATCH CORD. MAKE ALL FINAL CONNECTIONS FOR A COMPLETE AND OPERATIONAL DIGITAL VIDEO SURVEILLANCE SYSTEM.

E19. CONTRACTOR SHALL PROVIDE (1) AXIS #M7116 16-CHANNEL VIDEO ENCODER IN EXISTING MDF RACK.

E20. THE GENETEC SYSTEM (SOFTWARE MANAGEMENT AGREEMENT) AT KENWOOD IS VERSION 5.8. CONTRACTOR SHALL UPDATE SOFTWARE TO VERSION 5.9.

E21. CONTRACTOR SHALL PROVIDE LEGRAND 2-GANG STEEL RECESSED FLOOR BOX #RFB2 WITH TWO DUPLEX RECEPTACLES, TWO INTERNAL DUPLEX RECEPTACLE BRACKETS (LEGRAND #RFB2DP), AND FLANGED DIE-CAST ALUMINUM BLACK COVER PLATE (LEGRAND #FPBTCBK). INSERT IN LID ALLOWS FOR TILE OR CARPET CUTOUTS TO MATCH FINISHED FLOOR. INSTALL AS PER MANUFACTURER'S INSTRUCTIONS AND ALL APPLICABLE CODES. VERIFY EXACT LOCATION OF FLOOR BOX WITH ARCHITECT PRIOR TO DOING ANY WORK. MAKE ALL FINAL CONNECTIONS. FLOOR BOX SHALL BE FLUSH WITH FINISHED FLOOR.

2018 ELECTRICAL CODE

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCA# 5031)

Title: ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS

Sheet: E000-LNK

GENERAL ELECTRICAL NOTES: (APPLY TO ALL SHEETS)

1. ALL ELECTRICAL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATIONS AND ALL OTHER DRAWINGS RELATED TO THE PERFORMANCE OF THE WORK. THE CONTRACTOR SHALL VISIT THE JOB SITE AND FAMILIARIZE HIMSELF/HERSELF WITH ALL EXISTING AND PROPOSED EQUIPMENT LOCATIONS AND ROUTING REQUIREMENTS FOR NEW CONDUITS PRIOR TO SUBMITTING BID PROPOSAL.

2. GENERAL NOTES INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS SHALL BE CONSIDERED A PART OF THE CONTRACT.

3. ALL CONDUITS SHALL BE CONCEALED WHEREVER EXISTING OR NEW CONSTRUCTION, LAY-IN ACCESSIBLE CEILINGS, ETC. PERMIT.

4. THIS CONTRACTOR SHALL COORDINATE HIS WORK WITH ALL APPLICABLE TRADES.

5. BRANCH CIRCUIT WIRING IN EXCESS OF 75 FEET FOR 120V CIRCUITS SHALL BE #10 FROM PANEL TO MIDPOINT OUTLET OF THE CIRCUITS.

6. PROVIDE COVERPLATES FOR ALL JUNCTION BOXES, USED AND UNUSED, NEW OR EXISTING, FOR THIS WORK.

7. COORDINATE WITH ARCHITECTURAL DRAWINGS AND ALL APPLICABLE TRADES AND EXISTING CONDITIONS PRIOR TO INSTALLING CONDUITS, LIGHT FIXTURES, ETC.

8. CONDUIT RUNS SHOWN ON DRAWINGS ARE DIAGRAMMATIC ONLY. ACTUAL FIELD CONDITIONS SHALL BE VERIFIED AND CONDUITS SHALL BE ROUTED ACCORDINGLY.

9. ALL MEASUREMENTS AND DIMENSIONS SHALL BE FIELD VERIFIED BY THIS CONTRACTOR.

10. THIN WALL FITTINGS SHALL BE OF THE COMPRESSION TYPE. THE USE OF CRIMPING TYPE FITTINGS SHALL NOT BE ACCEPTABLE.

11. THE LOCATION OF ALL EQUIPMENT IS SHOWN DIAGRAMMATICALLY. THE EXACT LOCATION SHALL BE DETERMINED BY ACTUAL FIELD CONDITIONS. IF CONFLICT OCCURS WITH THE PLACEMENT OF EQUIPMENT SHOWN ON DRAWINGS AND EXISTING STRUCTURES AND APPURTENANCES, CONTRACTOR SHALL COORDINATE WITH DESIGN ENGINEER BEFORE FINAL INSTALLATION. CONTRACTOR SHALL OBTAIN AND VERIFY ALL DIMENSIONS AND CONDITIONS AT JOB SITE AND BE FULLY RESPONSIBLE FOR SAME.

12. THE CONTRACTOR SHALL FURNISH, INSTALL, AND CONNECT ALL EQUIPMENT IN ACCORDANCE WITH 2019 CHICAGO BUILDING CODE. AFTER EACH WORK DAY, CONTRACTOR SHALL CLEAN ALL WORK AREAS AND REMOVE ALL DEBRIS.

13. LOCATION OF ITEMS NOT FIXED BY DIMENSIONS ARE APPROXIMATE ONLY AND EXACT LOCATIONS NECESSARY TO SECURE THE BEST CONDITIONS AND RESULTS SHALL BE DETERMINED AT THE SITE AND SHALL BE SUBJECT TO REVIEW.

14. DO NOT SCALE FROM THESE DRAWINGS.

15. IDENTIFY ALL NEW RECEPTACLES WITH "BRADY" CLEAR VINYL POLYESTER TAPE WITH BLACK LETTERING. LABEL SHALL INDICATE RECEPTACLE PANEL AND CIRCUIT NUMBER AT BOTTOM OF COVER PLATE. (i.e.: CP-3:22)

16. PENETRATIONS OF FIRE RATED WALL AND FLOOR ASSEMBLIES SHALL BE PROTECTED WITH AN APPROVED THROUGH-PENETRATION SYSTEM AND SHALL BE A TESTED ASSEMBLY IN ACCORDANCE WITH ASTM E119. ALL CONDUIT PENETRATIONS THROUGH FLOORS AND WALLS SHALL BE FIRE SEALED. SEALANT RATING SHALL MEET OR EXCEED THE FIRE RATING OF FLOOR AND WALL CONSTRUCTION. REFER TO SECTION 07 84 00.

17. CPS RESERVES THE RIGHT TO RELOCATE ANY ELECTRICAL EQUIPMENT OR CONNECTION WITHIN FIVE FEET FROM THAT SHOWN ON THE DRAWINGS PRIOR TO INSTALLATION AT NO EXTRA COST TO CPS.

18. THIS CONTRACTOR RESPONSIBLE FOR THE EXECUTION OF THIS WORK SHALL BECOME THOROUGHLY FAMILIAR WITH THE PROJECT SPECIFICATIONS BEFORE COMMENCING ANY WORK. THE PROJECT SPECIFICATIONS AND DRAWINGS FORM THE BASIS OF THIS CONTRACT REQUIREMENTS AND INCLUDE THE TYPE AND GRADE OF MATERIALS TO BE INSTALLED, EQUIPMENT TO BE FURNISHED, THE MANNER BY WHICH TO BE INSTALLED AND WHERE TO BE LOCATED. IN THE EVENT OF A CONFLICT BETWEEN THE PROJECT SPECIFICATIONS AND DRAWINGS, SPECIFICATIONS GOVERN UNLESS THE ARCHITECT/ENGINEER DIRECTS OTHERWISE.

19. ALL BRANCH CIRCUIT FEEDERS SHALL BE PROVIDED WITH SEPARATE GROUNDING CONDUCTORS SIZED PER ARTICLE 250 OF THE CHICAGO BUILDING CODE.

20. PROVIDE PULL STRING IN ALL EMPTY CONDUITS.

21. CIRCUIT NUMBERS SHOWN ARE FOR CLARITY ONLY AND DO NOT REPRESENT ACTUAL CIRCUIT BREAKER NUMBERS IN EXISTING OR NEW PANELS. BRING ALL EXISTING PANEL DIRECTORIES UP TO DATE FOR ALL NEW AND EXISTING CIRCUITS, INCLUDING SPARES. PROVIDE NEW TYPEWRITTEN PANEL DIRECTORIES.

22. NO WIRING SHALL BE DONE PRIOR TO THIS CONTRACTOR'S REVIEW OF THE PROJECT EQUIPMENT SHOP DRAWINGS. COORDINATE FIELD CONDITIONS WITH THE CONTRACT DOCUMENTS. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ARCHITECT/ENGINEER'S ATTENTION FOR FINAL RESOLUTION. WORK THAT HAS TO BE REPLACED DUE TO LACK OF PROPER SHOP DRAWINGS COORDINATION SHALL BE DONE AT CONTRACTOR'S EXPENSE.

23. ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN DEMOLITION, REMOVAL, RECAPPING, STORING, DISCONNECTING, RELOCATING, AND RECONNECTING OF EXISTING CONDUIT AND EQUIPMENT. ANY DISPUTE BETWEEN CONTRACTORS AS TO THEIR RESPECTIVE RESPONSIBILITY FOR THIS WORK SHALL BE RESOLVED BY THE ENGINEER AND HIS DECISION SHALL BE FINAL.

24. FURNISH AND INSTALL ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND APPURTENANCES FOR A COMPLETE ELECTRICAL SYSTEM. WHERE THERE IS NO MENTION OF THE RESPONSIBLE PARTY FOR A SPECIFIC ITEM TO BE FURNISHED, INSTALLED, OR WIRED ON THE ELECTRICAL DRAWINGS, THIS CONTRACTOR SHALL BE RESPONSIBLE COMPLETELY FOR A COMPLETE AND OPERATING SYSTEM FOR THIS ITEM.

25. LOCATION OF ITEMS NOT FIXED BY DIMENSIONS ARE APPROXIMATE ONLY AND EXACT LOCATIONS NECESSARY TO SECURE THE BEST CONDITIONS AND RESULTS SHALL BE DETERMINED AT THE SITE AND SHALL BE SUBJECT TO REVIEW.

26. THIS CONTRACTOR SHALL CHECK CAREFULLY ALL CONSTRUCTION DRAWINGS AND SPECIFICATIONS THAT ARE PART OF THIS PROJECT TO INSURE THAT NO FIXTURE, OUTLET, PUSH PLATE OR CONTROL AND POWER WIRING IS OMITTED. THE CONTRACTOR SHALL CONSULT ALL TRADES FURNISHING EQUIPMENT AND OBTAIN FROM THEM ALL DATA. IN SOME CASES EQUIPMENT, FIXTURES AND DEVICES ARE SHOWN ONLY. ASCERTAIN AND PROVIDE THE WIRING AND CONTROL STATIONS REQUIRED FOR THE PROPER FUNCTION OF BUILDING EQUIPMENT.

27. ALL CONDUIT CONNECTIONS TO MOTORS SHALL BE SEALTIGHT FLEXIBLE CONDUIT; SAME CONDUIT SIZE AS CIRCUIT CONDUIT FROM MOTOR STARTER OR VARIABLE FREQUENCY DRIVE TO MOTOR.

28. PREPARE AND SUBMIT 1/4" SCALE COORDINATION DRAWINGS PRIOR TO ORDERING EQUIPMENT AND ROUGHING BRANCH CIRCUITS. LOCATE ALL ELECTRICAL EQUIPMENT, INDICATE CLEARANCES AND ROUTING OF ALL OVERHEAD BRANCH CIRCUITS.

29. CONTRACTOR SHALL COORDINATE EXACT LOCATIONS AND MOUNTING HEIGHTS OF ALL DEVICES WITH THE ARCHITECTURAL DRAWINGS INCLUDING BUT NOT LIMITED TO ARCHITECTURAL DETAILS, ELEVATIONS, AND CASEWORK DETAILS.

30. THE GENERAL CONTRACTOR SHALL SUBMIT MECHANICAL AND ELECTRICAL CONSTRUCTION AND COORDINATION DRAWINGS TO A SCALE OF 1/4"=1'-0" FOR 'REVIEW OF DESIGN INTENT' INDICATING COORDINATION OF ALL TRADES PRIOR TO INSTALLATION OF MECHANICAL AND ELECTRICAL WORK. PROVIDE MECHANICAL AND ELECTRICAL COORDINATION DRAWINGS, AT MINIMUM, FOR ALL CORRIDORS, CLASSROOMS, ELECTRICAL ROOMS, AND MECHANICAL ROOMS. GENERAL CONTRACTOR SHALL DETAIL MAJOR ELEMENTS, COMPONENTS, AND SYSTEMS OF MECHANICAL AND ELECTRICAL EQUIPMENT AND MATERIALS IN RELATIONSHIP WITH OTHER SYSTEMS AND BUILDING COMPONENTS.

31. WHERE THERE IS A CONFLICT BETWEEN THE DRAWINGS AND SPECIFICATIONS, BID SHALL BE BASED ON THAT ITEM WHICH IS GREATER IN QUANTITY OR QUALITY. VERIFY WITH THE ENGINEER WHICH ITEM SHALL TAKE PRECEDENCE PRIOR TO THE INSTALLATION OF THIS ITEM.

32. PROVIDE A DEDICATED NEUTRAL FOR EACH 120 VOLT CIRCUIT.

DEMOLITION/REMOVAL NOTES:

D1. VERIFY EXISTING CONDITIONS AND LOCATIONS IN FIELD PRIOR TO SUBMITTING BID PROPOSAL. FAILURE TO DO SO SHALL NOT RELIEVE THIS CONTRACTOR FROM PERFORMING THE WORK UNDER THIS CONTRACT.

D2. MAKE NECESSARY MODIFICATIONS AND ADJUSTMENTS TO ALL ELECTRICAL ITEMS AND EQUIPMENT, BOTH NEW AND EXISTING, AS MAY BE REQUIRED BY THESE ALTERATIONS.

D3. DISCONNECT AT SOURCE AND REMOVE EXISTING ELECTRICAL MATERIALS AND EQUIPMENT, INCLUDING BUT NOT LIMITED TO: LIGHTING FIXTURES, WIRING DEVICES, FIRE ALARM DEVICES, MOTION SENSORS, SPEAKERS, DOOR CONTACTS, SURFACE STEEL RACEWAY, CONDUIT AND WIRES, AND ALL OTHER ELECTRICAL ITEMS WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS. THESE ARE THE PROPERTY OF CPS AND SHALL EITHER BE REMOVED FROM THE SITE LEGALLY OR RETURNED TO THE OWNER'S STOCK AT THE DISCRETION OF CPS.

D4. IT SHALL BE THIS CONTRACTOR'S RESPONSIBILITY TO MAINTAIN THE ELECTRICAL CONTINUITY AND CONTINUITY OF EXISTING MISCELLANEOUS SYSTEMS DURING THE ENTIRE CONSTRUCTION PERIOD. IF IT IS ABSOLUTELY NECESSARY TO SHUT DOWN ANY FEEDER OR SERVICE OR DISTRIBUTION EQUIPMENT AT ANY TIME, THIS CONTRACTOR SHALL CONSULT WITH CPS TO MAKE ARRANGEMENTS TO DO SO ON SUNDAYS OR OFF-HOUR PERIODS AT THE CONVENIENCE OF CPS. PRIOR WRITTEN NOTICE SHALL BE GIVEN TO THE CPS (3) CALENDAR DAYS IN ADVANCE OF THE DESIRED SHUTDOWN TIME. ANY PREMIUM OR OVERTIME COSTS NECESSARY TO ACCOMPLISH THE ABOVE SHALL BE INCLUDED IN BID PROPOSAL. CONTRACTOR SHALL PROVIDE ALL TEMPORARY WIRING, OVER DEVICES, CONDUITS, PULLBOXES, IN ORDER TO MAINTAIN CONTINUITY OF ELECTRICAL SERVICES IN THE EXISTING BUILDING.

D5. DISCONNECT, REMOVE, AND REINSTALL EXISTING ELECTRICAL MATERIALS AND EQUIPMENT INCLUDING BUT NOT LIMITED TO LIGHTING FIXTURES, WIRING DEVICES, CONDUIT, SURFACE STEEL RACEWAY, AND ALL OTHER ELECTRICAL ITEMS WHICH INTERFERE OR ARE INTERFERED WITH, OBSTRUCT OR ARE OBSTRUCTED BY, THESE ALTERATIONS. PERMANENTLY REINSTALL SUCH ITEMS. PROVIDE NEW OUTLETS, CONDUITS, SURFACE STEEL RACEWAY, WIRING, ETC., AS REQUIRED TO EXTEND SERVICE TO NEW LOCATIONS. RECONNECT SUCH ITEMS IN PROPER OPERATING CONDITION AT NEW OR EXISTING LOCATIONS AS REQUIRED.

D6. ANY EQUIPMENT THAT IS TO BE REINSTALLED AND RECONNECTED SHALL BE CAREFULLY EXAMINED FOR ANY DEFECTS AND TESTED FOR ELECTRICAL CONTINUITY AND PROPER OPERATION PRIOR TO REMOVAL. ANY DEFECTS OR MALFUNCTIONS DETECTED SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ARCHITECT AND CPS. AFTER EQUIPMENT HAS BEEN CERTIFIED TO BE IN GOOD ELECTRICAL/MECHANICAL CONDITION, THE EQUIPMENT MAY BE REMOVED, BOXED, STORED, AND PROTECTED BY THE CONTRACTOR. CONTRACTOR SHALL BEAR ALL EXPENSES FOR ANY EQUIPMENT REINSTALLED THAT IS NOT OPERATING PROPERLY. CONTRACTOR SHALL REPLACE WITH NEW EQUIPMENT OR PROPERLY REPAIR ANY DAMAGED OR NON-WORKING EQUIPMENT TO THE SATISFACTION OF CPS.

D7. WHERE EXISTING CONDUITS HAVE BEEN MADE OBSOLETE BY THESE ALTERATIONS AND IT IS IMPRACTICAL TO REMOVE SAME, THIS CONTRACTOR SHALL:
a). PULL OUT ALL WIRE AND CABLE.
b). CUT CONDUIT OFF AT SLAB OR WALL LINE.
c). BLANK-UP ALL OBSOLETE CONDUIT ENTRIES INTO EXISTING JUNCTION BOXES, PANELBOARD, PULL BOXES, ETC.
d). CAP CONDUIT AND PATCH SURFACE TO MATCH EXISTING.

D8. REFER TO ARCHITECTURAL AND MECHANICAL DEMOLITION DRAWINGS AND SPECIFICATIONS FOR ADDITIONAL ELECTRICAL DEMOLITION/REMOVAL WORK REQUIRED.

D9. WHERE THE CONTINUITY OF CIRCUITS OR CONDUITS SERVING ANY EXISTING ELECTRICAL EQUIPMENT IN AREAS OF THE EXISTING BUILDING NOT BEING ALTERED IS INTERFERED WITH, THIS CONTRACTOR SHALL REROUTE AND RECONNECT ALL SUCH CIRCUITS OR CONDUITS.

D10. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES FOR LIGHT FIXTURES AND MOTORS WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS.

D11. REMOVE ALL CONDUITS INCLUDING ALL CONDUITS ABOVE THE CEILING AND ALL EXPOSED CONDUITS AND ASSOCIATED HANGERS AND MISCELLANEOUS AND INCIDENTAL HARDWARE WHICH ARE RENDERED OBSOLETE BY THESE ALTERATIONS.

D12. LIGHT FIXTURES. REMOVE LIGHT FIXTURES, STEMS, LAMPS, ACCESSORIES, JUNCTION BOXES, CONDUITS AND WIRING. WHERE PARTIAL LIGHTING IS REMOVED, REWIRE EXISTING LIGHTING TO REMAIN TO THE EXISTING CIRCUIT OR OVERCURRENT DEVICE.

D13. HVAC MOTORS. REMOVE EXISTING MOTORS, MOTOR STARTERS, PUSH BUTTONS, DISCONNECT SWITCHES, CONDUITS, WIRING, FITTINGS, AND BOXES. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES. REFER TO MECHANICAL DEMOLITION DRAWINGS FOR EXACT LOCATIONS.

D14. LIGHTING FIXTURES, SWITCHES, RECEPTACLES, MISCELLANEOUS DEVICES, AND MISCELLANEOUS WIRING DEVICES SHOWN TO BE REMOVED DO NOT REPRESENT THE EXACT QUANTITY OF ELECTRICAL MATERIALS, WIRING DEVICES, EQUIPMENT TO BE REMOVED. CONTRACTOR SHALL PROVIDE FOR THE FOLLOWING:
a). REMOVE ALL EXISTING LIGHT FIXTURES WHERE NEW LIGHTING IS SHOWN AND SPECIFIED. MAINTAIN CONTINUITY OF ALL EXISTING LIGHTING FIXTURES TO REMAIN.
b). REMOVE ALL UNUSED WIRING BACK TO OVERCURRENT DEVICE.

D15. CAREFULLY REMOVE AND REINSTALL EXISTING CEILING OR WALL MOUNTED EQUIPMENT AS REQUIRED FOR INSTALLATION OF NEW WORK, INCLUDING DISCONNECTING, REMOVAL, REINSTALLATION AND RECONNECTING OF EXISTING CEILING OR WALL MOUNTED DEVICES.

D16. CAREFULLY REVIEW THE ARCHITECTURAL AND MECHANICAL DRAWINGS FOR ADDITIONAL ITEMS TO BE REMOVED AND/OR RELOCATED. INCLUDE ALL COSTS IN BID PROPOSAL FOR REMOVAL, DISCONNECTING, OR RELOCATION OF EQUIPMENT AFFECTED BY DEMOLITION OF OTHER TRADES.

D17. ALL EXISTING CONDUIT AND WIRING INTERFERING WITH THE NEW WORK SHALL BE REROUTED AND CONCEALED IN THE NEW CONSTRUCTION WHERE POSSIBLE.

D18. EXISTING ELECTRICAL EQUIPMENT NOT SHOWN ON THIS DRAWING; HOWEVER, REQUIRED TO BE REMOVED AND/OR RELOCATED BY DEMOLITION, SHALL BE INCLUDED BY THIS CONTRACTOR IN HIS/HER BID PROPOSAL.

D19. REFER TO MECHANICAL DEMOLITION DRAWINGS FOR EXACT LOCATIONS OF ALL MOTORS SHOWN TO BE REMOVED. PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES FOR DISCONNECTION AND REMOVAL OF ALL RELATED ELECTRICAL EQUIPMENT AND DEVICES INCLUDING, BUT NOT LIMITED TO THE FOLLOWING:
a). REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES.
b). REMOVE ALL CONDUITS, HANGERS, BOXES, ANCHORS, CHANNELS, ETC. FOR A COMPLETE REMOVAL.
c). UPDATE DISTRIBUTION PANEL, PANELBOARD, NAMEPLATES, AND DIRECTORIES. WHERE A CIRCUIT BREAKER OR FUSIBLE BRANCH SWITCH IS NOW SPARE; PROVIDE ENGRAVED NAMEPLATE "SPARE".
d). REMOVE DISCONNECT MEANS.
e). DISCONNECT MOTORS FROM SUPPLY SOURCE.
f). REMOVE ALL CONTROL CONDUITS AND ASSOCIATED WIRING.
g). REMOVE MOTOR STARTER

D20. CONTRACTOR SHALL BE RESPONSIBLE FOR HIS OWN CLEANUP THROUGHOUT THE COURSE OF THE DEMOLITION WORK.

D21. FLOOR SLABS MAY CONTAIN CONDUIT SYSTEMS. THIS CONTRACTOR IS RESPONSIBLE FOR TAKING ANY MEASURES REQUIRED TO ENSURE NO CONDUITS OR OTHER SERVICES ARE DAMAGED. THIS INCLUDES X-RAY OR SIMILAR NON-DESTRUCTIVE MEANS.

D22. THIS CONTRACTOR IS RESPONSIBLE FOR ALL COSTS INCURRED IN REPAIR, RELOCATIONS, OR REPLACEMENT OF ANY CABLES, CONDUITS, OR OTHER SERVICES IF DAMAGED WITHOUT PROPER INVESTIGATION.

D23. PERFORM ALL CUTTING, CORING, AND PATCHING REQUIRED TO COMPLETE THE WORK. PERFORM ALL DEMOLITION AND REMOVAL OF DEBRIS RESULTING THEREFROM AND REQUIRED TO COMPLETE THE WORK. PATCH AND PAINT EXISTING FINISHED SURFACES AND BUILDING COMPONENTS USING NEW MATERIALS MATCHING EXISTING MATERIALS AND TEXTURE USING EXPERIENCED INSTALLERS. REFER TO SPECIFICATIONS AND ARCHITECTURAL DRAWINGS.

D24. WHERE EXISTING SURFACE MOUNTED RACEWAY IS BEING REMOVED, THIS CONTRACTOR SHALL VERIFY THAT NO SERVICE INTERRUPTIONS HAVE OCCURRED ONCE RACEWAY HAS BEEN REMOVED.

D25. ALL EQUIPMENT SPECIFIED TO BE REMOVED, STORED, RE-INSTALLED, AND REWIRED, INCLUDING BUT NOT LIMITED TO LIGHT FIXTURES, MOTION SENSORS, AND FIRE ALARM DEVICES SHALL BE PRE-VERIFIED FOR PROPER OPERATION PRIOR TO REMOVAL IN THE PRESENCE OF CPS. ALL INOPERATIVE DEVICES SHALL BE RECORDED. ALL PARTIES, INCLUDING CPS, ARCHITECT, AND CONTRACTOR, SHALL RECEIVE DOCUMENTATION OF ANY EXISTING DEFECTIVE EQUIPMENT. CONTRACTOR SHALL BEAR ALL COST AND RESPONSIBILITY FOR ALL EQUIPMENT SCHEDULED TO BE REMOVED, STORED, REINSTALLED, AND REWIRED BY THE CONTRACTOR. CONTRACTOR AGREES TO REPAIR OR REPLACE TO THE SATISFACTION OF CPS ALL MATERIALS AND EQUIPMENT FOUND TO BE INOPERATIVE AFTER REINSTALLATION AT NO ADDITIONAL OR EXTRA COST TO THE CONTRACT. ALL EQUIPMENT NOT PRE-VERIFIED BY THE CONTRACTOR FOR PROPER OPERATION PRIOR TO EQUIPMENT REMOVAL SHALL AUTOMATICALLY ASSUME FULL RESPONSIBILITY FOR PROPER OPERATION UPON REINSTALLATION OF EQUIPMENT.

D26. MAINTAIN CONTINUITY FOR EXIT DIRECTIONAL SIGNS AND EMERGENCY LIGHTING FOR MEANS OF EGRESS. PROVIDE TEMPORARY WIRING FOR REMOVING, RELOCATING, RE-INSTALLING, REWIRING EXISTING EXIT SIGNS AND LIGHT FIXTURES AS REQUIRED TO MAINTAIN EXIT DIRECTIONAL SIGNAGE AND EMERGENCY LIGHTING DURING THE ENTIRE CONSTRUCTION PERIOD.

D27. EXISTING SCHOOL INTRUSION DETECTION SYSTEM, CCTV CAMERAS, AND INTERCOM SYSTEM HEAD END EQUIPMENT, LOCAL DEVICES, ASSOCIATED CONDUIT AND WIRING TO REMAIN. PRESERVE DURING ENTIRE CONSTRUCTION PERIOD AND MAINTAIN OPERATIONAL AT ALL TIMES. COORDINATE ANY DOWNTIME REQUIRED WITH CPS.

D28. IT SHALL BE THIS CONTRACTOR'S RESPONSIBILITY TO MAINTAIN ALL LOW VOLTAGE SYSTEM CABLING CONTINUITY DURING THE ENTIRE CONSTRUCTION PERIOD. IF IT IS ABSOLUTELY NECESSARY TO SHUT DOWN ANY ELECTRONIC EQUIPMENT AT ANY TIME, THIS CONTRACTOR SHALL CONSULT WITH CPS TO MAKE ARRANGEMENTS TO DO SO ON SUNDAYS OR OFF-HOUR PERIODS AT THE CONVENIENCE OF CPS. PRIOR WRITTEN NOTICE SHALL BE GIVEN TO CPS (3) CALENDAR DAYS IN ADVANCE OF THE DESIRED SHUTDOWN TIME. ANY PREMIUM OR OVERTIME COSTS NECESSARY TO ACCOMPLISH THE ABOVE SHALL BE INCLUDED IN BID PROPOSAL. CONTRACTOR SHALL PROVIDE ALL TEMPORARY CABLING, CONDUITS, IN ORDER TO MAINTAIN CONTINUITY OF ALL LOW VOLTAGE SYSTEM CABLING IN THE EXISTING BUILDING.

D29. WHERE EXISTING DATA OUTLETS ARE BEING REMOVED, CONTRACTOR SHALL REMOVE ALL CABLES BACK TO THE CLASSROOM CONCENTRATOR ENCLOSURE OR MDF ROOM AS REQUIRED.

GENERAL SYMBOLS

(NOT ALL SYMBOLS ARE USED ON THIS PROJECT)

Symbol	Description
	BRANCH CIRCUIT PANELBOARD
	DISTRIBUTION PANELBOARD
T	DRY TYPE TRANSFORMER
	FUSED HEAVY DUTY DISCONNECT SWITCH
	NON-FUSED HEAVY DUTY DISCONNECT SWITCH
	MAGNETIC MOTOR STARTER WITH HAND-OFF-AUTO SWITCH AND RED & GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (4 NORMALLY OPEN, 4 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
	COMBINATION STARTER/DISCONNECT SWITCH (NON-FUSED) WITH HAND-OFF-AUTO SWITCH AND RED AND GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (2 NORMALLY OPEN, 2 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
	COMBINATION STARTER/DISCONNECT SWITCH (FUSED) WITH HAND-OFF-AUTO SWITCH AND RED AND GREEN PILOT LIGHTS. PROVIDE (2) SETS OF FACTORY INSTALLED CONVERTIBLE AUXILIARY CONTACTS (2 NORMALLY OPEN, 2 NORMALLY CLOSED). REFER TO SECTION 26 29 13.
M	MOTOR. SEE DRAWINGS FOR HP RATINGS.
	MOTOR/EQUIPMENT TAG
F, Na	1' x 4' LED FIXTURE WHERE: 'F' IS THE FIXTURE TAG 'N' IS THE CIRCUIT NUMBER 'a' IS THE SWITCH DESIGNATION
EM	HATCHING INDICATES LIGHT FIXTURE CONNECTED TO EMERGENCY LIGHTING SYSTEM
X	EXISTING LIGHT FIXTURE TO REMAIN
$a	SINGLE POLE WALL SWITCH. REFER TO ARCHITECTURAL DRAWINGS FOR MOUNTING HEIGHT. WHERE: 'a' IS THE DESIGNATION INDICATING WHAT LIGHTS ARE CONTROLLED BY THAT SWITCH
$P	ILLUMINATED AND PILOT LIGHT CLEAR TOGGLE SWITCH (LIGHT ON WITH LOAD OFF) (HUBBELL #HBL1221ILC).
$EM	ILLUMINATED AND PILOT LIGHT RED TOGGLE SWITCH FOR EMERGENCY LIGHTING (LIGHT ON WITH LOAD OFF) (HUBBELL #HBL1221ILR). REFER TO ARCHITECTURAL DRAWINGS FOR MOUNTING HEIGHT.
$T-P	SINGLE POLE MANUAL FRACTIONAL MOTOR STARTER WITH RED PILOT LIGHT AND THERMAL OVERLOAD PROTECTION (TYPE T-P).
OS	MULTI-TECHNOLOGY CEILING-MOUNTED OCCUPANCY SENSOR - COOPER LIGHTING SOLUTIONS OR EQUIVALENT #OAC-DT-2000 WITH POWER PACK #FLT-SP-MV-DC1. CONNECT POWER PACK TO 120V LIGHTING CIRCUIT SERVING THE ROOM. REFER TO OCCUPANCY/VACANCY SENSOR NOTES ON DRAWING E002-MEP.
VS	MULTI-TECHNOLOGY CEILING-MOUNTED VACANCY SENSOR - COOPER LIGHTING SOLUTIONS OR EQUIVALENT #OAC-DT-2000 WITH POWER PACK #FLT-SP-MV-DC1. CONNECT POWER PACK TO 120V LIGHTING CIRCUIT SERVING THE ROOM. REFER TO OCCUPANCY/VACANCY SENSOR NOTES ON DRAWING E002-MEP.
	DUPLEX CONVENIENCE TAMPER-RESISTANT RECEPTACLE
GFI	GROUND FAULT INTERRUPTING DUPLEX CONVENIENCE TAMPER-RESISTANT RECEPTACLE
X-N	REMOTE EXISTING RECEPTACLE, WIRING, AND COVERPLATE. PROVIDE NEW RECEPTACLE, WIRING, AND COVERPLATE. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.
	QUADRUPLEX - TWO DUPLEX RECEPTACLES IN ONE BACKBOX MOUNTED IN A COMMON COVERPLATE
B	BATTERY OPERATED ANALOG CLOCK
	VOICE/DATA OUTLET - PROVIDE VOICE/DATA DROP TO CONSIST OF (1) 4-PAIR CATEGORY 6 CABLE (BLUE) AND (1) 4-PAIR CATEGORY 5e CABLE (YELLOW) TO NEAREST EXISTING CONCENTRATOR ENCLOSURE (OFFICE C112A). PROVIDE 3/4"C. FROM BACKBOX TO CONCENTRATOR ENCLOSURE. PROVIDE 4" SQUARE EXTRA DEEP SINGLE GANG BACKBOX. PROVIDE VERTICALLY MOUNTED SINGLE GANG PLASTER RING AND COVERPLATE. THIS CONTRACTOR SHALL TERMINATE ALL PAIRS OF CATEGORY 6 AND 5e CABLES AT BOTH ENDS. MAKE ALL FINAL CONNECTIONS FOR A COMPLETE AND OPERATIONAL DATA SYSTEM. REFER TO DIVISION 27 SPECIFICATION SECTIONS.
	GROUND
	GREEN GROUNDING WIRE CONDUCTOR INSTALLED WITH CIRCUIT CONDUCTORS
S	WALL MOUNTED SPEAKER TO BE ELECTRICALLY COMPATIBLE IN ALL RESPECTS WITH INTERCOM SYSTEM HEADEND EQUIPMENT. REFER TO SECTION 27 23 15.
S	INTELLIGENT DUAL ACTION MANUAL PULL STATION TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
D	INTELLIGENT ADDRESSABLE HEAT DETECTOR TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
SD	INTELLIGENT ADDRESSABLE SYSTEM SMOKE DETECTOR TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER)
V	ADA STROBE TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER) - 75 CANDELA STROBE
AV	ADA HORN/STROBE TO BE COMPATIBLE WITH EXISTING FIRE ALARM AND DETECTION SYSTEM (NOTIFIER) - 15 Db OVER AMBIENT NOISE
CO	NEW INTELLIGENT CARBON MONOXIDE (CO) DETECTOR TO COMPLY WITH UL 2075 AND EQUIPPED WITH A DISTINCT ALARM SIGNAL FROM THE FIRE ALARM SIGNAL, END OF LIFE TIMER, AND TEST/HUSH BUTTON AS REQUIRED BY THE CITY OF CHICAGO BUILDING CODE AND ILLINOIS STATE FIRE MARSHALL FOR SCHOOLS. CONNECT TO EXISTING NOTIFIER FIRE ALARM AND DETECTION SYSTEM FOR GENERAL ALARM SIGNAL. A TROUBLE SIGNAL SHALL BE SENT TO THE FACP UPON CO CELL TROUBLE OR CELL END OF LIFE. MOUNT AND WIRE ACCORDING TO MANUFACTURER'S INSTRUCTIONS.
	UNDERGROUND DUCT 5" PVC SCHEDULE 40 WITH 3" CONCRETE ENVELOPE. SQUARES INDICATE NUMBER OF DUCTS.
X	EXISTING ELECTRICAL EQUIPMENT (DEVICE) TO REMAIN
XR	EXISTING ELECTRICAL EQUIPMENT (DEVICE) TO BE REMOVED. REMOVE ALL WIRING BACK TO OVERCURRENT DEVICES, OR DISCONNECT AND RECONNECT NEW EQUIPMENT USING EXISTING WIRING AS INDICATED ON DRAWINGS.
XRR	EXISTING EQUIPMENT (DEVICE) TO BE REMOVED, STORED, RELOCATED, REINSTALLED, AND REWIRED, COMPLETE IN PLACE, READY FOR OPERATION.
H	INDICATES DEVICE MOUNTED ABOVE COUNTER
W	INDICATES DEVICE MOUNTED AT SWITCH HEIGHT (+48" A.F.F.)
WP	INDICATES DEVICE IN WEATHERPROOF ENCLOSURE
PROVIDE	FURNISHED, INSTALLED, AND WIRED BY ELECTRICAL CONTRACTOR

PANELBOARD WIRING CONVENTION

— — —
NORTH OR SOUTH PORTION OF BLDG.
LEVEL
PANEL TYPE

e.i. - 'L2S' (LIGHTING PANEL, 2ND FLOOR, SOUTH)

TYPE

LM - LIGHTING/GENERAL MAINTENANCE PANELBOARD
PP - POWER PANELBOARD
ACP - AIR CONDITIONING PANELBOARD (BEING REUSED AS GENERAL PANELBOARD FOR FAN COIL BOXES)

RACEWAYS & WIRING

Symbol	Description
	CONDUIT HOMERUN PHASE NEUTRAL GROUND
	CONDUIT - SURFACE MOUNTED OR CONCEALED
	CONDUIT UNDERFLOOR OR UNDERGROUND
	CONDUIT TURNED UP
	CONDUIT TURNED DOWN
	FLEXIBLE CONDUIT
J	JUNCTION BOX
J	JUNCTION BOX - WALL MOUNTED
J	JUNCTION BOX UNDER FLOOR
PB	PULLBOX
A	ALTERNATOR

ABBREVIATIONS

A - AMPS	CU - COPPER	F - FUSE	J/B - JUNCTION BOX	NIC - NOT IN CONTRACT	SW - SWITCH
AFF - ABOVE FINISHED FLOOR	CT - CURRENT TRANSFORMER	FDR - FEEDER	LTG - LIGHTING	NO - NORMALLY OPEN	SWBD - SWITCHBOARD
A/C - AIR CONDITIONING	DIA - DIAMETER	FLA - FULL LOAD AMPS	JPC - JOCKEY PUMP CONTROLLER	NTS - NOT TO SCALE	SWGR - SWITCHGEAR
AHU - AIR HANDLING UNIT	D/S - DISCONNECT SWITCH	FLR - FLOOR	M - MOTOR	O/H - OVERHEAD	TR - TRANSFORMER
ATS - AUTOMATIC TRANSFER SWITCH	DIV - DIVISION	FPC - FIRE PUMP CONTROLLER	MCB - MAIN CIRCUIT BREAKER	OL - OVERLOAD	TTC - TELEPHONE TERMINAL CABINET
BSMT - BASEMENT	DWG - DRAWING	FIXT - FIXTURE	MCC - MOTOR CONTROL CENTER	PB - PUSHBUTTON	TVSS - TRANSIENT VOLTAGE SURGE SUPPRESSOR
BPS - BOLTED PRESSURE SWITCH	EC - ELECTRICAL CONTRACTOR	FVNR - FULL VOLTAGE, NON REVERSING (MAGNETIC STARTER)	MCP - MAXIMUM CIRCUIT PROTECTION	P/N - PART NUMBER	UPS - UNINTERRUPTIBLE POWER SUPPLY
C - STEEL CONDUIT	EQUIP - EQUIPMENT	GFI - GROUND FAULT INTERRUPTER	MLO - MAIN LUGS ONLY	PNL - PANEL	V - VOLTS
CCT - CIRCUIT	ELECT - ELECTRIC, ELECTRICAL	GFP - GROUND FAULT PROTECTION	MECH - MECHANICAL	PRI - PRIMARY	VFD - VARIABLE FREQUENCY DRIVE
C/B - CIRCUIT BREAKER	EM - EMERG- EMERGENCY	GRD - GROUND	MOCP - MAIN OVERCURRENT PROTECTION	PT - POTENTIAL TRANSFORMER	W - WATTS
CLG - CEILING	EXIST- EXISTING	HP - HORSEPOWER	N - NEUTRAL	R - RELOCATED	WG - WIRE GUARD
CO - CARBON MONOXIDE DETECTOR	F&I - FURNISH AND INSTALL	HOA - HAND-OFF-AUTO	N/A - NOT APPLICABLE	S - SWITCH	WP - WEATHERPROOF
CP - CONTROL PANEL	FCU - FAN COIL UNIT	IG - ISOLATED GROUND	NC - NORMALLY CLOSED	SEC - SECONDARY	
				SPD - SURGE PROTECTIVE DEVICE	

ELECTRICAL KEY PLAN NOTES

E1. ALL CONDUITS SHALL BE CONCEALED WHEREVER EXISTING CONSTRUCTION OR NEW CONSTRUCTION, LAY-IN ACCESSIBLE CEILINGS, ETC. PERMIT, OR BE SURFACE METAL RACEWAY. RACEWAY SIZE AS REQUIRED TO ACCOMMODATE WIRING CAPACITY PER 2018 CITY OF CHICAGO ELECTRICAL CODE.

E2. CONTRACTOR MAY REUSE EXISTING CONDUIT SYSTEM WHERE EXISTING CONDUIT SYSTEMS MEET OR EXCEED THE APPLICABLE CODES IN ALL RESPECTS. ALL EXISTING CONDUITS SHALL BE CLEANED PRIOR TO CABLE INSTALLATION. PROVIDE GROUNDING CONDUCTOR IN ALL EXISTING CONDUITS REUSED. HOWEVER, WHERE EXISTING CONDUIT SYSTEM IS NOT REUSED, CONTRACTOR SHALL FURNISH AND INSTALL NEW CONDUIT SYSTEM FOR NEW FEEDERS AS SPECIFIED.

E3. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVAL, STORAGE, AND RE-INSTALLATION OF ALL LAY-IN CEILING TILES FOR INSTALLATION OF NEW CONDUITS. TAKE PRECAUTIONS SO AS NOT TO DAMAGE TILES. STORE CEILING TILES IN A CLEAN DRY LOCATION AS INDICATED BY THE SCHOOL. CONTRACTOR IS RESPONSIBLE FOR PROVIDING NEW CEILING TILES TO MATCH EXISTING FOR ANY TILES DAMAGED AT NO ADDITIONAL COST TO THE CONTRACT.

E4. OMIT

E5. PROVIDE NEW 2#10-3/4"C. (OR SURFACE STEEL RACEWAY IN ALL FINISHED AREAS) CONNECT TO EXISTING NEAREST EMERGENCY LIGHTING CIRCUIT IN CORRIDOR. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUIT, WIRING, ETC. MAKE ALL FINAL CONNECTIONS.

E6. NEW ROOFTOP UNIT INTERIOR LIGHTING AND RECEPTACLE SHALL BE PROVIDED BY MANUFACTURER, INSTALLED AND WIRED BY THIS CONTRACTOR. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

E7. PROVIDE WEATHERPROOF OUTLET BOX AND COVER TO MEET UL STANDARD 514A AND UL LISTED FOR WET LOCATIONS. THE ENCLOSURE SHALL BE CONSTRUCTED OF GASKETED CAST ALUMINUM WITH SELF-CLOSING HINGED COVER AND CORROSION-RESISTANT SCREWS; SUITABLE FOR USE IN WET LOCATIONS WHILE IN USE WITH ATTACHMENT PLUGS CONNECTED AND IDENTIFIED AS EXTRA-DUTY TYPE. ALL WIRING SHALL BE #10.

E8. EXISTING EXIT SIGN TO BE REMOVED AND REPLACED WITH NEW EXIT SIGN. THIS CONTRACTOR SHALL DISCONNECT EXISTING EXIT SIGN FROM SUPPLY SOURCE, AND RECONNECT NEW EXIT SIGN USING EXISTING WIRING. PROVIDE ALL REQUIRED NEW CONDUIT, WIRING, JUNCTION BOXES, ETC. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

E9. OMIT

E10. PROVIDE 2-BUTTON COOPER LIGHTING SOLUTIONS WAVELINX WIRED WALLSTATION #FDW-2TLB-RL-W. WALLSTATION SHALL SET FULL (100%) LIGHTS, HALF (50%) LIGHTS, RAISE AND LOWER LIGHTING LEVELS, AND TURN LIGHTS OFF. PROVIDE CUSTOM ENGRAVED BUTTONS PER CPS. PROVIDE METAL DECORATOR STYLE COLOR MATCHING WALLPLATE. VERIFY COLOR WITH ARCHITECT. PROVIDE COOPER LIGHTING SOLUTIONS DIGITAL TO ANALOG CONVERTOR #FLT-DAC-DALI-DC1 WITH BUILT-IN LATCHING RELAY AND 0-10V CURRENT SINKING INTERFACE TO INTEGRATE INDIVIDUAL OR A GROUP OF DIMMABLE 0-10V DRIVERS VIA A TWO WIRE COMMUNICATIONS BUS USED WITH COOPER LIGHTING SOLUTIONS. PROVIDE ONE DIGITAL TO ANALOG CONVERTOR FOR EACH SWITCH LEG (i.e. PROVIDE ONE PER LIGHTING CIRCUIT). REFER TO DETAIL 13 ON DRAWING E002-MEP.

E11. ALL VACANCY SENSORS SHALL BE PROGRAMMED FOR AND INSTALLED FOR MANUAL ON CONTROL AT THE SWITCH LOCATION IN EACH ROOM AND AUTOMATIC OFF WHEN THE ROOM BECOMES VACANT. REFER TO VACANCY SENSOR NOTES ON DRAWING E002-MEP.

E12. OCCUPANCY SENSOR SHALL BE PROGRAMMED FOR AND INSTALLED FOR AUTOMATIC ON CONTROL IN LOCKER ROOM AND AUTOMATIC OFF WHEN THE ROOM BECOMES VACANT. REFER TO VACANCY SENSOR NOTES ON DRAWING E002-MEP.

2018 ELECTRICAL CODE

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCA# 5031)
Title: ELECTRICAL SYMBOLS, NOTES, AND ABBREVIATIONS
Sheet: E000-MEP

NEW ELECTRICAL PANELBOARD SCHEDULE

	PANEL ID		RP-109	VOLT/PH		120/208V,3Ph,4W			MAIN		150A MAIN C/B	I.C. RATING	22,000 AIC RATING	
	MOUNTING		SURFACE	GRD BUS		YES			LOCATION		ELECTRIC ROOM C109			
LIGHT KW	RECPT KW	MTR KW	DESCRIPTION	BREAKER AMP	BREAKER POLE	CCT. NO.	PHASE A B C	CCT. NO.	BREAKER AMP	BREAKER POLE	DESCRIPTION	LIGHT KW	RECPT KW	MTR KW
		0.9	FAN POWERED BOX FPB-CT1	20	1	1	A	2	20	1	FAN POWERED BOX FPB-K2			1.2
		0.2	CABINET UNIT HEATER CUH-1	20	1	3	B	4	20	1	FAN POWERED BOX FPB-LK1			1.2
		1.2	FAN POWERED BOX FPB-K1	20	1	5	C	6	20	1	FAN POWERED BOX FPB-LK2			1.2
		0.2	CABINET UNIT HEATER CUH-2	20	1	7	A	8	20	1	FAN POWERED BOX FPB-CT2			0.9
		0.2	ELECTRIC ROOM EXHAUST FAN E-35	20	1	9	B	10	20	1	(4) LINK CORRIDOR RECEPTACLES		0.8	
			SPARE	20	1	11	C	12	20	1	SPARE			
	0.8		TRAINING ROOM REFRIGERATOR	20	1	13	A	14	20	1	SPARE			
	0.8		TRAINING ROOM ICE MACHINE	20	1	15	B	16	20	1	SPARE			
	0.6		TRAINING ROOM RECEPTACLES	20	1	17	C	18	20	1	SPARE			
			SPARE	20	1	19	A	20	20	1	SPARE			
			SPARE	20	1	21	B	22	20	1	SPARE			
			SPARE	20	1	23	C	24	20	1	SPARE			
			SPARE	20	1	25	A	26	20	1	SPARE			
			SPARE	20	1	27	B	28	20	1	SPARE			
			SPACE		1	29	C	30		1	SPACE			
			SPACE		1	31	A	32		1	SPACE			
			SPACE		1	33	B	34		1	SPACE			
			SPACE		1	35	C	36		1	SPACE			
			SURGE PROTECTIVE DEVICE	30	3	37 / 39 / 41	A / B / C	38 / 40 / 42	60	3	PANEL LP-109	0.7	0.0	0.0
0.0	2.2	2.7				TOTAL KW		10.9				0.7	0.8	4.5
						TOTAL AMPS		30.3						

FOR CIRCUIT NUMBERS 13, 15, AND 17 **REFER TO DRAWING E101-MEP**

NEW ELECTRICAL PANELBOARD SCHEDULE

	PANEL ID		LP-109	VOLT/PH		120/208V,3Ph,4W			MAIN		60A MLO	I.C. RATING	22,000 AIC RATING	
	MOUNTING		SURFACE	GRD BUS		YES			LOCATION		ELECTRIC ROOM C109			
LIGHT KW	RECPT KW	MTR KW	DESCRIPTION	BREAKER AMP	BREAKER POLE	CCT. NO.	PHASE A B C	CCT. NO.	BREAKER AMP	BREAKER POLE	DESCRIPTION	LIGHT KW	RECPT KW	MTR KW
0.2			PARKING LOT LIGHTING	20	1	1	A	2	20	1	SPARE			
0.1			ELECTRIC ROOM LIGHTING	20	1	3	B	4	20	1	SPARE			
0.1			TRAINING ROOM LIGHTING	20	1	5	C	6	20	1	SPARE			
0.3			TEAM LOCKER ROOM LIGHTING	20	1	7	A	8	20	1	SPARE			
			SPARE	20	1	9	B	10	20	1	SPARE			
			SPARE	20	1	11	C	12	20	1	SPARE			
			SPACE		1	13	A	14		1	SPACE			
			SPACE		1	15	B	16		1	SPACE			
			SPACE		1	17	C	18		1	SPACE			
0.7	0.0	0.0				TOTAL KW		0.7				0.0	0.0	0.0
						TOTAL AMPS		1.9						

FOR CIRCUIT NUMBERS 5 AND 7 **REFER TO DRAWING E101-MEP**

BRANCH CIRCUIT VOLTAGE DROP TABLE

RECEPTACLE AND LIGHTING BRANCH CIRCUIT WIRING SIZING TABLE
TABLE APPLIES TO NEW CIRCUITS RATED AT 15A AND 20A
MAXIMUM VOLTAGE DROP 3%

CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)		CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)
120V,1ø	#12	65'		277V,1ø	#12	100'
120V,1ø	#10	100'		277V,1ø	#10	225'
120V,1ø	#8	175'		277V,1ø	#8	350'
120V,1ø	#6	EXCEEDS 200'		277V,1ø	#6	EXCEEDS 400'
208V,3ø	#12	150'		480V,3ø	#12	350'
208V,3ø	#10	220'		480V,3ø	#10	450'
208V,3ø	#8	350'		480V,3ø	#8	700'

NOTES:
1. MINIMUM CONDUCTOR SIZE FOR LIFE SAFETY CIRCUITS (EXIT SIGNS) SHALL BE #10AWG.
2. THE LENGTH OF THE CIRCUIT SHALL BE DETERMINED BASED ON ACTUAL CIRCUITING LENGTH, NOT AS A STRAIGHT LINE BETWEEN POINTS A AND B.
3. LENGTH OF CIRCUIT SHALL BE MEASURED FROM SOURCE TO THE LAST OUTLET.

NEW DISTRIBUTION PANEL C3LC (SWITCHBOARD CONSTRUCTION)

800 AMP BUS WITH 800A MAIN C/B — 120/208V,3ø,4W
35,000 A.I.C. — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	EXISTING PANEL C3L1	100	100	RECONNECT EXISTING FEEDER	80
2	EXISTING PANEL C3L2	100	100	RECONNECT EXISTING FEEDER	80
3	EXISTING PANELS C1L1 & C2L1	225	200	RECONNECT EXISTING FEEDER	160
4	EXISTING PANELS C1L2 & C2L2	225	200	RECONNECT EXISTING FEEDER	160
5	SPACE	225			
6	SPACE	225			
				TOTAL	480

NEW MAIN SWITCHBOARD DISTRIBUTION SECTION

1200 AMP BUS WITH 1200A MAIN CIRCUIT BREAKER (100% RATED) — 277/480V,3ø,4W
65,000A AIC RATING — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	**NEW DISTRIBUTION PANEL C3HD**	**600**	**600**	**NEW (2) SETS 3#350MCM & 1#3/0 GRD.-(2) 3 1/2"C.**	**511**
2	NEW DISTRIBUTION PANEL C3-CU-E	400	400	NEW 3#600MCM & 1#3/0 GRD. - 3 1/2"C.	229
3	**NEW DISTRIBUTION PANEL C3-CU-W**	**400**	**400**	**NEW 3#600MCM & 1#3/0 GRD. - 3 1/2"C.**	**314**
4	SPARE	400	400		
5	**NEW 45 KVA TRANSFORMER (RP-109)**	**100**	**70**	**NEW 3#4 - 1"C.**	**54**
6	SPACE PROVISION	100			
7	SPACE PROVISION	100			
8	SPACE PROVISION	250			
9	SPACE PROVISION	250			
10	SPACE PROVISION	250			
11	SPACE PROVISION	250			
12	**SURGE PROTECTIVE DEVICE**	**100**	**70**		
				TOTAL	1108

NEW DISTRIBUTION PANEL C3HD

600 AMP BUS WITH 600A MAIN C/B (100% RATED) — 480V,3ø,3W
65,000 AIC RATING — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	NEW 225KVA TRANSFORMER (C3LC)	400	400	NEW 3#500MCM - 3"C.	271
2	EXISTING 150KVA TRANSFORMER TR1 (CDP-C)	250	225	NEW 3#4/0 - 2"C.	180
3	EXISTING DISTRIBUTION PANELS C3HP1 & C3HP2	250	200	RECONNECT EXISTING FEEDER	60
4	SPACE	250			
5	SPACE	250			
6	SPACE	250			
				TOTAL	511

NEW DISTRIBUTION PANEL C3-CU-W

400 AMP BUS WITH 400A MAIN C/B (100% RATED) — 480V,3ø,3W
65,000 AIC RATING — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	NEW ROOFTOP UNIT RTU-8 (39 FLA)	100	50	NEW 3#4 & 1#10 GRD. - 1"C.	39
2	NEW CONDENSING UNIT CU-9 (143 MCA)	225	175	NEW 3#4/0 & 1#6 GRD. - 2"C.	143
3	**NEW LINK ROOFTOP UNIT RTU-L (36 FLA)**	**100**	**50**	**NEW 3#6 & 1#6 GRD. - 3/4"C.**	**36**
4	**NEW PUMP P-C1 (3 HP)**	**100**	**15**	**NEW 3#10 & 1#10 GRD. - 3/4"C.**	**5**
5	**NEW PUMP P-C2 (3 HP)**	**100**	**15**	**NEW 3#10 & 1#10 GRD. - 3/4"C.**	**5**
6	NEW ELECTRIC DUCT HEATER EDH-9.1 (20 KW)	100	30	NEW 3#8 & 1#8 GRD. - 3/4"C.	24
7	NEW ELECTRIC DUCT HEATER EDH-9.2 (20 KW)	100	30	NEW 3#8 & 1#8 GRD. - 3/4"C.	24
8	NEW ELECTRIC DUCT HEATER EDH-9.3 (6 KW)	100	15	NEW 3#10 & 1#10 GRD. - 3/4"C.	7
9	NEW ELECTRIC DUCT HEATER EDH-9.4 (16 KW)	100	25	NEW 3#10 & 1#10 GRD. - 3/4"C.	19
10	NEW ELECTRIC DUCT HEATER EDH-9.5 (10 KW)	100	20	NEW 3#10 & 1#10 GRD. - 3/4"C.	12
11	SPARE	100	20		
12	SPARE	100	20		
13	SPARE	100	20		
14	SPARE	100	15		
				TOTAL	314

NEW DISTRIBUTION PANEL C3-CU-E

400 AMP BUS WITH 400A MAIN C/B (100% RATED) — 480V,3ø,3W
65,000 A.I.C. — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	NEW CONDENSING UNIT CU-10 (99 MCA)	225	110	NEW 3#1/0 & 1#6 GRD. - 1 1/2"C.	99
2	NEW CONDENSING UNIT CU-11 (130 MCA)	225	150	NEW 3#3/0 & 1#6 GRD. - 2"C.	130
3	SPARE	100	100		
4	SPARE	100	100		
5	SPACE	100			
6	SPACE	100			
				TOTAL	229

REFER TO DRAWING E001-MEP

NOTES APPLICABLE TO REPLACED DISTRIBUTION PANELS:

A. REPLACE EXISTING DISTRIBUTION PANEL IN ITS ENTIRETY WITH A NEW PANEL AS SPECIFIED. PICK UP EXISTING CONDUITS AND RECONNECT EXISTING FEEDERS TO NEW PANEL. MAKE ALL FINAL CONNECTIONS. HEIGHT OF PANEL SHALL NOT BE LESS THAN EXISTING PANEL HEIGHT.

B. FIELD MEASURE DEPTH x WIDTH x HEIGHT OF EXISTING PANEL ENCLOSURE SCHEDULED FOR REPLACEMENT. NEW MAIN BREAKER LOCATION SHALL MATCH EXISTING LUG LOCATIONS (TOP OR BOTTOM). CIRCUIT BREAKER ARRANGEMENT SHALL MATCH EXISTING CIRCUIT BREAKER ARRANGEMENT IN ORDER TO RECONNECT EXISTING WIRING. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUITS, AND WIRING IN ORDER TO EXTEND EXISTING FEEDERS WITH SAME WIRE SIZE TERMINATED AT NEW BREAKERS. MAKE ALL FINAL CONNECTIONS.

C. NEW CIRCUIT BREAKERS SHALL BE INSTALLED IN THE SAME RELATIVE POSITION AS IN THE EXISTING PANEL ENCLOSURE.

D. WHERE EXISTING WIRING DOES NOT REACH NEW BREAKER TERMINALS, PROVIDE HIGH COMPRESSION IN-LINE SPLICES WITH MATCHING EXISTING FEEDER SIZE INSULATED WITH COLD SHRINK INSULATORS.

E. PROVIDE AN ASSOCIATED PANEL TYPEWRITTEN DIRECTORY CARD FOR NEW DISTRIBUTION PANEL.

F. PROVIDE EQUIPMENT GROUND BUS.

G. ACCEPTABLE MANUFACTURERS: ILLINOIS SWITCHBOARD AND CHICAGO SWITCHBOARD.

NOTES APPLICABLE TO REPLACED PANELS:

A. REPLACE EXISTING PANEL IN ITS ENTIRETY WITH A NEW PANEL AS SPECIFIED. PICK UP EXISTING CONDUITS AND RECONNECT EXISTING BRANCH CIRCUIT WIRING AND NEW BRANCH CIRCUIT WIRING TO NEW PANEL. MAKE ALL FINAL CONNECTIONS. HEIGHT OF PANEL SHALL NOT BE LESS THAN EXISTING PANEL HEIGHT.

B. EXTEND EXISTING CONDUITS TO NEW PANEL. EXTEND EXISTING BRANCH CIRCUIT WIRING WITH HIGH COMPRESSION SPLICES WITH COLD SHRINK INSULATION TO NEW PANELBOARD OVERCURRENT DEVICES. REMOVE EXISTING BRANCH CIRCUIT WIRING THAT IS NO LONGER IN USE.

C. PROVIDE NEW PANEL TYPEWRITTEN DIRECTORY. PROVIDE NEW ENGRAVED NAMEPLATE.

D. PROVIDE EQUIPMENT GROUND BUS.

ONE-LINE DIAGRAM NOTES:

1. EXISTING ONE LINE RISER DIAGRAM INDICATED IS BASED ON EXISTING DRAWINGS AND VISUAL OBSERVATIONS. THIS ONE-LINE DIAGRAM MAY NOT REFLECT ALL FEEDERS SERVING EXISTING LOADS THAT SHOULD REMAIN IN OPERATION. CONTRACTOR SHALL FIELD VERIFY ALL FEEDERS AND THEIR PROTECTION TO INSURE THAT NO FEEDER OR PROTECTION IS OMITTED.

2. CONTRACTOR MAY REUSE EXISTING CONDUIT FEEDER SYSTEM WHERE EXISTING CONDUIT SYSTEMS MEET OR EXCEED THE APPLICABLE CODES IN ALL RESPECTS. ALL EXISTING CONDUITS SHALL BE CLEANED PRIOR TO CABLE INSTALLATION. PROVIDE GROUNDING CONDUCTOR IN ALL EXISTING CONDUITS REUSED. HOWEVER, WHERE EXISTING CONDUIT SYSTEM IS NOT REUSED, CONTRACTOR SHALL FURNISH AND INSTALL NEW CONDUIT SYSTEM FOR NEW FEEDERS AS SPECIFIED.

3. ALL PANELS SHALL BE BALANCED AS EVENLY AS POSSIBLE. ADJUST BRANCH CIRCUITS IN EACH PANEL ACCORDINGLY.

4. PROVIDE PULL BOXES FOR EVERY 270 DEGREES OF CONDUIT BENDS AND ELBOWS.

5. ALL SHUTDOWNS SHALL BE PRE-SCHEDULED NOT LESS THAN (3) DAYS IN ADVANCE OF THE SCHEDULED OUTAGE. PROVIDE SCHEDULE INDICATING DATE-TIME, MANPOWER, DURATION OF OUTAGE TO OWNER. WORK SHALL NOT COMMENCE WITHOUT WRITTEN CONFIRMATION FROM THE OWNER. ALL SHUTDOWNS SHALL BE ARRANGED AT THE CONVENIENCE OF OWNER DURING OFF-HOUR TIME PERIODS, WEEKENDS AS NECESSARY. INCLUDE ALL REQUIRED PREMIUM AND OVERTIME IN BID PROPOSAL FOR ALL SHUTDOWNS AND MAINTAINING CONTINUITY OF SERVICE AT ALL TIMES.

6. PROVIDE ALL CUTTING, CORING, AND PATCHING NECESSARY FOR THE RUNNING AND SECURING OF CONDUITS AND OTHER EQUIPMENT, AND PROVIDE ALL SUPPORTS NECESSARY FOR SAME AND ALL BRACING AND ANCHORAGE OF WORK. NO CUTTING OF STRUCTURAL WORK OR FIRE-PROOFING SHALL BE PERMITTED. PROVIDE ALL DEMOLITION AND REMOVAL OF DEBRIS RESULTING FROM CUTTING, CORING, AND PATCHING. REMOVE AND LEGALLY DISPOSE OF ALL DEBRIS OFF THE SITE. PATCH EXISTING FINISHED SURFACES AND BUILDING COMPONENTS USING NEW MATERIALS MATCHING EXISTING MATERIALS AND TEXTURE USING EXPERIENCED INSTALLERS.

7. PROVIDE ENGRAVED NAMEPLATE FOR MAIN SWITCHBOARD, DISTRIBUTION PANELS, AND EACH CIRCUIT BREAKER, INCLUDING ALL SPARES AND SPACES.

8. ALL RACEWAYS SHALL HAVE GROUNDING BUSHINGS FOR GROUND CONTINUITY AND IN COMPLIANCE WITH 2018 CHICAGO ELECTRICAL CODE.

9. VERIFY THAT MOUNTING SURFACES IN NEW ELECTRICAL ROOM ARE READY TO RECEIVE NEW SERVICE SWITCHBOARD.

10. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES IN ORDER TO CORE THROUGH ALL EXISTING FOUNDATION WALLS AS REQUIRED INCLUDING BUT NOT LIMITED TO INSTALLING ALL NEW ELECTRICAL MISCELLANEOUS CONDUITS AS REQUIRED FOR A COMPLETE INSTALLATION. COORDINATE WITH APPLICABLE TRADES. PROVIDE CONDUIT SEALING BUSHINGS ON INSIDE AND OUTSIDE OF WALL.

11. NEW BUILDING GROUND BUS - NEMA 1 ENCLOSURE, COPPER BUS. SEE DETAILS ON DRAWING E002-LNK.

12. PROVIDE EATON (OR EQUIVALENT) SERIES C CIRCUIT BREAKERS (65,000 AIC RATING) FOR ALL CIRCUIT BREAKERS MOUNTED IN MAIN SWITCHBOARD.

13. SWITCHBOARD SURGE PROTECTIVE DEVICE: REFER TO SECTION 26 43 00 FOR SURGE PROTECTIVE DEVICE LOCATED IN SERVICE ENTRANCE LOCATION.

ONE-LINE DIAGRAM NOTES: (CONT'D)

14. PROVIDE CUSTOMER DIGITAL ELECTRONIC POWER METER FOR MONITORING CURRENT, VOLTAGE, REAL POWER, POWER FACTOR, AND PROVIDING MIN./MAX. READINGS FOR CURRENT, VOLTAGE, TOTAL KW, KVA, POWER FACTOR, AND PEAK DEMAND LOADS. PROVIDE WITH ACCURACY OF CURRENT AND VOLTAGE READING OF 0.1%. PROVIDE GATEWAY CARD FOR REMOTE MONITORING BY THE BAS COMMUNICATIONS PROTOCOL (BACNET). DIGITAL METER SHALL BE EATON IQ250 OR EQUIVALENT.

15. PROVIDE RUBBER MAT IN FRONT OF MAIN SWITCHBOARD.

16. SUBMIT SWITCHBOARD SHOP DRAWINGS TO COMED FOR APPROVAL PRIOR TO SUBMITTING SHOP DRAWINGS TO THE ENGINEER. PROVIDE THE ENGINEER TWO COMED STAMPED APPROVAL SETS OF SHOP DRAWINGS FOR FILE.

17. NEW 3/4" SEALTITE FROM NEW COMED METER WITH PULSE OUTPUT TO NEW 4"x4" JUNCTION BOX FOR COMED WIRING TO TERMINAL STRIP LOCATED IN JUNCTION BOX.

18. ALL SPACES SHALL BE PROVIDED WITH BUS PROVISIONS FOR INSTALLATION OF FUTURE CIRCUIT BREAKERS.

19. TERMINATE ALL SECONDARY CONDUITS INTO BUILDING MAIN SWITCHBOARD WITH GROUNDING TYPE BUSHINGS. BOND CONDUITS TO GROUND BUS.

20. PROVIDE GROUNDING TYPE BUSHINGS FOR ALL CONDUITS ENTERING SWITCHBOARD. PROVIDE GROUNDING CONDUCTORS TO SWITCHBOARD GROUND BUS.

21. EXISTING LUNCHROOM BUILDING "D" MAIN SWITCHBOARD - EXISTING FUSIBLE BRANCH SWITCH TO REMAIN. REMOVE EXISTING FUSES. PROVIDE ENGRAVED NAMEPLATE READING "SPARE".

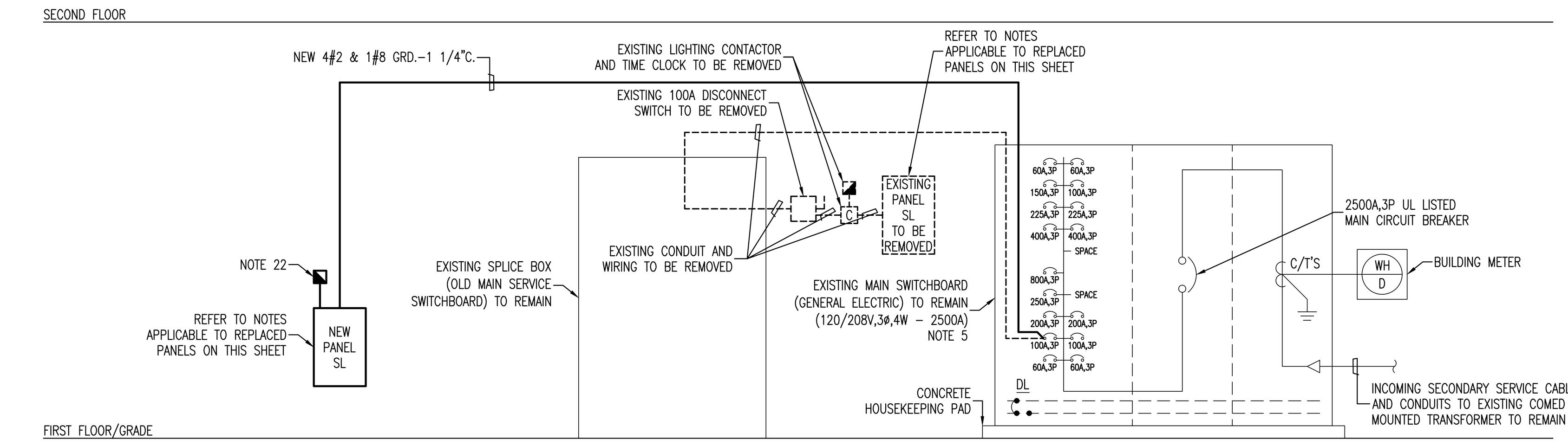
22. PROVIDE NEW TIME CLOCK FOR PARKING LOT/SITE LIGHTING. PROVIDE NEW 365 DAY ASTRONOMIC TIME SWITCH (2) CIRCUIT ELECTRONIC CONTROL WITH DAYLIGHT SAVINGS ADJUSTMENT, MANUAL OVER-RIDE, 30A RATED CONTACTS, BATTERY BACK-UP, LEAP YEAR, COMPATIBLE WITH MECHANICAL HELD, ELECTRONICALLY OPERATED CONTACTOR WITH 2 WIRE AUXILIARY RELAY - NEMA 1 ENCLOSURE. EXTERIOR LIGHTING TO BE CONTROLLED VIA TIME CLOCK ON-TIME CLOCK OFF. SET TIME SWITCH ON-OFF TIME PERIODS AS DIRECTED BY CPS. INTERMATIC ET90215CR SERIES OR ENGINEER APPROVED EQUIVALENT. PROVIDE ALL REQUIRED CONTROL WIRING IN NEW 3/4"C. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.

23. PANELBOARD SURGE PROTECTIVE DEVICE: REFER TO SECTION 26 43 00 FOR SURGE PROTECTIVE DEVICES LOCATED IN PANELBOARDS.

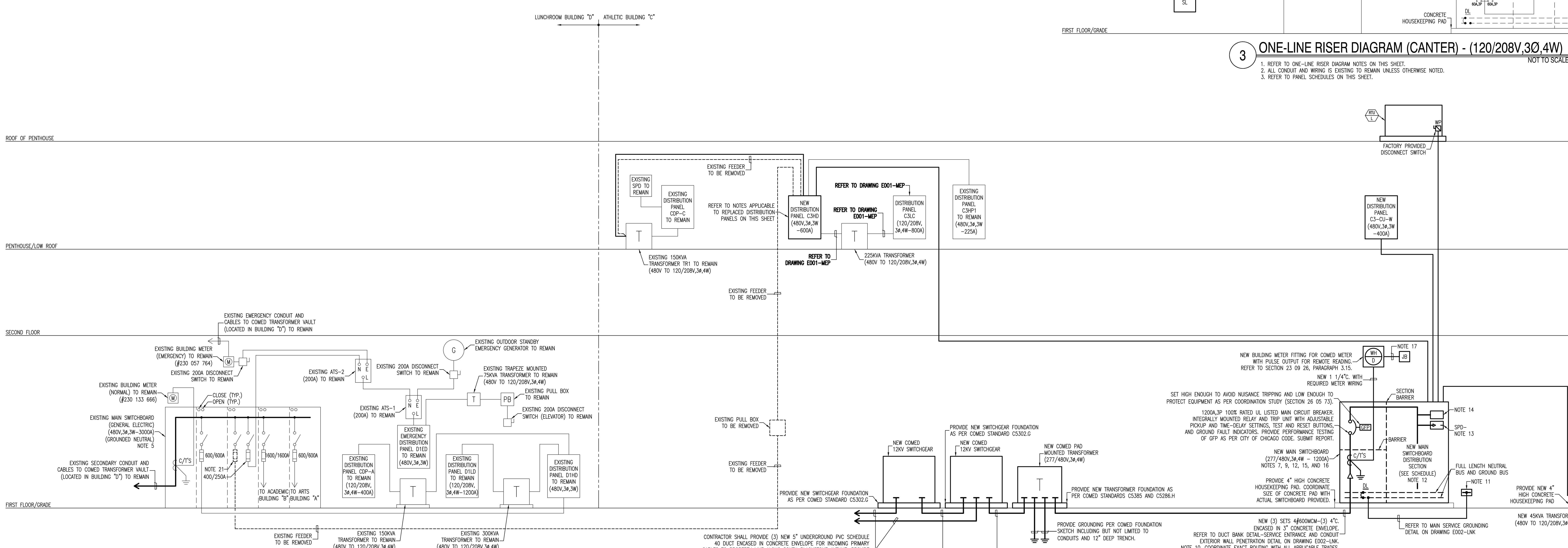
24. TYPICAL FOR ALL NEW EQUIPMENT WITH NEW CABLE CONNECTIONS: PROVIDE THERMAL ELECTRICAL/MECHANICAL INSPECTION FOR ALL NEW ELECTRICAL EQUIPMENT WITH NEW CABLE CONNECTIONS INCLUDING BUT NOT LIMITED TO: SWITCHBOARDS, DISTRIBUTION PANELS, PANELBOARDS, ALL BUS CONNECTIONS, CIRCUIT BREAKER CONNECTIONS, AND ALL BOLTED CONNECTIONS. PROVIDE THERMOGRAPH TESTING UNDER LOAD. MINIMUM LOADING DURING THERMAL IMAGING TESTING SHALL BE A MINIMUM OF 50% OF BUS RATING. SUBMIT DETAILED TYPEWRITTEN REPORT WITH PHOTOGRAPHIC DOCUMENTATION AND ANALYSIS STATING POTENTIAL FAULTS, HEATING, LOOSE PARTS OR THE LIKE. CONTRACTOR SHALL REPAIR OR REPLACE ANY FAULTY EQUIPMENT, DEVICES, WIRING, WORKMANSHIP, BUSWORK, CONNECTIONS, BUS DETAILS, COMPONENTS, APPARATUS, AT NO ADDITIONAL COST TO THE OWNER.

NEW ELECTRICAL PANELBOARD SCHEDULE

	PANEL ID		SL	VOLT/PH		120/208V,3Ph,4W			MAIN		100A MAIN C/B	I.C. RATING	22,000 AIC RATING	
	MOUNTING		SURFACE	GRD BUS		YES			LOCATION		PUMP & TANK ROOM 107A			
LIGHT KW	RECPT KW	MTR KW	DESCRIPTION	BREAKER AMP	BREAKER POLE	CCT. NO.	PHASE A B C	CCT. NO.	BREAKER AMP	BREAKER POLE	DESCRIPTION	LIGHT KW	RECPT KW	MTR KW
0.4			EXISTING EQUIPMENT	20	1	1	A	2	20	1	EXISTING EQUIPMENT	0.4		
0.4			EXISTING EQUIPMENT	20	1	3	B	4	20	1	EXISTING EQUIPMENT	0.4		
0.2			PARKING LOT LIGHTING	20	1	5	C	6	20	1	EXISTING EQUIPMENT	0.4		
0.4			PARKING LOT LIGHTING	20	1	7	A	8	20	1	EXISTING EQUIPMENT	0.4		
			SPARE	20	1	9	B	10	20	1	SPARE			
			SPARE	20	1	11	C	12	20	1	SPARE			
			SPARE	20	1	13	A	14	20	1	SPARE			
			SPARE	20	1	15	B	16	20	1	SPARE			
			SPARE	20	1	17	C	18	20	1	SPARE			
			SPARE	20	1	19	A	20	20	1	SPARE			
			SPARE	20	1	21	B	22	20	1	SPARE			
			SPARE	20	1	23	C	24	20	1	SPARE			
1.4	0.0	0.0				TOTAL KW		3.0				1.6	0.0	0.0
						TOTAL AMPS		8.3						



3 ONE-LINE RISER DIAGRAM (CANTER) - (120/208V,3Ø,4W)
NOT TO SCALE
1. REFER TO ONE-LINE RISER DIAGRAM NOTES ON THIS SHEET.
2. ALL CONDUIT AND WIRING IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
3. REFER TO PANEL SCHEDULES ON THIS SHEET.



2 ONE-LINE RISER DIAGRAM - (480V,3Ø,3W-3000A) (CORNER GROUNDED DELTA)
NOT TO SCALE
1. REFER TO ONE-LINE RISER DIAGRAM NOTES ON THIS SHEET.
2. ALL CONDUIT AND WIRING IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
3. REFER TO PANEL SCHEDULES ON THIS SHEET.

1 ONE-LINE RISER DIAGRAM (KENWOOD) - (277/480V,3Ø,4W)
NOT TO SCALE
1. REFER TO ONE-LINE RISER DIAGRAM NOTES ON THIS SHEET.
2. ALL CONDUIT AND WIRING IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
3. REFER TO PANEL SCHEDULES ON THIS SHEET.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

Architect:
NIA ARCHITECTS, INC.
nia architects Inc
ADDRESS: 850 W. JACKSON BLVD. SUITE 600 CHICAGO, ILLINOIS 60607
PHONE: 312.431.9515
FAX: 312.431.9518
WEB: www.niaarch.com

Civil Engineer:
Engage Civil, Inc.
1 North State Street
15th Floor
Chicago, IL 60602
872 216 9819

Landscape Architect:
Site Design
888 South Michigan Avenue
Suite PH1
Chicago, IL 60605
312 427 7240

Structural Engineer:
Milhouse Engineering, Inc.
333 South Wabash Avenue
Suite 2901
Chicago, IL 60604
312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates, Inc.
223 West Jackson Boulevard
Suite 820
Chicago, IL 60606
312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCA# 5031)

Title
ONE-LINE RISER DIAGRAM AND NOTES

Sheet
E001-LNK

NEW ELECTRICAL PANELBOARD SCHEDULE

	PANEL ID:		BP-109	VOLT/PH:	120/208V,3Ph,4W	MAIN:	150A MAIN C/B	I.C. RATING:	22,000 AIC RATING:	
	MOUNTING:		SURFACE	GRD BUS:	YES	LOCATION:	ELECTRIC ROOM C109			
LIGHT KW	RECPT KW	MTR KW	DESCRIPTION	BREAKER AMP	BREAKER POLE	CCT. NO.	PHASE A B C	CCT. NO.	BREAKER AMP	BREAKER POLE	DESCRIPTION	LIGHT KW	RECPT KW	MTR KW
		0.9	FAN POWERED BOX FPB-CT1	20	1	1	♦	2	20	1	FAN POWERED BOX FPB-K2			1.2
		0.2	CABINET UNIT HEATER CUH-1	20	1	3	♦	4	20	1	FAN POWERED BOX FPB-LK1			1.2
		1.2	FAN POWERED BOX FPB-K1	20	1	5	♦	6	20	1	FAN POWERED BOX FPB-LK2			1.2
		0.2	CABINET UNIT HEATER CUH-2	20	1	7	♦	8	20	1	FAN POWERED BOX FPB-CT2			0.9
		0.2	ELECTRIC ROOM EXHAUST FAN E-35	20	1	9	♦	10	20	1	(4) LINE CORRIDOR RECEPTACLES		0.8	
			SPARE	20	1	11	♦	12	20	1	SPARE			
	0.8		TRAINING ROOM REFRIGERATOR	20	1	13	♦	14	20	1	SPARE			
	0.8		TRAINING ROOM ICE MACHINE	20	1	15	♦	16	20	1	SPARE			
	0.6		TRAINING ROOM RECEPTACLES	20	1	17	♦	18	20	1	SPARE			
			SPARE	20	1	19	♦	20	20	1	SPARE			
			SPARE	20	1	21	♦	22	20	1	SPARE			
			SPARE	20	1	23	♦	24	20	1	SPARE			
			SPARE	20	1	25	♦	26	20	1	SPARE			
			SPARE	20	1	27	♦	28	20	1	SPARE			
			SPACE		1	29	♦	30		1	SPACE			
			SPACE		1	31	♦	32		1	SPACE			
			SPACE		1	33	♦	34		1	SPACE			
			SPACE		1	35	♦	36		1	SPACE			
						37	♦	38						
			SURGE PROTECTIVE DEVICE	30	3	39	♦	40	60	3	PANEL LP-109	0.7	0.0	0.0
						41	♦	42						
0.0	2.2	2.7					TOTAL KW	10.9				0.7	0.8	4.5
							TOTAL AMPS	30.3						

NEW ELECTRICAL PANELBOARD SCHEDULE

	PANEL ID:		LP-109	VOLT/PH:	120/208V,3Ph,4W	MAIN:	60A MLO	I.C. RATING:	22,000 AIC RATING:	
	MOUNTING:		SURFACE	GRD BUS:	YES	LOCATION:	ELECTRIC ROOM C109			
LIGHT KW	RECPT KW	MTR KW	DESCRIPTION	BREAKER AMP	BREAKER POLE	CCT. NO.	PHASE A B C	CCT. NO.	BREAKER AMP	BREAKER POLE	DESCRIPTION	LIGHT KW	RECPT KW	MTR KW
0.2			PARKING LOT LIGHTING	20	1	1	♦	2	20	1	SPARE			
0.1			ELECTRIC ROOM LIGHTING	20	1	3	♦	4	20	1	SPARE			
0.1			TRAINING ROOM LIGHTING	20	1	5	♦	6	20	1	SPARE			
0.3			TEAM LOCKER ROOM LIGHTING	20	1	7	♦	8	20	1	SPARE			
			SPARE	20	1	9	♦	10	20	1	SPARE			
			SPARE	20	1	11	♦	12	20	1	SPACE			
			SPACE		1	13	♦	14		1	SPACE			
			SPACE		1	15	♦	16		1	SPACE			
			SPACE		1	17	♦	18		1	SPACE			
0.7	0.0	0.0					TOTAL KW	0.7				0.0	0.0	0.0
							TOTAL AMPS	1.9						

BRANCH CIRCUIT VOLTAGE DROP TABLE

RECEPTACLE AND LIGHTING BRANCH CIRCUIT WIRING SIZING TABLE
TABLE APPLIES TO NEW CIRCUITS RATED AT 15A AND 20A
MAXIMUM VOLTAGE DROP 3%

CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)	CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)
120V,1Ø	#12	65'	277V,1Ø	#12	100'
120V,1Ø	#10	100'	277V,1Ø	#10	225'
120V,1Ø	#8	175'	277V,1Ø	#8	350'
120V,1Ø	#6	EXCEEDS 200'	277V,1Ø	#6	EXCEEDS 400'
208V,3Ø	#12	150'	480V,3Ø	#12	350'
208V,3Ø	#10	220'	480V,3Ø	#10	450'
208V,3Ø	#8	350'	480V,3Ø	#8	700'

NOTES:
1. MINIMUM CONDUCTOR SIZE FOR LIFE SAFETY CIRCUITS (EXIT SIGNS) SHALL BE #10AWG.
2. THE LENGTH OF THE CIRCUIT SHALL BE DETERMINED BASED ON ACTUAL CIRCUITING LENGTH, NOT AS A STRAIGHT LINE BETWEEN POINTS A AND B.
3. LENGTH OF CIRCUIT SHALL BE MEASURED FROM SOURCE TO THE LAST OUTLET.

NEW MAIN SWITCHBOARD DISTRIBUTION SECTION

1200 AMP BUS WITH 1200A MAIN CIRCUIT BREAKER (100% RATED) — 277/480V,3Ø,4W
65,000A AIC RATING — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	NEW DISTRIBUTION PANEL C3HD	600	600	NEW (2) SETS 3Ø350MCM & 1Ø3/0 GRD.-(2) 3 1/2"C.	511
2	**NEW DISTRIBUTION PANEL C3-CU-E**	**400**	**400**	**NEW 3Ø600MCM & 1Ø3/0 GRD. – 3 1/2"C.**	**229**
3	NEW DISTRIBUTION PANEL C3-CU-W	400	400	NEW 3Ø600MCM & 1Ø3/0 GRD. – 3 1/2"C.	314
4	SPARE	400	400		
5	NEW 45 KVA TRANSFORMER (RP-109)	100	70	NEW 3Ø4 – 1"C.	54
6	SPACE PROVISION	100			
7	SPACE PROVISION	100			
8	SPACE PROVISION	250			
9	SPACE PROVISION	250			
10	SPACE PROVISION	250			
11	SPACE PROVISION	250			
12	SURGE PROTECTIVE DEVICE	100	70		
				TOTAL	1108

NEW DISTRIBUTION PANEL C3HD

600 AMP BUS WITH 600A MAIN C/B (100% RATED) — 480Y,3Ø,3W
65,000 AIC RATING — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	**NEW 225KVA TRANSFORMER (C3LC)**	**400**	**400**	**NEW 3Ø500MCM – 3"C.**	**271**
2	EXISTING 150KVA TRANSFORMER TR1 (CDP–C)	250	225	NEW 3Ø4/0 – 2"C.	180
3	EXISTING DISTRIBUTION PANELS C3HP1 & C3HP2	250	200	RECONNECT EXISTING FEEDER	60
4	SPACE	250			
5	SPACE	250			
6	SPACE	250			
				TOTAL	511

NEW DISTRIBUTION PANEL C3–CU–W

400 AMP BUS WITH 400A MAIN C/B (100% RATED) — 480Y,3Ø,3W
65,000 A.I.C. — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	**NEW ROOFTOP UNIT RTU–8 (39 FLA)**	**100**	**50**	**NEW 3Ø4 & 1Ø10 GRD. – 1"C.**	**39**
2	**NEW CONDENSING UNIT CU–9 (143 MCA)**	**225**	**175**	**NEW 3Ø4/0 & 1Ø6 GRD. – 2"C.**	**143**
3	NEW LINK ROOFTOP UNIT RTU–L (36 FLA)	100	50	NEW 3Ø6 & 1Ø6 GRD. – 3/4"C.	36
4	NEW PUMP P–C1 (3 HP)	100	15	NEW 3Ø10 & 1Ø10 GRD. – 3/4"C.	5
5	NEW PUMP P–C2 (3 HP)	100	15	NEW 3Ø10 & 1Ø10 GRD. – 3/4"C.	5
6	**NEW ELECTRIC DUCT HEATER EDH–9.1 (20 KW)**	**100**	**30**	**NEW 3Ø8 & 1Ø8 GRD. – 3/4"C.**	**24**
7	**NEW ELECTRIC DUCT HEATER EDH–9.2 (20 KW)**	**100**	**30**	**NEW 3Ø8 & 1Ø8 GRD. – 3/4"C.**	**24**
8	**NEW ELECTRIC DUCT HEATER EDH–9.3 (6 KW)**	**100**	**15**	**NEW 3Ø10 & 1Ø10 GRD. – 3/4"C.**	**7**
9	**NEW ELECTRIC DUCT HEATER EDH–9.4 (16 KW)**	**100**	**25**	**NEW 3Ø10 & 1Ø10 GRD. – 3/4"C.**	**19**
10	**NEW ELECTRIC DUCT HEATER EDH–9.5 (10 KW)**	**100**	**20**	**NEW 3Ø10 & 1Ø10 GRD. – 3/4"C.**	**12**
11	SPARE	100	20		
12	SPARE	100	20		
13	SPARE	100	20		
14	SPARE	100	20		
				TOTAL	314

NEW DISTRIBUTION PANEL C3LC (SWITCHBOARD CONSTRUCTION)

800 AMP BUS WITH 800A MAIN C/B — 120/208V,3Ø,4W
35,000 A.I.C. — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	EXISTING PANEL C3L1	100	100	RECONNECT EXISTING FEEDER	80
2	EXISTING PANEL C3L2	100	100	RECONNECT EXISTING FEEDER	80
3	EXISTING PANELS C1L1 & C2L1	225	200	RECONNECT EXISTING FEEDER	160
4	EXISTING PANELS C1L2 & C2L2	225	200	RECONNECT EXISTING FEEDER	160
5	SPACE	225			
6	SPACE	225			
				TOTAL	480

NEW DISTRIBUTION PANEL C3–CU–E

400 AMP BUS WITH 400A MAIN C/B (100% RATED) — 480Y,3Ø,3W
65,000 A.I.C. — GROUND BUS

FDR. NO.	EQUIPMENT SERVED	C/B FRAME SIZE	TRIP SIZE	CONDUCTOR AND CONDUIT SIZE	AMPS
1	**NEW CONDENSING UNIT CU–10 (99 MCA)**	**225**	**110**	**NEW 3Ø1/0 & 1Ø6 GRD. – 1 1/2"C.**	**99**
2	**NEW CONDENSING UNIT CU–11 (130 MCA)**	**225**	**150**	**NEW 3Ø3/0 & 1Ø6 GRD. – 2"C.**	**130**
3	SPARE	100	100		
4	SPARE	100	100		
5	SPACE	100			
6	SPACE	100			
				TOTAL	229

ONE–LINE DIAGRAM NOTES:

1. EXISTING ONE LINE RISER DIAGRAM INDICATED IS BASED ON EXISTING DRAWINGS AND VISUAL OBSERVATIONS. THIS ONE–LINE DIAGRAM MAY NOT REFLECT ALL FEEDERS SERVING EXISTING LOADS THAT SHOULD REMAIN IN OPERATION. CONTRACTOR SHALL FIELD VERIFY ALL FEEDERS AND THEIR PROTECTION TO INSURE THAT NO FEEDER OR PROTECTION IS OMITTED.
2. CONTRACTOR MAY REUSE EXISTING CONDUIT FEEDER SYSTEM WHERE EXISTING CONDUIT SYSTEMS MEET OR EXCEED THE APPLICABLE CODES IN ALL RESPECTS. ALL EXISTING CONDUITS SHALL BE CLEANED PRIOR TO CABLE INSTALLATION. PROVIDE GROUNDING CONDUCTOR IN ALL EXISTING CONDUITS REUSED. HOWEVER, WHERE EXISTING CONDUIT SYSTEM IS NOT REUSED, CONTRACTOR SHALL FURNISH AND INSTALL NEW CONDUIT SYSTEM FOR NEW FEEDERS AS SPECIFIED.
3. ALL PANELS SHALL BE BALANCED AS EVENLY AS POSSIBLE. ADJUST BRANCH CIRCUITS IN EACH PANEL ACCORDINGLY.
4. PROVIDE PULL BOXES FOR EVERY 270 DEGREES OF CONDUIT BENDS AND ELBOWS.
5. ALL SHUTDOWNS SHALL BE PRE–SCHEDULED NOT LESS THAN (3) DAYS IN ADVANCE OF THE SCHEDULED OUTAGE. PROVIDE SCHEDULE INDICATING DATE–TIME, MANPOWER, DURATION OF OUTAGE TO OWNER. WORK SHALL NOT COMMENCE WITHOUT WRITTEN CONFIRMATION FROM THE OWNER; ALL SHUTDOWNS SHALL BE ARRANGED AT THE CONVENIENCE OF OWNER DURING OFF–HOUR TIME PERIODS, WEEKENDS AS NECESSARY, INCLUDE ALL REQUIRED PREMIUM AND OVERTIME IN BID PROPOSAL FOR ALL SHUTDOWNS AND MAINTAINING CONTINUITY OF SERVICE AT ALL TIMES.
6. PROVIDE ALL CUTTING, CORING, AND PATCHING NECESSARY FOR THE RUNNING AND SECURING OF CONDUITS AND OTHER EQUIPMENT, AND PROVIDE ALL SUPPORTS NECESSARY FOR SAME AND ALL BRACING AND ANCHERAGE OF WORK. NO CUTTING OF STRUCTURAL WORK OR FIRE–PROOFING SHALL BE PERMITTED. PROVIDE ALL DEMOLITION AND REMOVAL OF DEBRIS RESULTING FROM CUTTING, CORING, AND PATCHING. REMOVE AND LEGALLY DISPOSE OF ALL DEBRIS OFF THE SITE. PATCH EXISTING FINISHED SURFACES AND BUILDING COMPONENTS USING NEW MATERIALS MATCHING EXISTING MATERIALS AND TEXTURE USING EXPERIENCED INSTALLERS.
7. PROVIDE ENGRAVED NAMEPLATE FOR MAIN SWITCHBOARD, DISTRIBUTION PANELS, AND EACH CIRCUIT BREAKER, INCLUDING ALL SPARES AND SPACES.
8. ALL RACEWAYS SHALL HAVE GROUNDING BUSHINGS FOR GROUND CONTINUITY AND IN COMPLIANCE WITH 2018 CHICAGO ELECTRICAL CODE.
9. VERIFY THAT MOUNTING SURFACES IN NEW ELECTRICAL ROOM ARE READY TO RECEIVE NEW SERVICE SWITCHBOARD.
10. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES IN ORDER TO CORE THROUGH ALL EXISTING FOUNDATION WALLS AS REQUIRED INCLUDING BUT NOT LIMITED TO INSTALLING ALL NEW ELECTRICAL MISCELLANEOUS CONDUITS AS REQUIRED FOR A COMPLETE INSTALLATION. COORDINATE WITH APPLICABLE TRADES. PROVIDE CONDUIT SEALING BUSHINGS ON INSIDE AND OUTSIDE OF WALL.
11. NEW BUILDING GROUND BUS – NEMA 1 ENCLOSURE, COPPER BUS. SEE DETAILS ON DRAWING E002–MEP.

ONE–LINE DIAGRAM NOTES: (CONT'D)

12. PROVIDE EATON (OR EQUIVALENT) SERIES C CIRCUIT BREAKERS (65,000 A.I.C.) FOR ALL CIRCUIT BREAKERS MOUNTED IN MAIN SWITCHBOARD.
13. SWITCHBOARD SURGE PROTECTIVE DEVICE: REFER TO SECTION 26 43 00 FOR SURGE PROTECTIVE DEVICE LOCATED IN SERVICE ENTRANCE LOCATION.
14. PROVIDE CUSTOMER DIGITAL ELECTRONIC POWER METER FOR MONITORING CURRENT, VOLTAGE, REAL POWER, POWER FACTOR, AND PROVIDING MIN./MAX. READINGS FOR CURRENT, VOLTAGE, TOTAL KW, KVA, POWER FACTOR, AND PEAK DEMAND LOADS. PROVIDE WITH ACCURACY OF CURRENT AND VOLTAGE READING OF 0.1%. PROVIDE GATEWAY CARD FOR REMOTE MONITORING BY THE BAS COMMUNICATIONS PROTOCOL (BACNET). DIGITAL METER SHALL BE EATON I2250 OR EQUIVALENT.
15. PROVIDE RUBBER MAT IN FRONT OF MAIN SWITCHBOARD.
16. SUBMIT SWITCHBOARD SHOP DRAWINGS TO COMED FOR APPROVAL PRIOR TO SUBMITTING SHOP DRAWINGS TO THE ENGINEER. PROVIDE THE ENGINEER TWO COMED STAMPED APPROVAL SETS OF SHOP DRAWINGS FOR FILE.
17. NEW 3/4" SEALTITE FROM NEW COMED METER WITH PULSE OUTPUT TO NEW 4"x4" JUNCTION BOX FOR COMED WIRING TO TERMINAL STRIP LOCATED IN JUNCTION BOX.
18. ALL SPACES SHALL BE PROVIDED WITH BUS PROVISIONS FOR INSTALLATION OF FUTURE CIRCUIT BREAKERS.
19. TERMINATE ALL SECONDARY CONDUITS INTO BUILDING MAIN SWITCHBOARD WITH GROUNDING TYPE BUSHINGS. BOND CONDUITS TO GROUND BUS.
20. PROVIDE GROUNDING TYPE BUSHINGS FOR ALL CONDUITS ENTERING SWITCHBOARD. PROVIDE GROUNDING CONDUCTORS TO SWITCHBOARD GROUND BUS.
21. EXISTING LUNCHROOM BUILDING "D" MAIN SWITCHBOARD – EXISTING FUSIBLE BRANCH SWITCH TO REMAIN. REMOVE EXISTING FUSES. PROVIDE ENGRAVED NAMEPLATE READING "SPARE."
22. PROVIDE NEW TIME CLOCK FOR PARKING LOT/SITE LIGHTING. PROVIDE NEW 365 DAY ASTRONOMIC TIME SWITCH (2) CIRCUIT ELECTRONIC CONTROL WITH DAYLIGHT SAVINGS ADJUSTMENT, MANUAL OVER–RIDE, 30A RATED CONTACTS, BATTERY BACK–UP, LEAP YEAR, COMPATIBLE WITH MECHANICAL HELD, ELECTRONICALLY OPERATED CONTACTOR WITH 2 WIRE AUXILIARY RELAY – NEMA 1 ENCLOSURE. EXTERIOR LIGHTING TO BE CONTROLLED VIA TIME CLOCK ON–TIME CLOCK OFF: SET TIME SWITCH ON–OFF TIME PERIODS AS DIRECTED BY CPS. INTERMATIC ET90215CR SERIES OR ENGINEER APPROVED EQUIVALENT. PROVIDE ALL REQUIRED CONTROL WIRING IN NEW 3/4"C. MAKE ALL FINAL CONNECTIONS, COMPLETE IN PLACE, READY FOR OPERATION.
23. PANELBOARD SURGE PROTECTIVE DEVICE: REFER TO SECTION 26 43 00 FOR SURGE PROTECTIVE DEVICES LOCATED IN PANELBOARDS.

NOTES APPLICABLE TO REPLACED DISTRIBUTION PANELS:

A. REPLACE EXISTING DISTRIBUTION PANEL IN ITS ENTIRETY WITH A NEW PANEL AS SPECIFIED. PICK UP EXISTING CONDUITS AND RECONNECT EXISTING FEEDERS TO NEW PANEL. MAKE ALL FINAL CONNECTIONS. HEIGHT OF PANEL SHALL NOT BE LESS THAN EXISTING PANEL HEIGHT.

B. FIELD MEASURE DEPTH x WIDTH x HEIGHT OF EXISTING PANEL ENCLOSURE SCHEDULED FOR REPLACEMENT. NEW MAIN BREAKER LOCATION SHALL MATCH EXISTING LUG LOCATIONS (TOP OR BOTTOM). CIRCUIT BREAKER ARRANGEMENT SHALL MATCH EXISTING CIRCUIT BREAKER ARRANGEMENT IN ORDER TO RECONNECT EXISTING WIRING. PROVIDE ALL REQUIRED JUNCTION BOXES, CONDUITS, AND WIRING IN ORDER TO EXTEND EXISTING FEEDERS WITH SAME WIRE SIZE TERMINATED AT NEW BREAKERS. MAKE ALL FINAL CONNECTIONS.

C. NEW CIRCUIT BREAKERS SHALL BE INSTALLED IN THE SAME RELATIVE POSITION AS IN THE EXISTING PANEL ENCLOSURE.

D. WHERE EXISTING WIRING DOES NOT REACH NEW BREAKER TERMINALS, PROVIDE HIGH COMPRESSION IN–LINE SPLICES WITH MATCHING EXISTING FEEDER SIZE INSULATED WITH COLD SHRINK INSULATORS.

E. PROVIDE AN ASSOCIATED PANEL TYPEWRITTEN DIRECTORY CARD FOR NEW DISTRIBUTION PANEL.

F. PROVIDE EQUIPMENT GROUND BUS.

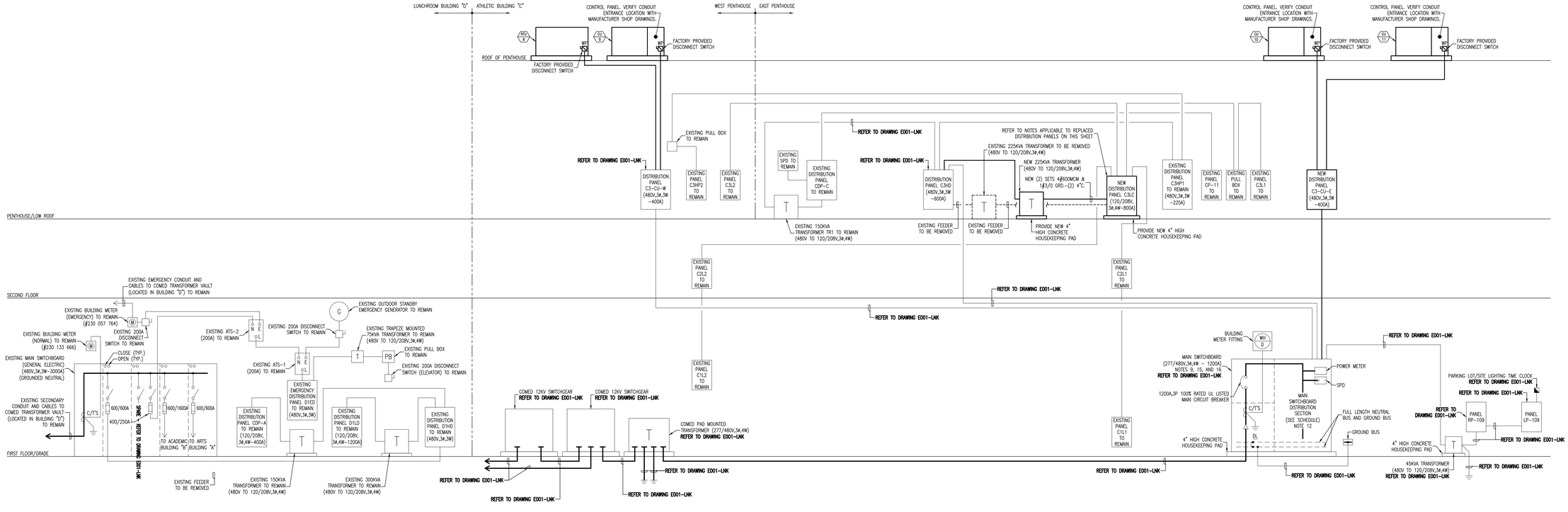
G. ACCEPTABLE MANUFACTURERS: ILLINOIS SWITCHBOARD AND CHICAGO SWITCHBOARD.

BRANCH CIRCUIT VOLTAGE DROP TABLE

RECEPTACLE AND LIGHTING BRANCH CIRCUIT WIRING SIZING TABLE
TABLE APPLIES TO NEW CIRCUITS RATED AT 15A AND 20A
MAXIMUM VOLTAGE DROP 3%

CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)	CIRCUIT TYPE	WIRE SIZE	MAXIMUM CIRCUIT LENGTH (FEET)
120V,1Ø	#12	65'	277V,1Ø	#12	100'
120V,1Ø	#10	100'	277V,1Ø	#10	225'
120V,1Ø	#8	175'	277V,1Ø	#8	350'
120V,1Ø	#6	EXCEEDS 200'	277V,1Ø	#6	EXCEEDS 400'
208V,3Ø	#12	150'	480V,3Ø	#12	350'
208V,3Ø	#10	220'	480V,3Ø	#10	450'
208V,3Ø	#8	350'	480V,3Ø	#8	700'

NOTES:
1. MINIMUM CONDUCTOR SIZE FOR LIFE SAFETY CIRCUITS (EXIT SIGNS) SHALL BE #10AWG.
2. THE LENGTH OF THE CIRCUIT SHALL BE DETERMINED BASED ON ACTUAL CIRCUITING LENGTH, NOT AS A STRAIGHT LINE BETWEEN POINTS A AND B.
3. LENGTH OF CIRCUIT SHALL BE MEASURED FROM SOURCE TO THE LAST OUTLET.



2 ONE–LINE RISER DIAGRAM - (480V,3Ø,3W-3000A) (CORNER GROUNDED DELTA)

NOT TO SCALE

1. REFER TO ONE–LINE RISER DIAGRAM NOTES ON THIS SHEET.
2. ALL CONDUIT AND WIRING IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
3. REFER TO PANEL SCHEDULES ON THIS SHEET.

1 ONE–LINE RISER DIAGRAM - (277/480V,3Ø,4W)

NOT TO SCALE

1. REFER TO ONE–LINE RISER DIAGRAM NOTES ON THIS SHEET.
2. ALL CONDUIT AND WIRING IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
3. REFER TO PANEL SCHEDULES ON THIS SHEET.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION OF CHICAGO — Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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312 427 7240

Structural Engineer:
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Suite 2901
Chicago, IL 60604
312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
Melvin & Cohen Associates, Inc.
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Suite 820
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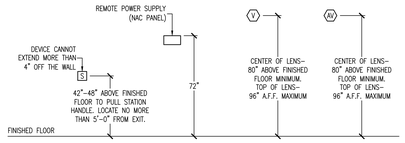
312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCW 5311)

Title: ONE-LINE RISER DIAGRAM AND NOTES

Sheet: E001-MEP



17 FIRE ALARM DEVICE MOUNTING HEIGHTS

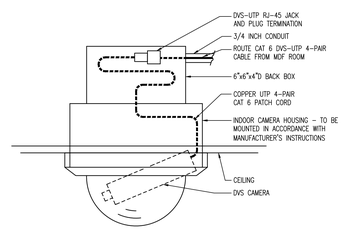
NOT TO SCALE

TRADE SIZE (INCHES)	MAXIMUM NUMBER OF CABLES THAT FIT INTO THE CONDUIT
	(0.402" X 0.175") STANDARD RANGE OF CAT 6 CABLE INCHES
3/4	3
1	5
1 1/4	10
1 1/2	13
2	22
2 1/2	39
3	58
3 1/2	76
4	98

NOTES:
1. 3/4 INCH CONDUIT IS THE MINIMUM SIZE CONDUIT TO BE USED FOR CAT 6 CABLE INSTALLATION.
2. CONTRACTOR SHALL NOT EXCEED THE 40% FILL RATIO IN INDIVIDUAL CONDUITS.

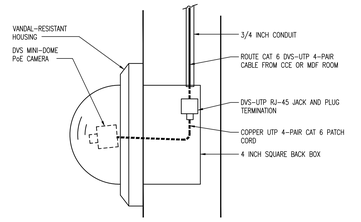
16 CONDUIT FILL CHART CCTV-UTP CABLES

NOT TO SCALE



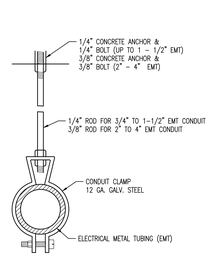
15 INDOOR CEILING-MOUNTED CAMERA

NOT TO SCALE



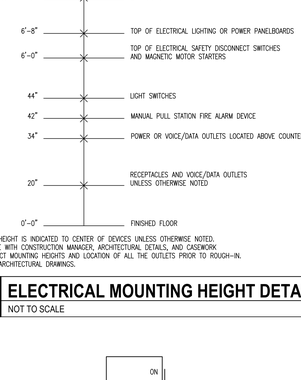
14 INDOOR WALL-MOUNTED CAMERA

NOT TO SCALE



13 TYPICAL SINGLE CONDUIT HANGER

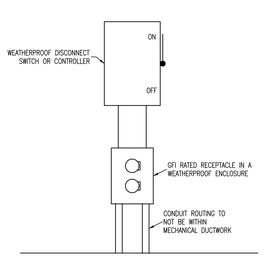
NOT TO SCALE



1. MOUNTING HEIGHT IS INDICATED TO CENTER OF DEVICES UNLESS OTHERWISE NOTED.
2. COORDINATE WITH CONSTRUCTION MANAGER, ARCHITECTURAL DETAILS, AND CASEWORK DRAWINGS EXACT MOUNTING HEIGHTS AND LOCATION OF ALL THE OUTLETS PRIOR TO ROUGH–IN.
3. REFER TO ARCHITECTURAL DRAWINGS.

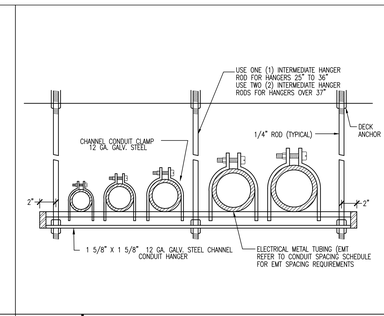
12 ELECTRICAL MOUNTING HEIGHT DETAILS

NOT TO SCALE



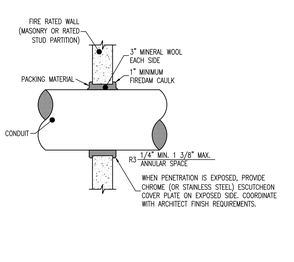
11 ROOFTOP RECEPTACLE MOUNTING DETAIL

NOT TO SCALE



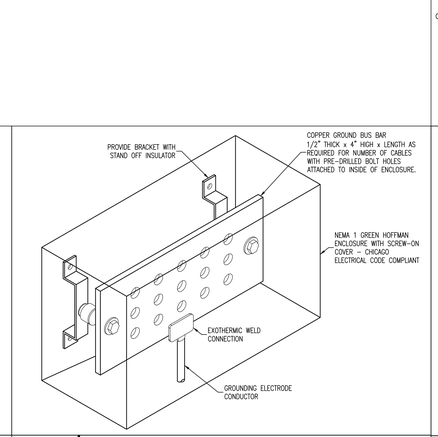
10 TYPICAL SINGLE ROW CONDUIT HANGER (TRAPEZE)

NOT TO SCALE



9 CONDUIT INTERIOR WALL PENETRATION

NOT TO SCALE



7 GROUND BUS ENCLOSURE DETAIL (BGB)

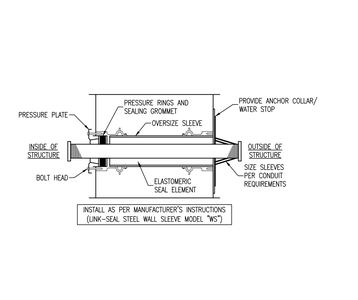
NOT TO SCALE

GROUNDING OF BUILDING METAL WATER PIPING SYSTEM

NOT TO SCALE

4 MAIN SERVICE GROUNDING DETAIL

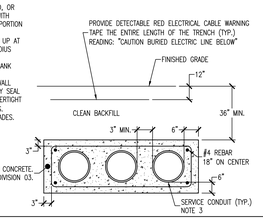
NOT TO SCALE



3 CONDUIT EXTERIOR WALL PENETRATION

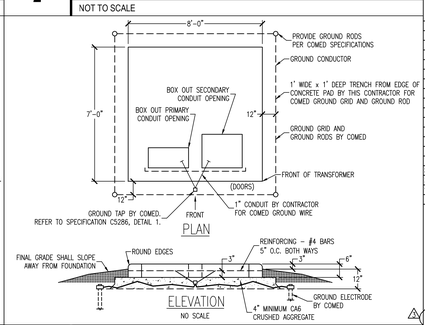
NOT TO SCALE

NOTES:
1. ALL SERVICE ENTRANCE CONDUIT SHALL BE HOT DIPPED GALVANIZED RIGID STEEL WITH THREADED FITTINGS.
2. SIZE OF CONDUITS AS INDICATED ON ONE–LINE RISER DIAGRAM.
3. PROVIDE RIGID, UNPLASTICIZED, POLYVINYL CHLORIDE SPACERS TO SECURELY SUPPORT AND MAINTAIN UNIFORM SPACING OF THE DUCT ASSEMBLY A MINIMUM OF THREE INCHES ABOVE BOTTOM OF TRENCH DURING THE CONCRETE POUR. SPACER SPACING SHALL NOT EXCEED FIVE FEET.
4. DUCTS SHALL BE KEPT CLEAN OF EARTH, SAND, OR GRAVEL DURING CONSTRUCTION, AND SEALED WITH TAPERED PLUGS UPON COMPLETION OF EACH PORTION OF THE WORK.
5. WHERE CONDUITS CHANGE DIRECTION OR TURN UP AT TRANSFORMER, BUILDING, ETC., USE LARGE RADIUS SWEEP RIGID GALVANIZED STEEL ELBOWS.
6. REFER TO STRUCTURAL DRAWINGS FOR DUCT BANK DETAILS.
7. INSTALL CONDUIT PENETRATIONS OF BUILDING WALL USING GALVANIZED STEEL SLEEVES. COMPLETELY SEAL THE GAP AROUND CONDUIT TO RENDER IT WATERTIGHT USING "LINK–SEAL" MODULAR SEAL ASSEMBLIES.
8. COORDINATE ROUTING WITH ALL APPLICABLE TRADES.
9. REFER TO SECTION 31 23 17 – EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES.



2 DUCT BANK DETAIL-SERVICE ENTRANCE

NOT TO SCALE



1 COMED TRANSFORMER PAD DETAIL

NOT TO SCALE

COMMONWEALTH EDISON COMPANY SERVICE NOTES:

COMED–1 ENTIRE INSTALLATION SHALL BE IN COMPLIANCE WITH THE RULES AND REGULATIONS OF COMED AND ALL APPLICABLE CODES.

COMED–2 CONTRACTOR SHALL VERIFY ALL COMED REQUIREMENTS PRIOR TO INSTALLATION.
CONTACT: TIM BOSTON
PHONE: 773–677–1343

COMED–3 CONTRACTOR SHALL SECURE COPIES OF COMED SERVICE ENTRANCE SKETCH AND ALL APPLICABLE STANDARDS FOR TRANSFORMERS, CONCRETE PADS, GROUNDING REQUIREMENTS.

COMED–4 CONTRACTOR SHALL COORDINATE ALL SERVICE ENTRANCE LOCATION REQUIREMENTS WITH COMED INCLUDING BUT NOT LIMITED TO THE FOLLOWING:
A. ALL PULLING AND FEEDING OF PRIMARY AND SECONDARY CABLES.
B. SERVICE ENTRANCE LOCATIONS.
C. GROUNDING PER COMED STANDARD C5293.B.
D. TRANSFORMER PAD.
E. CONCRETE PAD FOR COMPARTMENTAL TRANSFORMER AS PER COMED STANDARD C5286.

COMED–5 CONTRACTOR SHALL NOTIFY COMED 48 HOURS IN ADVANCE OF PERFORMING ANY WORK.

COMED–6 CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, SERVICES, ETC., TO PROVIDE SECONDARY ELECTRIC SERVICE, UNDERGROUND DUCT, GROUNDING, TRANSFORMER CONCRETE PAD, AND SECONDARY METERING AS PER COMED SPECIFICATIONS.

COMMONWEALTH EDISON COMPANY SERVICE NOTES:

COMED–7 ALL CONDUIT TERMINATIONS INTO TRANSFORMER PAD SHALL BE RIGID GALVANIZED STEEL HEAVY WALL TYPE CONDUIT ENCASED IN 3" CONCRETE ENVELOPE. PROVIDE GROUNDING BUSHINGS AND BONDING FOR ALL METALLIC CONDUITS ENTERING TRANSFORMER.

COMED–8 PROVIDE GROUNDING AT COMED TRANSFORMER IN CONFORMANCE WITH COMED SPECIFICATIONS AND COMED SERVICE ENTRANCE SKETCH. PROVIDE 1" CONDUIT AND TRENCH FOR COMED GROUND WIRE PER APPLICABLE TRANSFORMER PAD SPECIFICATION C8550.

COMED–9 TERMINATE ALL SECONDARY CONDUITS INTO BUILDING MAIN SERVICE PANEL WITH GROUNDING TYPE BUSHINGS. BOND CONDUITS TO GROUND BUS.

COMED–10 COMED SHALL FURNISH AND INSTALL PAD MOUNTED COMPARTMENTAL TRANSFORMER, MEDIUM VOLTAGE SWITCHGEAR, AND ALL PRIMARY CABLE CONNECTIONS AND ALL SECONDARY CABLE CONNECTIONS AT THE TRANSFORMER.

COMED–11 PROVIDE GROUNDING BUSHINGS ON ALL METALLIC CONDUITS ENTERING TRANSFORMER PAD. BOND CONDUITS TO GROUND GRID.

COMED–12 CONTRACTOR SHALL CONSTRUCT CONCRETE PAD FOR COMED TRANSFORMER, IN CONFORMANCE TO COMED STANDARD C5286.H AND STANDARDS INCLUDING ALL EXCAVATION, TRENCHING, GROUNDING, ANCHOR BOLTS, ETC.

COMED–13 CONTRACTOR TO INSTALL PULL ROPE IN ALL CONDUITS, SEAL ENDS, AND MARK LOCATIONS ABOVE GROUND WITH STAKES.

COMED–14 ALL CONDUITS SHALL BE SCHEDULE 40 PVC AND INSTALLED PER COMED STANDARDS C4050, C4090, AND C4171. COORDINATE WITH COMED PRIOR TO DOING ANY WORK.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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No.	Date	Description
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2	02.08.24	ISSUED FOR BID
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PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title
ELECTRICAL DETAILS

Sheet
E002-LNK

LIGHTING FIXTURE SCHEDULE NOTES:

1. REFER TO THE SPECIFICATIONS FOR ADDITIONAL LIGHTING FIXTURE REQUIREMENTS.

2. ANY MANUFACTURERS SUBMITTED TO QUALIFY UNDER AN "ALTERNATE" LISTING IN THE LIGHTING FIXTURE SCHEDULE SHALL MEET ALL REQUIREMENTS OF THE BASE MANUFACTURER(S) INCLUDING PHOTOMETRIC PERFORMANCE.

3. MINIMUM LENS THICKNESS TO BE .125 INCHES, WHERE LENSES ARE USED.

4. THE FIXTURE SCHEDULE AND CATALOG NUMBER DOES NOT NECESSARILY REFLECT ALL FIXTURES REQUIREMENTS OR LIST ALL ACCESSORIES AND HARDWARE NECESSARY FOR THE COMPLETION OF INSTALLATION, NOR DOES IT DETAIL THE CEILING CONSTRUCTION TO BE ENCOUNTERED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROPERLY DETERMINE AND PROVIDE CORRECT FLANGE TYPES, FITTINGS, AND HARDWARE REQUIRED FOR THE INSTALLATION OF LIGHTING FIXTURES INTO CEILING GRIDS, DRYWALL CEILINGS, AND OTHER CONSTRUCTION MATERIALS AS REQUIRED.

5. ALL LIGHTING FIXTURES ARE TO BE LOCATED AS REQUIRED ON THE JOB TO CLEAR DUCTS, STRUCTURAL MEMBERS, PIPING, EQUIPMENT, AND/OR MECHANICAL EQUIPMENT.

6. ALL LIGHTING FIXTURES INSTALLED IN A CEILING AIR PLENUM SHALL BE CITY OF CHICAGO PLENUM APPROVED AND SHALL BE MARKED CCEA.

7. ALL CONDUIT SERVING EXTERIOR LIGHTING SHALL BE CONCEALED WITHOUT EXCEPTIONS.

8. REFER TO ARCHITECTURAL ROOM FINISH SCHEDULE. THIS CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ORDERING RECESSED FIXTURES WITH CORRECT TRIM TO PROVIDE EXACT FIT REQUIRED FOR THE TYPE OF CEILING AND CEILING SUPPORTING SYSTEM SPECIFIED. BEFORE PLACING ORDER FOR FIXTURES, CONTRACTOR SHALL EXAMINE FINAL APPROVED CEILING SHOP DRAWINGS TO VERIFY COMPATIBILITY BETWEEN LIGHT FIXTURES AND CEILING CONSTRUCTION.

9. ALL PENDANT MOUNTED LIGHT FIXTURES, REGARDLESS OF WEIGHT, SHALL BE SUPPORTED FROM THE STRUCTURE ABOVE AT EACH SUSPENSION POINT AND SHALL NOT BE SUPPORTED DIRECTLY FROM A SUSPENDED CEILING SYSTEM OR DRYWALL CEILING SYSTEM. CONTRACTOR SHALL COORDINATE EXACT MOUNTING HARDWARE NECESSARY FOR INSTALLATION BASED ON THE SPECIFIED CEILING SYSTEMS AND SELECTED LIGHT FIXTURE MANUFACTURER. SHOP DRAWINGS SHALL BE SUBMITTED FOR ALL PENDANT MOUNTED LIGHT FIXTURE LENGTHS CLEARLY NOTING EXACT SUSPENSION POINTS TO THE CEILING AND PROPOSED SUSPENSION COMPONENTS.

10. RECESSED LUMINAIRES SHALL BE SUPPORTED WITH 12 GAUGE WIRE HANGERS, (2) PER LUMINAIRE, AT DIAGONALLY OPPOSITE CORNERS. LUMINAIRES SHALL BE ATTACHED TO CEILING GRID TO RESIST HORIZONTAL FORCE EQUAL TO WEIGHT OF LUMINAIRE.

11. ALL EXIT SIGNS SHALL BE SUPPORTED AND FED FROM CADDY SNAP ON BOX HANGER, ELECTRICAL BOX HANGER, OR SUPPORT FROM LUMINAIRE MANUFACTURER, AND ADDITIONAL 12 GAUGE WIRE INSTALLED FROM BOX TO STRUCTURE.

12. GRID-TYPE LIGHT FIXTURES SHALL BE SUPPORTED BY A MINIMUM OF 4 RODS OR WIRES SECURED TO THE CEILING SUPPORT SYSTEM WITHIN 6 INCHES OF THE FIXTURE CORNERS.

13. INSTALL FLUSH MOUNTED LUMINAIRES PROPERLY TO ELIMINATE LIGHT LEAKAGE BETWEEN LUMINAIRE FRAME AND FINISHED SURFACE.

14. WHERE DIMMING OR INTEGRAL LIGHT FIXTURE CONTROLS ARE SPECIFIED, COMPATIBILITY OF FIXTURE AND CONTROLS SHALL BE VERIFIED PRIOR TO ORDERING ANY EQUIPMENT.

15. FRAMING MEMBERS OF SUSPENDED CEILING SYSTEMS USED TO SUPPORT LUMINAIRES SHALL BE SECURELY FASTENED TO EACH OTHER AND SHALL BE SECURELY ATTACHED TO THE BUILDING STRUCTURE AT APPROPRIATE INTERVALS. LUMINAIRES SHALL BE SECURELY FASTENED TO THE CEILING FRAMING MEMBERS BY MECHANICAL MEANS SUCH AS BOLTS, SCREWS, OR RIVETS. LISTED CLIPS IDENTIFIED FOR USE WITH THE TYPE OF CEILING FRAMING MEMBERS AND LUMINAIRES SHALL ALSO BE PERMITTED.

LIGHTING FIXTURE SCHEDULE

SYMBOL & TYPE	MANUFACTURER AND CATALOG NUMBER	WATTAGE	LOCATION	MOUNTING	SHIELDING	REMARKS	ALTERNATE MANUFACTURER SUBJECT TO THE APPROVAL OF THE ENGINEER
LS4	1' x 4' LED EDGE LIT PANEL WITH SURFACE MOUNT KIT METALUX # 14FP4235C-FPSURF14	LED MODULE (38 WATTS) (4259 LUMENS) (3500°K)	TRAINING ROOM	SURFACE	WHITE FROSTED ACRYLIC LENS	120 VOLT LED 0-10V DIMMING DRIVER. NOTE 1. REFER TO INSTALLATION INSTRUCTIONS FOR VARIOUS CEILING INTERFACE DETAILS.	DAY-BRITE LITHONIA COLUMBIA
LT2	2' x 4' SEALED LED PANEL FAIL-SAFE # FSP-24-47-35-CP187-FPEQ	LED MODULE (41 WATTS) (4538 LUMENS) (3500°K)	LOCKER ROOM	RECESSED	0.187" CLEAR POLYCARBONATE LENS	120 VOLT LED 0-10V DIMMING DRIVER. PROVIDE MOUNTING CLIPS TO SECURE FIXTURES TO GRID. NOTE 1.	PHILIPS DAY-BRITE LITHONIA
X2	EXIT DIRECTIONAL SIGN WITH INTEGRAL LED DRIVER RED LETTERS WITH WHITE BACKGROUND SURE-LITES # CHX SERIES	LONG LIFE WHITE LED'S	SEE PLANS	RECESSED/ SURFACE CEILING OR WALL MOUNTED AS REQUIRED	STEEL HOUSING	120/277 VOLT. EXACT WORDING, ARROWS, SINGLE OR DOUBLE FACE AS APPROVED BY LOCAL CODE AUTHORITY. EXIT SIGNS SHALL NOT EXCEED 5 WATTS PER SIDE OF SIGN. CITY OF CHICAGO APPROVED, ALL EXIT SIGNS SHALL BE MOUNTED TO BE VISIBLE BELOW ALL CEILING PLANES AND SOFFITS.	LITHONIA CHLORIDE

CHICAGO FIRE PREVENTION BUREAU EXIT SIGN SYMBOLS

SINGLE FACE SIGNS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
1	FIRE ESCAPE	2	STAIR(S)/STAIRWAY	3	EXIT
4	FIRE ESCAPE	5	STAIR(S)	6	EXIT
7	FIRE ESCAPE	8	STAIR(S)	9	EXIT
10	FIRE ESCAPE	11	STAIR(S)	12	EXIT

DOUBLE FACE SIGNS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
14	14-3G SHOW THE FACES WITH THE PROPER ANGLE OF THE FACE AND FACE NUMBER (1, 2, OR 3)				
16	FIRE ESCAPE	17	STAIR(S)	18	EXIT
19	FIRE ESCAPE	20	STAIR(S)	21	EXIT
22	FIRE ESCAPE	23	STAIR(S)	24	EXIT

LIGHTING CONTROL SYSTEM - SEQUENCE OF OPERATIONS:

A. TRAINING ROOM (SINGLE ZONE)
WALLSTATION: HALF LIGHTS (50%), FULL LIGHTS (100%), RAISE/LOWER/OFF. VACANCY SENSORS SHALL TURN OFF AND HOLD UNTIL MANUAL ON OPERATION IS PRESSED. BUTTONS SHALL HOLD STATE DURING OCCUPIED MODE..

B. LOCKER ROOM (SINGLE ZONE)
KEY SWITCH OVERRIDES TO KEEP LIGHT FIXTURES OFF. OCCUPANCY SENSORS SHALL TURN LIGHTS ON UNTIL 20 MINUTE MAXIMUM DELAY AFTER THE LAST MOTION IS SENSED.

OCCUPANCY/VACANCY SENSOR NOTES

VS-1. LIGHT FIXTURES IN AREAS WITH VACANCY SENSORS SHALL BE MANUAL ON/AUTO OFF WITH OVERRIDE SWITCH. LIGHT FIXTURES IN AREAS WITH OCCUPANCY SENSORS SHALL BE AUTO ON/AUTO OFF WITH OVERRIDE KEY SWITCH.

VS-2. REFER TO MANUFACTURER'S DATA SHEETS AND INSTALLATION INSTRUCTIONS PRIOR TO INSTALLATION.

VS-3. THE DELAYED-OFF TIME FOR ALL CEILING MOUNTED OCCUPANCY/ VACANCY SENSORS SHALL BE SET WITH 20 MINUTE MAXIMUM DELAY AFTER THE LAST MOTION IS SENSED.

VS-4. PROVIDE ALL OCCUPANCY/VACANCY SENSORS WITH APPROPRIATE POWER PACKS.

VS-5. ALL OCCUPANCY/VACANCY SENSORS SHALL BE INSTALLED AS PER MANUFACTURER'S WIRING DIAGRAMS, RECOMMENDATIONS, AND ALL APPLICABLE CODES.

VS-6. ALL OCCUPANCY/VACANCY SENSORS SHALL BE LOCATED AT LEAST 6 FEET FROM AIR SUPPLY/RETURN REGISTERS.

VS-7. CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER SENSITIVITY AND TIME DELAY SETTINGS AND MANUFACTURERS RECOMMENDED PLACEMENT. FIELD VERIFICATION OF CIRCUITS WITH RESPECT TO POWER PACK PLACEMENT.

VS-8. CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFICATION OF REQUIRED NUMBER OF POWER PACKS.

OCCUPANCY/VACANCY SENSOR NOTES (CONT'D)

VS-9. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, AND SERVICES REQUIRED TO INSTALL A COMPLETE AND OPERATING LIGHTING CONTROL SYSTEM. THIS WORK SHALL INCLUDE BUT NOT NECESSARILY BE LIMITED TO WIRING, CONDUIT, JUNCTION BOXES, BRACKETS, AND HARDWARE COMPLETE WITH ALL ACCESSORIES AND INCIDENTALS AND ALL FINAL CONNECTIONS FOR A COMPLETE INSTALLATION READY FOR OPERATION. CONTRACTOR SHALL INCLUDE STARTUP AND DEMONSTRATION TO OWNER IN BID PROPOSAL.

VS-10. ALL OCCUPANCY/VACANCY SENSORS SHALL BE MOUNTED ON A VIBRATION FREE SURFACE.

VS-11. OCCUPANCY/VACANCY SENSOR INSTALLATION SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, MANUFACTURER'S WIRING DIAGRAMS, MANUFACTURER'S RECOMMENDATIONS, AND ALL APPLICABLE CODES.

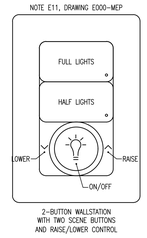
VS-12. CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING MANUFACTURER FOR PROPER PLACEMENT AND ADJUSTING OF ALL OCCUPANCY/VACANCY SENSORS.

VS-13. DO NOT MOUNT SENSORS CLOSER THAN 10 FEET FROM EACH OTHER.

VS-14. ALL OCCUPANCY/VACANCY SENSORS SHALL BE MOUNTED A MINIMUM 3 FEET AWAY FROM ALL SUSPENDED LIGHT FIXTURES.

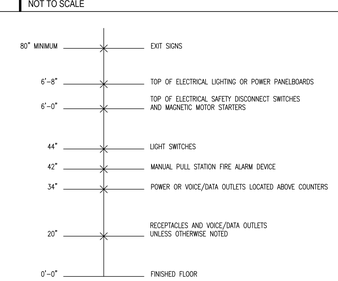
VS-15. ALL OCCUPANCY/VACANCY SENSORS SHALL BE MOUNTED A MINIMUM 2 FEET AWAY FROM ALL RECESSED LIGHT FIXTURES.

VS-16. CONTRACTOR SHALL SUBMIT A FACTORY GENERATED SHOP DRAWING INDICATING ALL OCCUPANCY/VACANCY SENSOR LOCATIONS AND PATTERN ARRAYS.



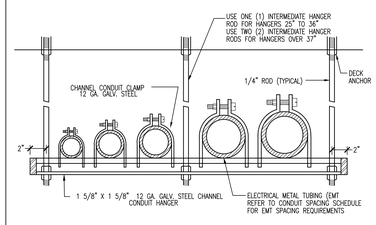
NOTES
1. ALL PROGRAMMING AND CUSTOM ENGRAVING SHALL BE CONFIRMED WITH CPS TO MEET SCHOOL'S REQUIREMENTS. CONFIRM ENGRAVINGS FOR EACH BUTTON/SWITCH WITH CPS. ALL COVER PLATES SHALL BE SATIN STAINLESS STEEL.
2. ALL COOPER LIGHTING SOLUTIONS WALLSTATIONS FIT IN A STANDARD SINGLE GANG BACKBOX.
3. EACH WALLSTATION SHALL BE PROGRAMMED IN THE FIELD WITH CUSTOM ENGRAVED BUTTONS.

13 LIGHTING CONTROL STATIONS
NOT TO SCALE

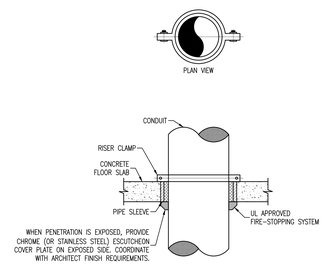


1. MOUNTING HEIGHT IS INDICATED TO CENTER OF DEVICES UNLESS OTHERWISE NOTED.
2. COORDINATE WITH CONSTRUCTION MANAGER, ARCHITECTURAL DETAILS, AND CASEWORK DRAWINGS EXACT MOUNTING HEIGHTS AND LOCATION OF ALL THE OUTLETS PRIOR TO ROUGH-IN.
3. REFER TO ARCHITECTURAL DRAWINGS.

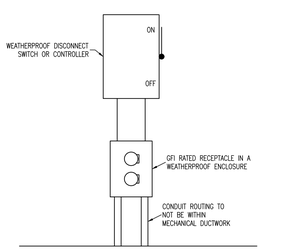
12 ELECTRICAL MOUNTING HEIGHT DETAILS
NOT TO SCALE



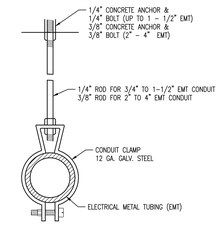
10 TYPICAL SINGLE ROW CONDUIT HANGER (TRAPEZE)
NOT TO SCALE



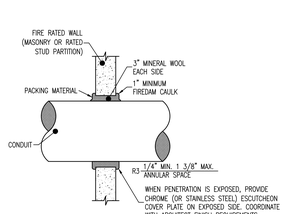
8 CONDUIT INTERIOR FLOOR PENETRATION
NOT TO SCALE



11 ROOFTOP RECEPTACLE MOUNTING DETAIL
NOT TO SCALE



9 TYPICAL SINGLE CONDUIT HANGER
NOT TO SCALE



7 CONDUIT INTERIOR WALL PENETRATION
NOT TO SCALE

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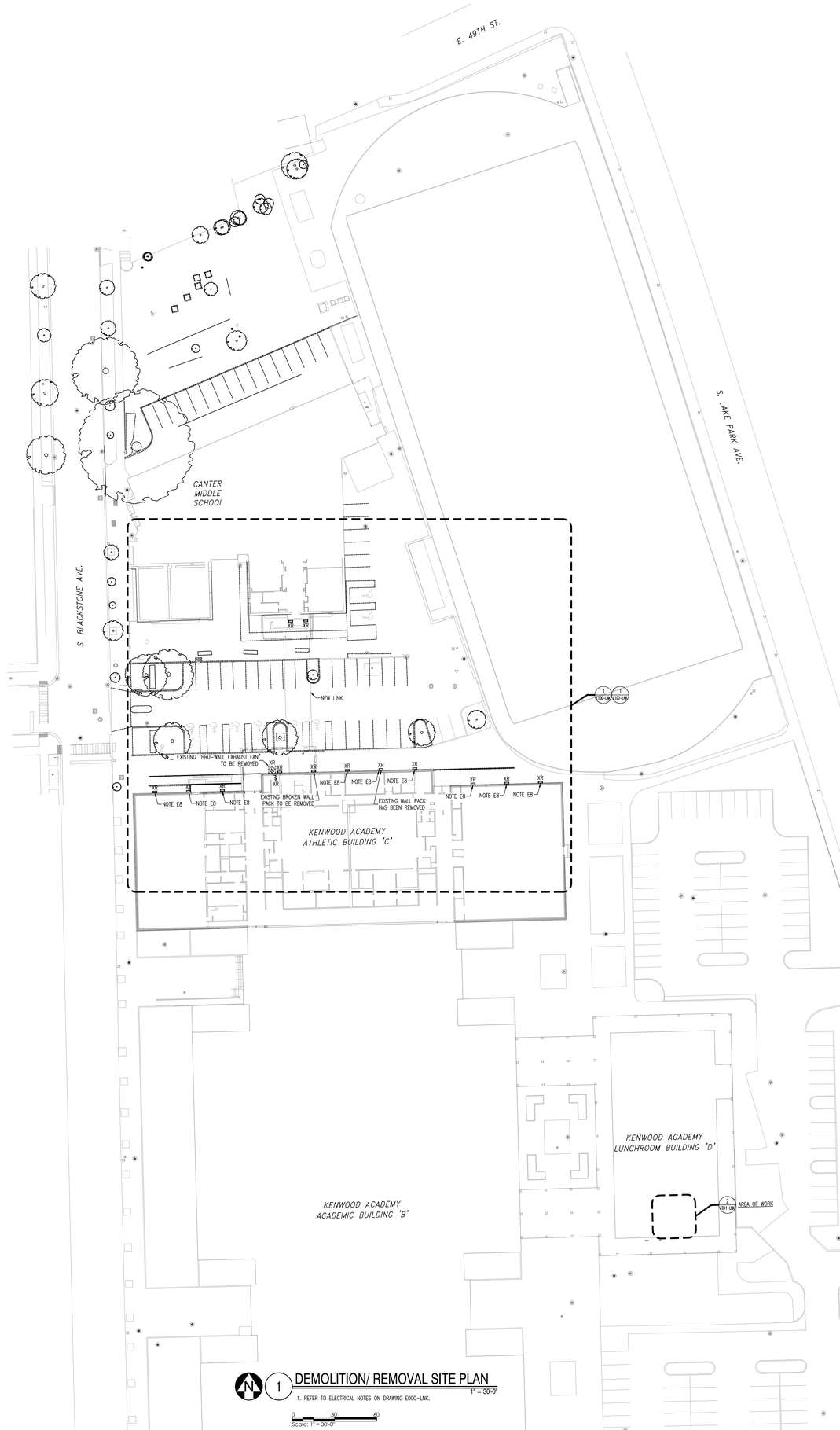
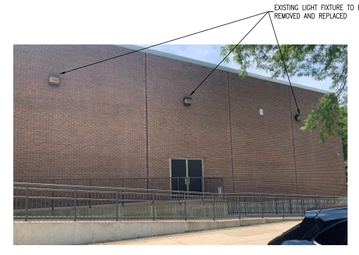
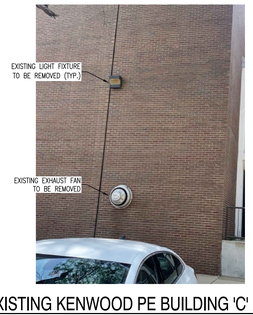
Sheet: E002-MEP

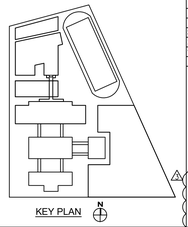




3 EXISTING KENWOOD PE BUILDING 'C' (NORTH ELEVATION)
NOT TO SCALE



2 EXISTING KENWOOD PE BUILDING 'C' (NORTH ELEVATION)
NOT TO SCALE



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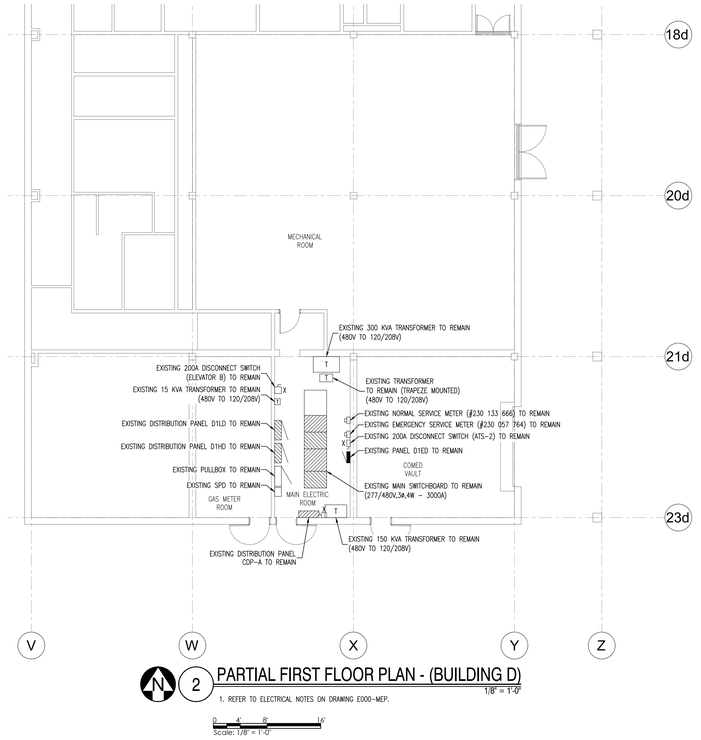
Project No.: 05326 (NCAA 5031)
Title
DEMOLITION/ REMOVAL SITE PLAN
Sheet
E010-LNK

1 ELECTRICAL SITE PLAN
1" = 30'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

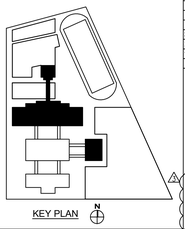
Scale: 1" = 30'-0"



2 PARTIAL FIRST FLOOR PLAN - (BUILDING D)
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

Scale: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

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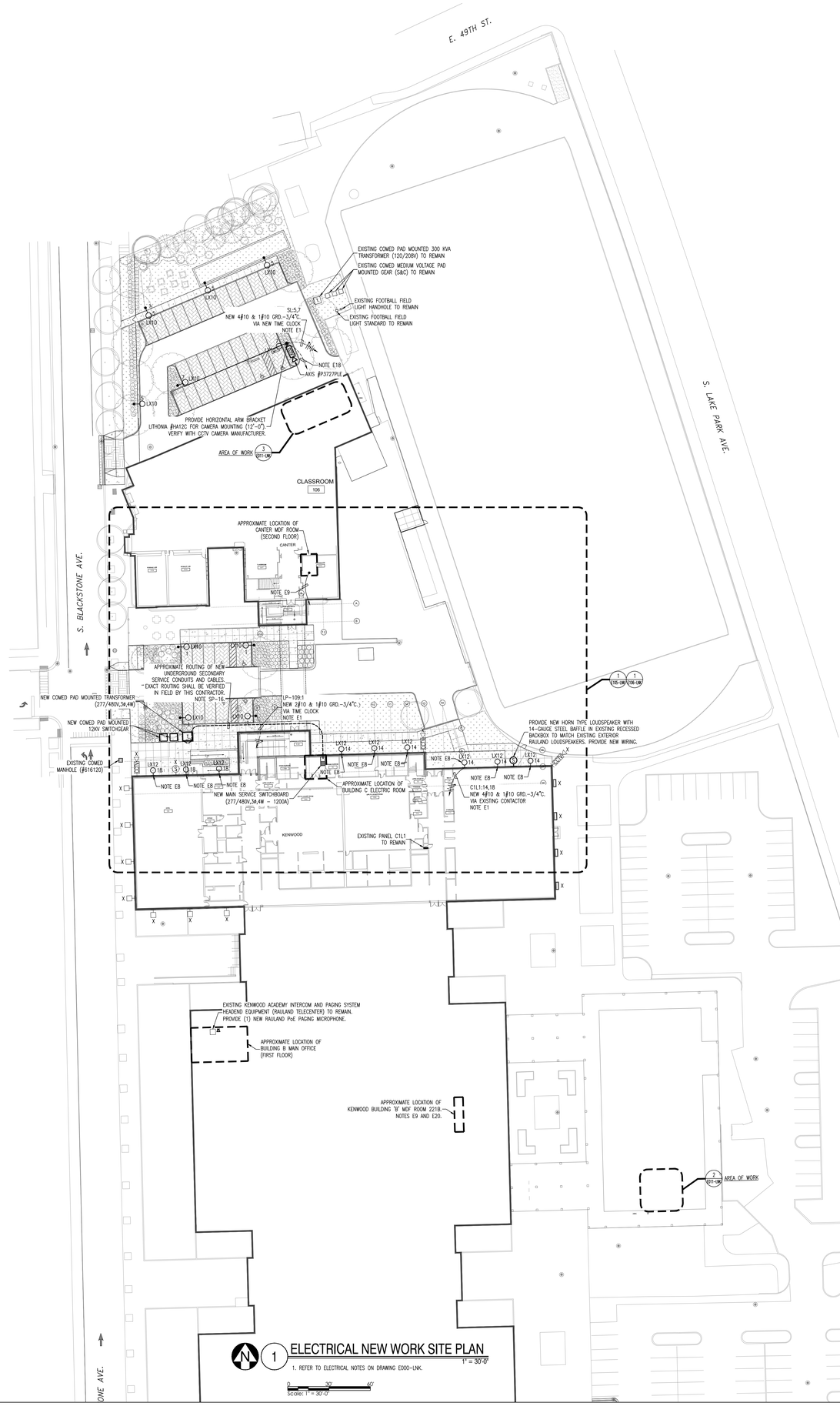
Project No.: 05326 (MCM 5031)

Title: ELECTRICAL SITE PLAN

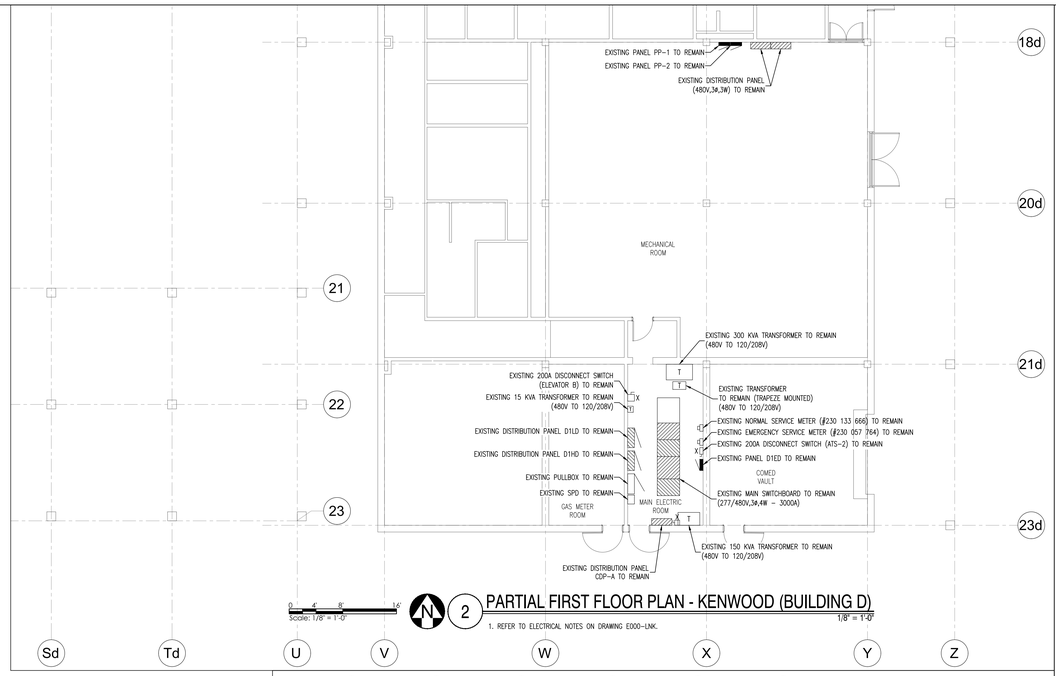
Sheet: E010-MEP



1 ELECTRICAL NEW WORK SITE PLAN
1" = 30'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

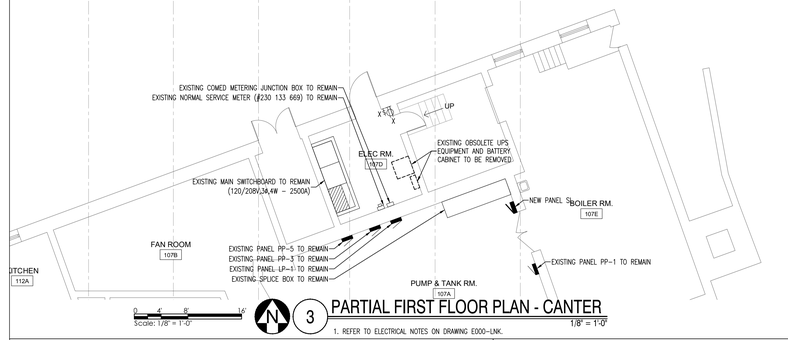
Scale: 1" = 30'-0"



2 PARTIAL FIRST FLOOR PLAN - KENWOOD (BUILDING D)
1/8" = 1'-0"

Scale: 1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.



Scale: 1/8" = 1'-0"

3 PARTIAL FIRST FLOOR PLAN - CANTER
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

SITE PLAN NOTES:

SP-1. ALL SITE LIGHTING POLES SHALL BE CERTIFIED BY POLE MANUFACTURER AND/OR REGISTERED STRUCTURAL ENGINEER EMPLOYED BY THE ELECTRICAL CONTRACTOR TO BE CAPABLE OF WITHSTANDING A 100 MPH WIND WITH A SAFETY FACTOR OF 1.35. POLES SHALL BE CERTIFIED WITH QUANTITIES AND TYPES OF LUMINAIRES INSTALLED AS SPECIFIED FOR ACTUAL SOIL CONDITIONS. SUBMIT WRITTEN CERTIFICATION.

SP-2. MANUFACTURER SHALL PROVIDE CONCRETE BASE DETAIL TO ELECTRICAL CONTRACTOR FOR ALL POLE BASES.

SP-3. VERIFY BOLT CIRCLE TEMPLATE WITH MANUFACTURER FOR EACH LIGHT STANDARD TYPE PRIOR TO DOING WORK. INCREASE FOUNDATION DIAMETER AS REQUIRED IN ORDER TO ACCOMMODATE BASE COVER ON TOP OF THE FOUNDATION WITH AT LEAST 4" FROM BASE COVER CORNER TO EDGE OF FOUNDATION.

SP-4. PROVIDE RIGID GALVANIZED STEEL HEAVY WALL CONDUIT FOR ALL HOMERUNS TO A POINT 6'-0" FROM BUILDING LINE. PROVIDE PVC-TO-STEEL ADAPTERS. PVC CONDUIT SHALL BE SCHEDULE 40. PROVIDE PVC-40 CONDUIT FROM ADAPTER TO RIGID GALVANIZED STEEL TO EXTERIOR AREA LIGHT STANDARDS. ALL TERMINATIONS ABOVE GRADE SHALL BE RIGID GALVANIZED STEEL HEAVY WALL. ALL CONDUIT SHALL BE INSTALLED 3'-0" BELOW GRADE.

SP-5. CONTRACTOR SHALL FIELD MEASURE AND STAKE OUT LIGHT STANDARDS PRIOR TO DOING ANY EXCAVATIONS FOR LIGHT STANDARD FOUNDATIONS OR TRENCHING. THE OWNER HAS THE OPTION OF RELOCATING LIGHT STANDARDS WHEN OBSTRUCTED BY INCLUDING BUT NOT LIMITED TO TREES, EXISTING UNDERGROUND UTILITIES, OBSTACLES, FIRE HYDRANTS, OR THE LIKE.

SP-6. ALL SITE LIGHTING UNDERGROUND CABLE SHALL BE 600 VOLT TYPE THHN/THWN.

SP-7. PROVIDE GROUND LUG IN ALL LIGHT POLE STANDARDS.

SITE PLAN NOTES:

SP-8. CONTRACTOR SHALL INSTALL RED DETECTABLE WARNING TAPE 12 INCHES ABOVE CONDUIT IN ALL EXTERIOR TRENCHES WHERE CONDUIT IS INSTALLED READING "CAUTION BURIED ELECTRIC LINE BELOW".

SP-9. ALL UNDERGROUND DUCTS FOR EXTERIOR SITE LIGHTING SHALL BE PVC SCHEDULE 40 EXCEPT AS NOTED.

SP-10. PROVIDE PULL ROPE IN ALL EMPTY UNDERGROUND DUCT.

SP-11. SEAL ALL UNDERGROUND DUCT OR CONDUITS ENTERING OR LEAVING BUILDING WITH WATERTIGHT SEALANT.

SP-12. PROVIDE GROUNDING CONDUCTOR WITH ALL EXTERIOR CIRCUITS WITHIN THE SAME CONDUITS.

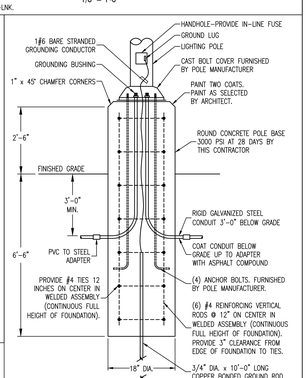
SP-13. PROVIDE ONE-PIECE BASE COVER TO CONCEAL ANCHOR BOLTS FOR ALL LIGHT STANDARDS.

SP-14. CABLE ENDS SHALL BE SEALED WITH END CAPS PRIOR TO PULLING NEW CABLES INTO UNDERGROUND DUCTS.

SP-15. PROVIDE LINK-SEAL MODULAR MECHANICAL HYDROSTATIC SEAL FOR CORE DRILLED HOLE AROUND CONDUIT PENETRATION TO ENSURE AGAINST THE ENTRY OF WATER, SOIL, OR BACKFILL MATERIAL. INSTALL AS PER MANUFACTURER'S INSTRUCTIONS.

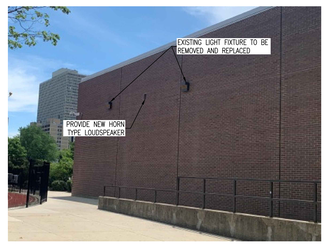
SP-16. THIS CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THIS CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

SP-17. ALL CONDUITS UNDER ROADWAYS SHALL BE RIGID GALVANIZED STEEL HEAVY.

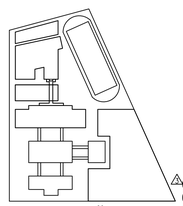


4 RAISED BASE DETAIL FOR FIXTURE TYPE "LX10"
NOT TO SCALE

NOTES:
1. VERIFY BOLT CIRCLE WITH MANUFACTURER'S INSTRUCTIONS PRIOR TO DOING ANY WORK.
2. DEPTH OF BASE DEPENDANT ON SOIL CONDITIONS AND AVERAGE WIND SPEEDS. VERIFY WITH ARCHITECT.



5 EXISTING KENWOOD PE BUILDING 'C' (NORTH ELEVATION)
NOT TO SCALE



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
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CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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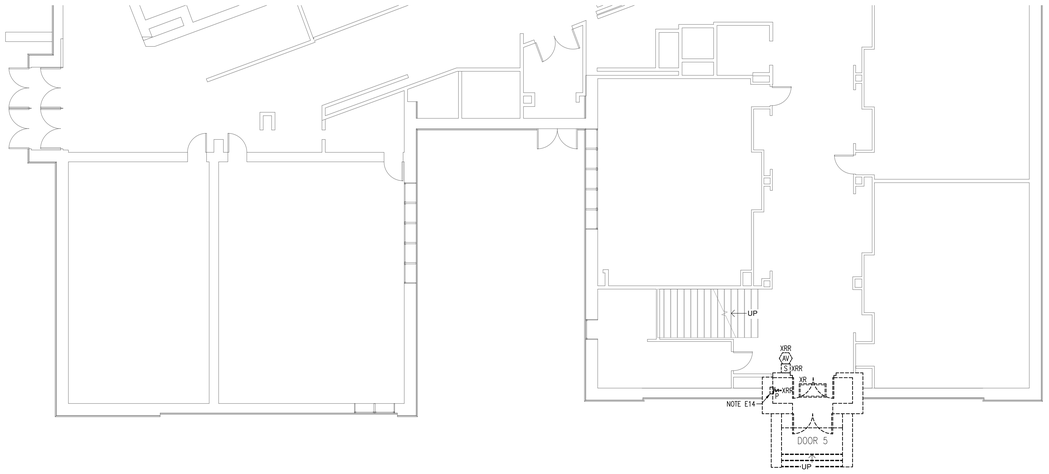
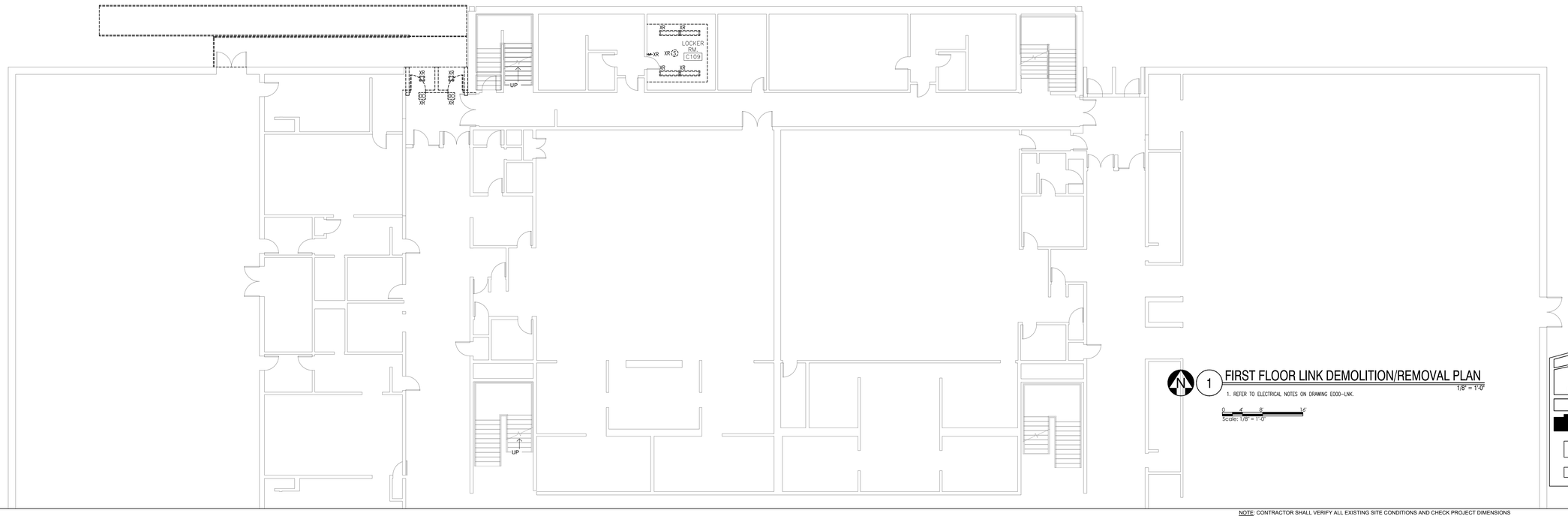
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCM 9331)

Title
ELECTRICAL SITE PLAN

Sheet
E011-LNK

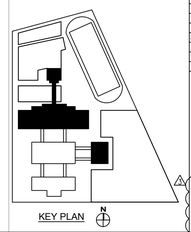




1 FIRST FLOOR LINK DEMOLITION/REMOVAL PLAN
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

SCALE: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION

Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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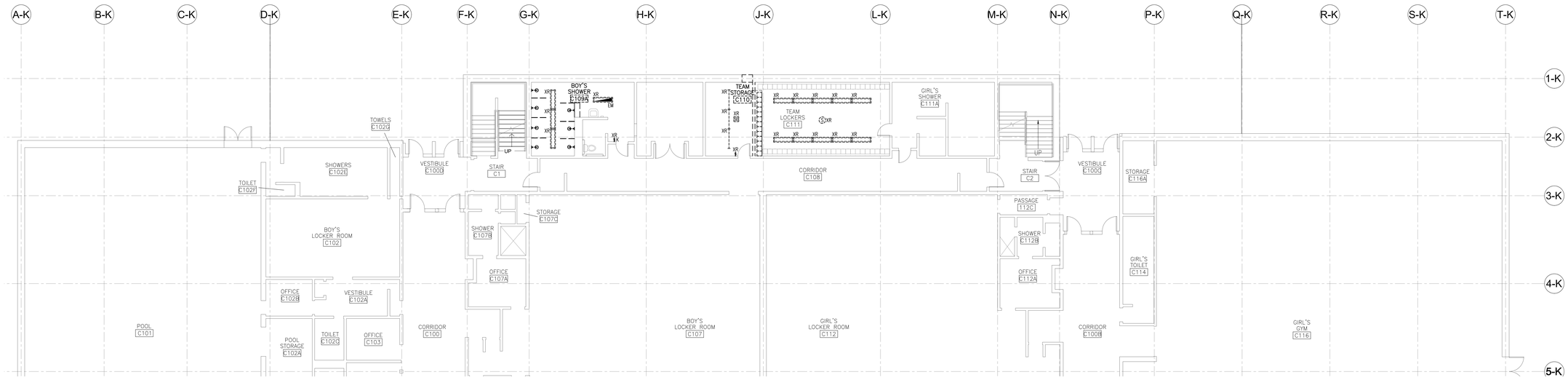
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: FIRST FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C) AND CANTER

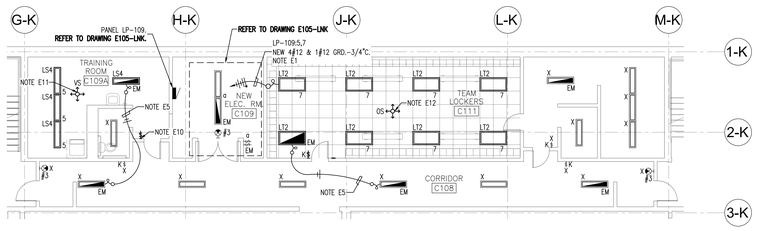
Sheet: E100-LNK



N 2 PARTIAL FIRST FLOOR DEMOLITION/REMOVAL PLAN
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

Scale: 1/8" = 1'-0"



N 3 PARTIAL FIRST FLOOR LIGHTING PLAN
1/8" = 1'-0"

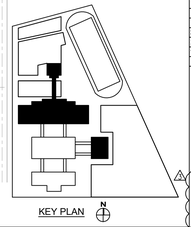
1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

Scale: 1/8" = 1'-0"

N 1 PARTIAL FIRST FLOOR ELECTRICAL PLAN
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

Scale: 1/8" = 1'-0"



NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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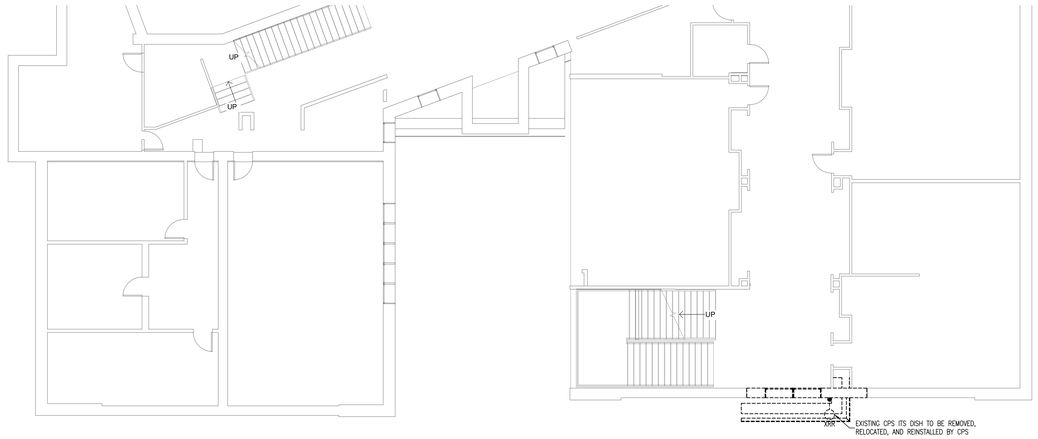
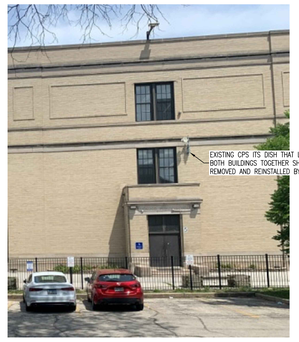
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 10311)

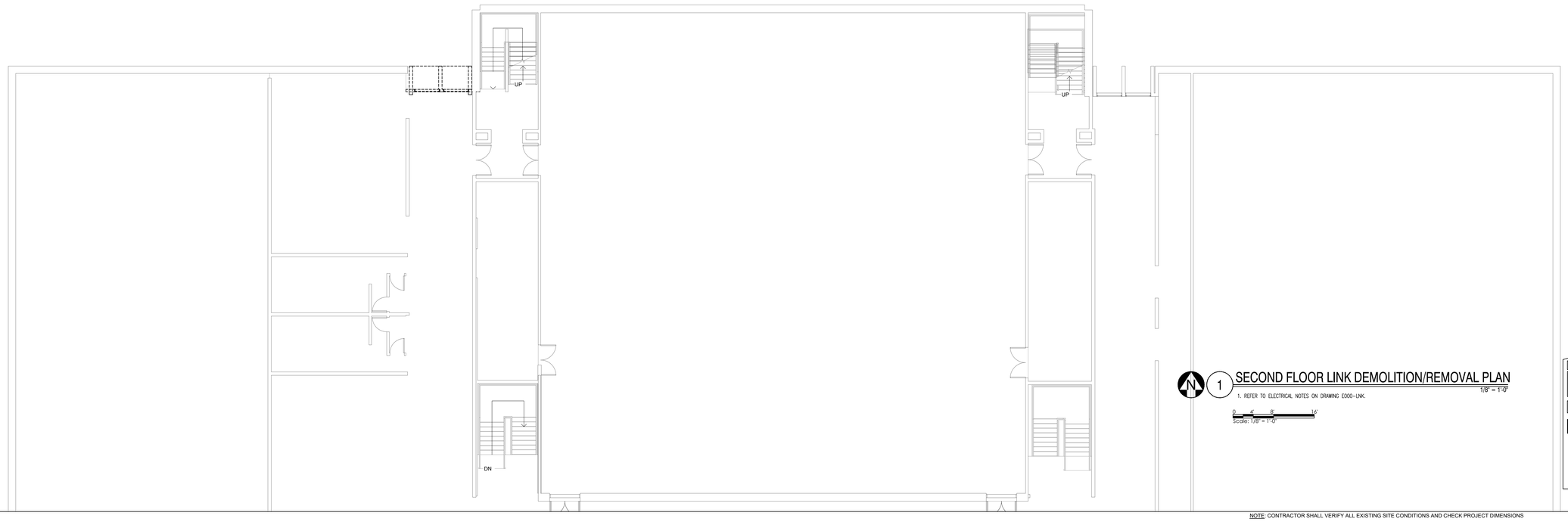
Title
ELECTRICAL
FIRST FLOOR PLANS - KENWOOD (BUILDING C)

Sheet
E101-MEP





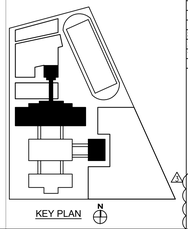
2 EXISTING CANTER BUILDING (SOUTH ELEVATION)
NOT TO SCALE



1 SECOND FLOOR LINK DEMOLITION/REMOVAL PLAN
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

SCALE: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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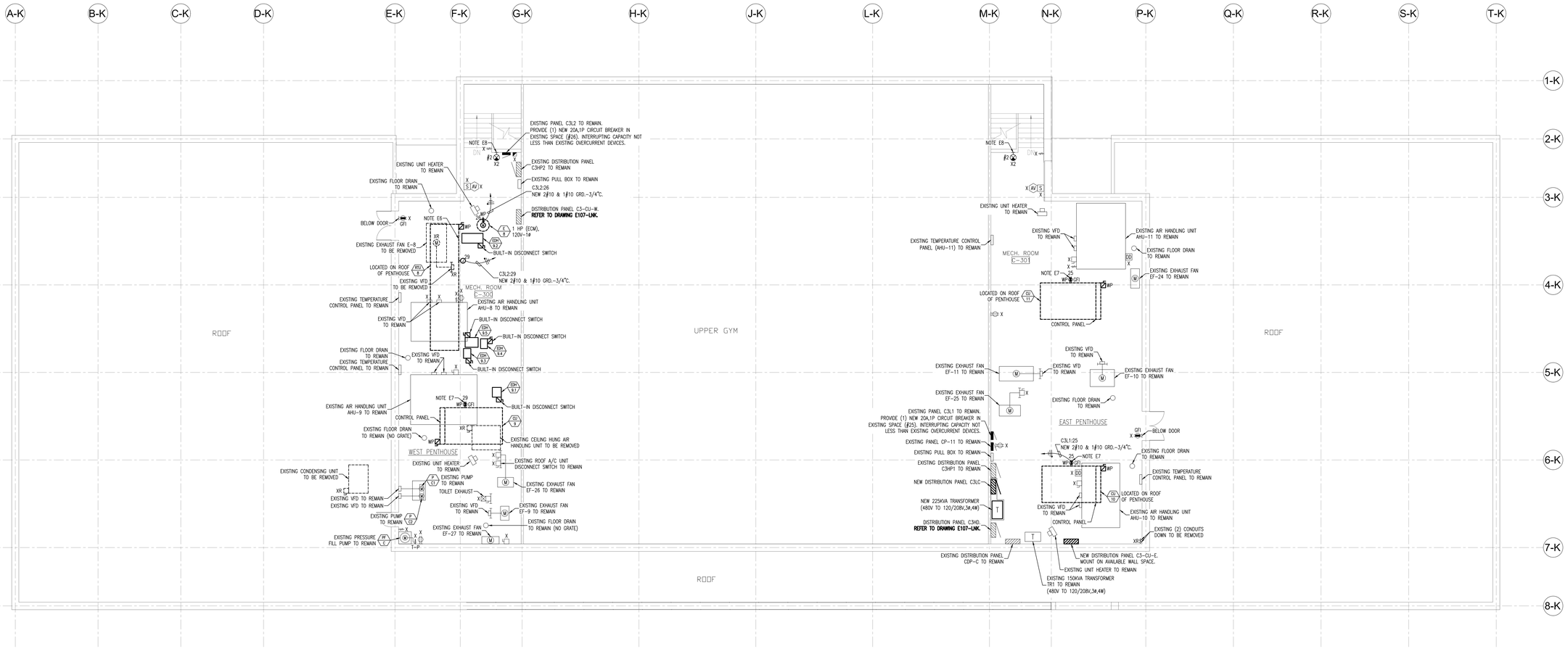
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: SECOND FLOOR LINK DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet: E102-LNK



1 ELECTRICAL PENTHOUSE PLAN - KENWOOD (BUILDING C)

1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-MEP.

Scale: 1/8" = 1'-0"

KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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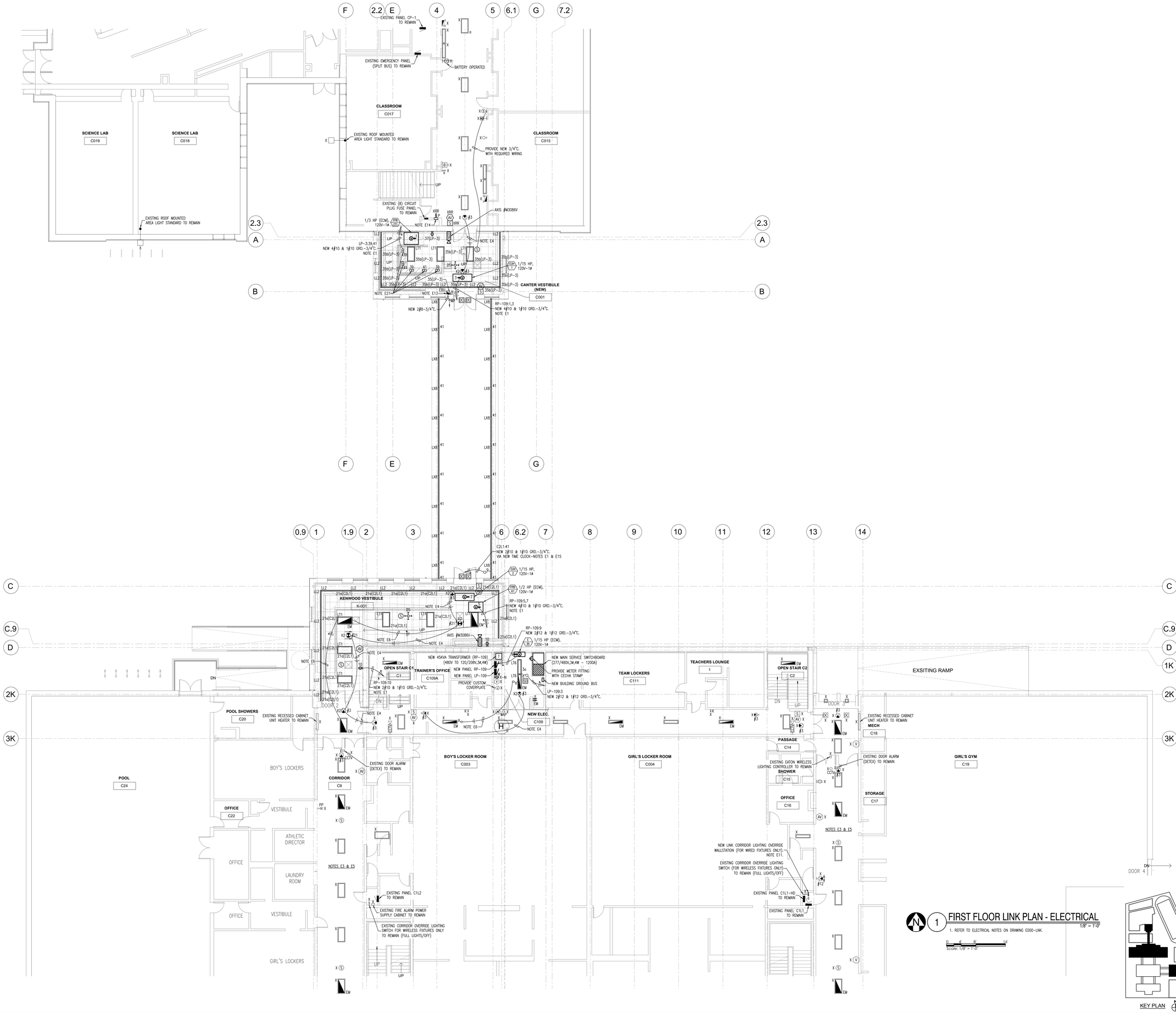
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 10311)

Title: ELECTRICAL PENTHOUSE PLAN - KENWOOD (BUILDING C)

Sheet: E103-MEP



1 FIRST FLOOR LINK PLAN - ELECTRICAL

1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

SCORE: 1/8 = 1'-0"

KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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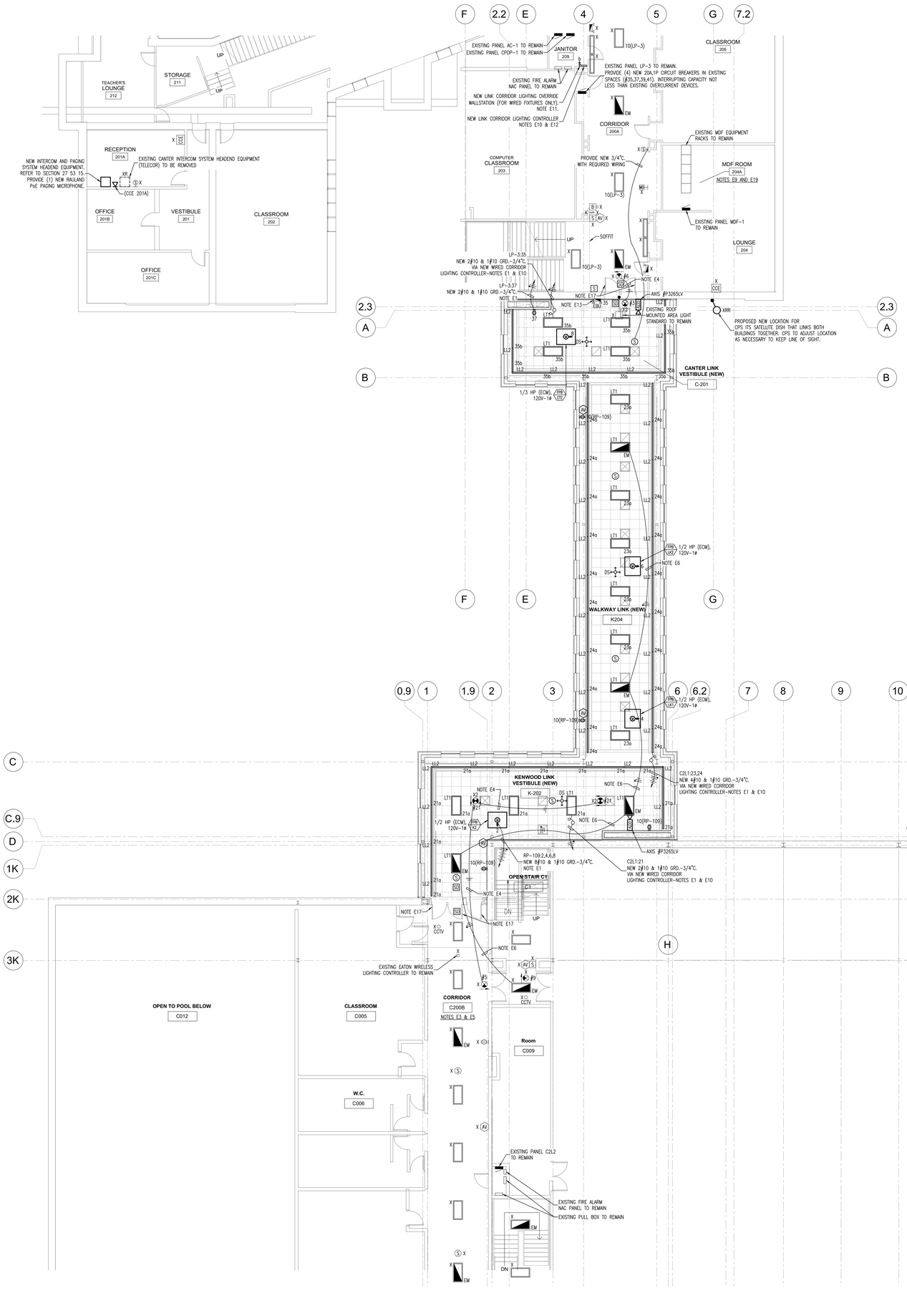
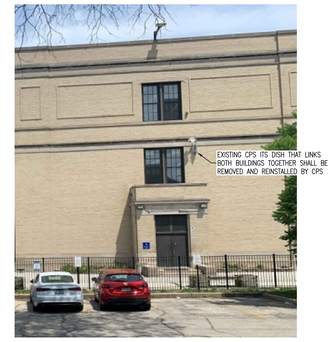
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

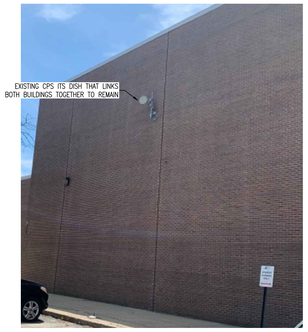
Title
FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet
E105-LNK





3 EXISTING CANTER BUILDING (SOUTH ELEVATION)
NOT TO SCALE



2 EXISTING KENWOOD PE BUILDING 'C' (NORTH ELEVATION)
NOT TO SCALE

N 1 SECOND FLOOR LINK PLAN - ELECTRICAL
1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

Scale: 1/8" = 1'-0"

KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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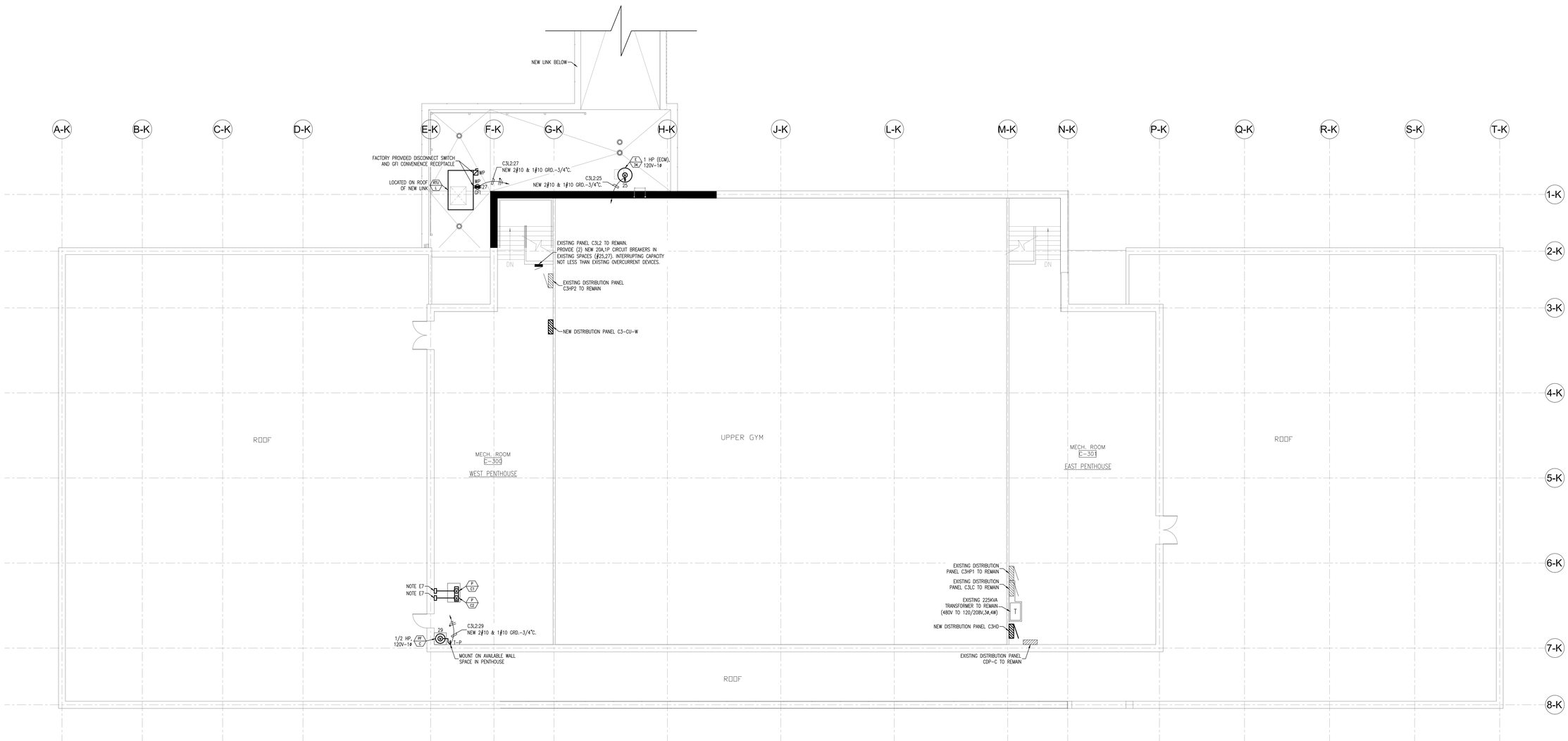
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MOM 5031)

Title
SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet
E106-LNK

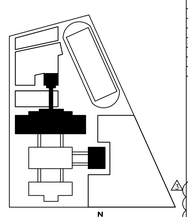


1 PENTHOUSE PLAN - ELECTRICAL

1/8" = 1'-0"

1. REFER TO ELECTRICAL NOTES ON DRAWING E000-LNK.

0 4' 8' 16'
Scale: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title: PENTHOUSE/ROOF PLAN - KENWOOD (BUILDING C)

Sheet: E107-LNK

ABBREVIATIONS LIST

ABBREVIATION	DESCRIPTION
AC	AIR COMPRESSOR
AD	AREA DRAIN
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHJ	AUTHORITY HAVING JURISDICTION
ANB	ACID NEUTRALIZING BASIN
AP	ACCESS PANEL
ARCH	ARCHITECTURE, ARCHITECTURAL
AS	AUTOMATIC SPRINKLER
ASSY	ASSEMBLY
ATM	ATMOSPHERE
AUTO	AUTOMATIC
AUX	AUXILIARY
AV	ACID VENT
AVTR	ACID VENT THRU ROOF
AW	ACID WASTE
B/W	BETWEEN
BC	BALANCING COCK OR VALVE
BFP	BACKFLOW PREVENTER
BHP	BRAKE HORSEPOWER
BOB	BOTTOM OF BEAM
BOP	BOTTOM OF PIPE
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNIT PER HOUR
BV	BUTTERFLY VALVE W/TAMPER SWITCH
BV	BALL VALVE
BWV	BACKWATER VALVE
CALC	CALCULATIONS
CAP	CAPACITY
CC	CEILING COLUMN
CCD	CHICAGO CITY DATUM
CD	CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CG	COMPOUND GAUGE
CI	CAST IRON
CLG	CEILING
CM	CENTIMETER
CO2	CARBON DIOXIDE
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CO	CLEAN OUT
CONT	CONTINUATION
CV	CHECK VALVE
CW	COLD WATER
DCV	DOUBLE CHECK VALVE
DDCV	DOUBLE DETECTOR CHECK VALVE
DF	DRINKING FOUNTAIN
DI	DUCTILE IRON
DIA	DIAMETER
DIM	DIMENSION
DER	DEIONIZED WATER RECIRCULATING
DN	DOWN
DR	DRAIN
DPV	DRY PIPE VALVE
DS	DOWNSPOUT
DV	DRAIN VALVE
DW	DISHWASHER
DWG	DRAWING
DWH	DOMESTIC WATER HEATER
E	EXISTING
EC	ELECTRICAL CONTRACTOR
EEW	EMERGENCY EYEWASH
EFF	EFFICIENCY
EL	ELEVATION
ELEC	ELECTRICAL
EQUIP	EQUIPMENT
ES	EMERGENCY SHOWER
ES/EEW	EMERGENCY SHOWER/EYEWASH
ET	EXPANSION TANK
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EXIST OR E	EXISTING
EXP	EXPANSION
FBO	FURNISHED BY OTHERS
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FIN.	FINISHED
FFE	FINISHED FLOOR ELEVATION
FIXT	FIXTURE
FLR OR FL	FLOOR
FP	FIRE PROTECTION
FPC	FIRE PUMP CONTROLLER
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FS	FLOW SWITCH, FLOOR SINK
FT	FEET
FV	FLUSH VALVE
FHYD	FIRE HYDRANT
G	NATURAL GAS
GALV	GALVANIZED
GCO	GRADE CLEANOUT
GC	GENERAL CONTRACTOR
GD	GARAGE DRAIN
GGB	GUY GRAY BOX
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GT	GREASE TRAP
GV	GATE VALVE
GW	GARAGE WASTE
GW	GREASE WASTE
GW	GLASSWASHER
H	HYDROGEN
HB	HOSE BIBB
H.PT.	HIGH POINT
HD	HEAD
HD	HUB DRAIN
HP	HORSEPOWER
HVAC	HEATING/VENTILATING/AIR CONDITIONING
HW	DOMESTIC HOT WATER
HWR	DOMESTIC HOT WATER RECIRCULATING
HYD	HYDRAULIC
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCHES
INSUL	INSULATION
ITC	INSPECTOR TEST CONNECTION
IW	INDIRECT WASTE
JC	INSULATING COUPLING
JMB	JANITOR MOP BASIN
KW	KITCHEN WASTE, KILOWATT
L	LITER
LAV	LAVATORY
LA	LAB AIR
LBS	POUNDS
LP	LOW POINT

ABBREVIATION	DESCRIPTION
LPA	LINE PRESSURE ALARM
LPG	LIQUID PROPANE GAS
LPM	LITERS PER MINUTE
LSK	LAB SINK
LV	LAB VENT
LVAC	LAB VACUUM
LW	LAUNDRY WASTE
LWH	LAB WATER HEATER
LT	LAUNDRY TRAY
MD	MAIN DRAIN
MAX	MAXIMUM
MB	MOP BASIN
MBH	1000 BRITISH THERMAL UNITS
MECH	MECHANICAL
MH	MANHOLE
MIN	MINIMUM
MINS	MINUTES
MR	MOP RECEPTOR
MVP	MEDICAL VACUUM PUMP
MM	MILLIMETER
NFWH	NON-FREEZE WALL HYDRANT
N&C	NIPPLE AND CAP
N/A	NOT APPLICABLE
NB	NEUTRALIZING BASIN
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NPW	NON POTABLE WATER
NS	NOT SPRINKLERED
NTS	NOT TO SCALE
OD	OVERFLOW DRAIN OR OUTSIDE DIAMETER
OBV	OIL BASIN VENT
OHD	OPEN HUB DRAIN
OS & Y	OUTSIDE SCREW AND YOKE
OSD	OPEN SITE DRAIN
OST	OVERFLOW STORM WATER
OW	OIL WASTE
PBV	PRESSURE BALANCING VALVE
PC	PLUMBING CONTRACTOR
PD	PUMP DISCHARGE, PLANTER DRAIN
PG	PRESSURE GAUGE
PH	PENTHOUSE, PHASE
PIV	POST INDICATOR VALVE
PKG	PACKAGE
PLBG	PLUMBING
POC	POINT OF CONNECTION
PPM	PARTS PER MILLION
PP	PLUMBING PUMP
PRESS	PRESSURE
PRV	PRESSURE REDUCING VALVE
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PS	PLUMBING STACK
QTY	QUANTITY
RD	ROOF DRAIN
RO	REVERSE OSMOSIS, ROD OUT BASIN
ROR	REVERSE OSMOSIS RETURN
RPBP	REDUCED PRESSURE BACKFLOW PREVENTER
RPM	REVOLUTIONS PER MINUTE
RP	RECIRCULATING PUMP
S	VACUUM BOTTLE SLIDE
S OR SAN	SANITARY
SCSK	SCRUB SINK
SCV	SECTIONAL CONTROL VALVE W/TAMPER SWITCH
SD	SHOWER DRAIN
SE	SEWAGE EJECTOR
SF	SQUARE FEET
SH	SHOWER
SK	SINK
SL	SLOPE
SLSK	SLOP SINK
SP	SUMP PUMP
SP	STANDPIPE
SS	SERVICE SINK
SSD	SUB SOIL DRAINAGE
SSK	SCULLERY SINK
ST	STORM WATER
SUB	SUBCONTRACTOR
SYS	SYSTEM
SW	STORM WATER (FROM DETENTION TANK)
TB	THRUST BLOCK
TD	TRENCH DRAIN
T&P	TEMPERATURE AND PRESSURE
TEMP	TEMPERATURE
THERM OR T	THERMOMETER
TOB	TRIPLE OIL BASIN
TMV	THERMOSTATIC MIXING VALVE
TS	TAMPER SWITCH
TW	TEMPERED WATER
TYP	TYPICAL
UG	UNDERGROUND
UNO	UNLESS NOTED OTHERWISE
UR	URINAL
V	VENT
VAC	VACUUM
VACC	VACUUM CLEANING
VACV	VACUUM VENT
VB	VACUUM BREAKER
VIF	VERIFY IN FIELD
VEL	VELOCITY
VERT	VERTICAL
VTR	VENT THROUGH ROOF
W	WASTE
WBN	WASHBASIN
W/O	WITHOUT
WCO	WALL CLEANOUT
WC	WATER CLOSET
WIP	WALL INDICATOR POST
WF	WATER FILTER
WFS	WATER FLOW SWITCH
WFN	WASH FOUNTAIN
WM	WATER METER
WH	WATER HEATER
WH	WALL HYDRANT
WHA	WATER HAMMER ARRESTOR
WSB	WASHER SUPPLY BOX
ZVB	ZONE VALVE BOX
(X)	FIXTURE OR EQUIPMENT TO BE REMOVE

SYMBOLS LIST

SYMBOL	DESCRIPTION
	SUSPENDED PIPING
SAN / OR S	SANITARY
ST	STORM
KW	KITCHEN WASTE
LW	LAUNDRY WASTE
IW	INDIRECT WASTE
CD	CONDENSATE DRAIN
CW	DOMESTIC COLD WATER
OR HW	DOMESTIC HOT WATER SUPPLY
HWR	DOMESTIC HOT WATER RECIRCULATING
V / OR	SANITARY VENT
AV	ACID VENT
	NEW PIPING
(E)	EXISTING PIPE/EQUIPMENT TO REMAIN
(E)	EXISTING PIPE/EQUIPMENT TO BE REMOVED
	EXISTING PIPE/EQUIPMENT TO BE ABANDONED
	POINT OF NEW CONNECTION TO EXISTING
	BALL VALVE
	BALL VALVE ON VERTICAL
	GENERAL OR GATE VALVE (SEE SPECIFICATIONS FOR TYPE)
	OS & Y GATE VALVE
	CHECK VALVE
	TERMINAL VALVE
	CHECK VALVE ON VERTICAL
	COMBINATION OF BALANCING VALVE (SEE SPECIFICATIONS FOR TYPE), SHUT-OFF VALVE, AND CHECK VALVE
	GAS COCK
	PRESSURE AND TEMPERATURE RELIEF VALVE
	BUTTERFLY VALVE WITH TAMPER SWITCH
RPBP	REDUCED PRESSURE BACKFLOW PREVENTER ASSEMBLY
	PRESSURE REDUCING VALVE
	PRESSURE REDUCING VALVE STATION
	3-WAY VALVE (THERMOSTATIC MIXING VALVE)
	STRAINER (SEE SPECIFICATIONS FOR TYPE)
	FLOAT OPERATED VALVE
	PLUG VALVE
	SOLENOID VALVE
	ANGLE VALVE
	AIR CHAMBER
	AIR VENT OR VTR
	BRANCH-TOP CONNECTION
	BRANCH-BOTTOM CONNECTION
	BRANCH-SIDE CONNECTION
	RISER DOWN (ELBOW)
	RISER UP (ELBOW)
	WASTE PIPE WITH TRAP
GCO	GROUND CLEAN OUT
PITCH	PITCHES DOWN OR UP IN DIRECTION OF ARROW
	PLUG OR CAP PIPE
	REDUCER
WHA	WATER HAMMER ARRESTER
	PRESSURE GAUGE
	THERMOMETER
HB-#	HOSE BIBB (SEE SPECIFICATIONS FOR TYPE)
NFWH-#	NON-FREEZE WALL HYDRANT (SEE SPECIFICATIONS FOR TYPE)
NFPH-#	NON-FREEZE POST HYDRANT
DH-#	DECK HYDRANT
FCO	FLOOR CLEANOUT
	SUSPENDED CLEANOUT
	WALL CLEANOUT

SYMBOL	DESCRIPTION
SB-#	SETTLING BASIN
SE-#	SEWAGE BASIN W/SELF PRIMING PIPING
SP-#	SUMP PUMP
RD	ROD-OUT BASIN
	EXTERIOR WALL SLEEVE
	INTERIOR WALL SLEEVE/BEAM PENETRATION
	UNION
	PIPE ANCHOR
	ALIGNMENT GUIDE
EJ	EXPANSION JOINT
	FLEXIBLE CONNECTION
BWV	BACK WATER VALVE
M / OR	WATER METER
ANB	ACID NEUTRALIZING BASIN
	EXPANSION LOOP
	CAPPED PIPE
	BLIND FLANGE
	FLOW DIRECTION OF ARROW
	ELECTRICAL HEAT TRACED PIPING
VTR (AVTR)	DROP AT ANGLE
	VENT THRU ROOF OR ACID VENT THRU ROOF
	SHOCK ABSORBER
	PRESSURE SWITCH
P	PLUMBING RISER OR STACK DESIGNATION
D/S	DOWNSPOUT OR RAIN LEADER DESIGNATION
1 / P1.1	DETAIL NUMBER / DRAWING NUMBER
A / B	EQUIPMENT DESIGNATION A – TYPE OF EQUIPMENT B – TAG NUMBER
#	KEYNOTE TAG
#	KEYNOTE TAG

FIXTURE SYMBOLS

SYMBOL	DESCRIPTION
WC-#	WATER CLOSET (TYPE INDICATED)
UR-#	URINAL (TYPE INDICATED)
LAV-#	LAVATORY (TYPE INDICATED)
EWC-#	ELECTRIC WATER COOLER (TYPE INDICATED)
DF-#	DRINKING FOUNTAIN (TYPE INDICATED)
SS-#	SCULLERY SINK (TYPE INDICATED)
MB-#	MOP BASIN (TYPE INDICATED)
SH-#	SHOWER (TYPE INDICATED)
SK-#	SINK (TYPE INDICATED)
FD-#	FLOOR DRAIN (TYPE INDICATED)
FS-#	FLOOR SINK (TYPE INDICATED)
AD-#	AREA DRAIN (TYPE INDICATED)

NOTES: 1. THIS IS A GENERAL SYMBOL LIST THEREFORE SOME ITEMS MAY NOT DIRECTLY APPLY TO THIS PROJECT AND DRAWINGS.
2. EXISTING PIPING SHOWN WITH THIN LINE WEIGHT. NEW PIPING SHOWN WITH THICK LINE WEIGHT.
3. DISREGARD SYMBOLS AND ABBREVIATIONS WHICH DO NOT APPLY TO THIS PROJECT.
4. THIS IS A GENERAL ABBREVIATION LIST THEREFORE SOME ITEMS MAY NOT DIRECTLY APPLY TO THIS PROJECT AND RELATED DRAWINGS.

PLUMBING GENERAL NOTES

1. GENERAL NOTES INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS SHALL BE CONSIDERED A PART OF THE CONTRACT.

2. PROVIDE ALL LABOR AND MATERIALS, EQUIPMENT, FACILITIES, TRANSPORTATION AND SERVICES NECESSARY TO FURNISH, INSTALL AND COMPLETE THE SCOPE OF WORK AS INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS. THE WORKMANSHIP SHALL BE COMPLETE IN EVERY RESPECT, BE TESTED AND APPROVED, AND BE SATISFACTORY TO THE ARCHITECT, ENGINEER AND OWNER, AND IN ACCORDANCE WITH LOCAL COUNTY AND STATE LAWS GOVERNING THIS INSTALLATION, INCLUDING THE FIRE MARSHALL.

3. ALL PLUMBING WORK SUPPLIED BY THIS CONTRACTOR SHALL BE IN COMPLIANCE WITH THE 2019 BUILDING CODE OF THE CITY OF CHICAGO AND OTHER LOCAL AUTHORITIES HAVING JURISDICTION.

4. CONTRACTOR SHALL INSTALL ALL EQUIPMENT AND MATERIAL IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS.

5. CONTRACTOR SHALL PROVIDE FIRESTOPPING AROUND ALL WALL AND FLOOR PENETRATIONS AS REQUIRED TO MAINTAIN THE RATING OF WALLS AND FLOORS. ALL HOLES THROUGH FLOORS SHALL BE CAULKED AND SEALED AIR AND WATERTIGHT TO RESTRICT THE PASSAGE OF SMOKE, SOUND OR FLAMES.

6. WHERE DRAWINGS, SPECIFICATIONS, AND NOTES CONFLICT WITH ONE ANOTHER THE CONTRACTOR SHALL IMMEDIATELY ADVISE THE ENGINEER OF SUCH CONFLICTS. FOR PURPOSES OF BIDDING, AND PENDING UPON WRITTEN RECEIPT OF ANY DIRECTION TO THE CONTRARY, THE CONTRACTOR SHALL INCLUDE IN HIS PROPOSAL THE MORE EXPENSIVE ALTERNATE DESCRIBED.

7. ALL CUTTING, PATCHING, REPAIRING, REPLACEMENT, PAINTING, AND REFINISHING OF EXISTING BUILDING MATERIALS AS REQUIRED TO ACCOMMODATE INSTALLATION OF NEW WORK AND/OR DEMOLITION IN ALL AREAS OF THE BUILDING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR WHOSE SPECIFIC WORK IS INVOLVED. ALL PATCHING, REPAIRING, REPLACEMENT, PAINTING, REFINISHING, AND CAULKING SHALL MATCH THE EXISTING CONSTRUCTION AS NEARLY AS POSSIBLE.

8. ALL WORK PERFORMED BY THIS CONTRACTOR, INCLUDING ALL NECESSARY CUTTING OR DRILLING OPERATIONS, SHALL BE PERFORMED SO AS TO CAUSE A MINIMUM OF INTERFERENCE TO BUILDING OPERATIONS. ANY INTERRUPTION OF FIRE ALARM SYSTEM FUNCTIONS SHALL NOT BE PERMITTED WITHOUT NOTIFICATION AND PERMISSION.

9. BUILDING SYSTEMS OPERATIONS AND UTILITY SERVICES SHALL CONTINUE IN SERVICE WITHOUT INTERRUPTION. ANY MANDATORY INTERRUPTION OF ANY SERVICE OR UTILITIES SHALL BE ARRANGED WITH THE OWNER'S ENGINEER. CONTRACTOR SHALL INFORM THE OWNER'S ENGINEER 10 DAYS IN ADVANCE PRIOR TO ANY BUILDINGS SERVICE INTERRUPTION. ANY ADDITIONAL EXPENSE RESULTING FROM TEMPORARY SERVICE INTERRUPTIONS SHALL BE PAID BY THE CONTRACTOR.

10. NOT IN USE

11. CONNECTIONS OF NEW PIPING TO EXISTING SHALL UTILIZE CITY OF CHICAGO APPROVED METHODS AND FITTINGS. IN ALL CASES WHERE COPPER PIPE CONNECTIONS ARE MADE TO PIPING OR AN ITEM OF DISSIMILAR METAL, PROVIDE DIELECTRIC FITTINGS.

12. IN INSTANCES WHERE EXISTING PIPING INSULATION AT CONNECTION POINTS OR EXISTING AREAS IS DAMAGED DUE TO NEW WORK, THIS CONTRACTOR SHALL REPLACE SAME TO THE SATISFACTION OF THE OWNER AS SPECIFIED FOR NEW WORK.

13. PROTECT EXISTING BUILDING STRUCTURE AND GROUNDS FROM ANY DAMAGE WHICH MAY OCCUR DURING INSTALLATION OF NEW WORK. ANY DAMAGE TO EXISTING FACILITIES SHALL BE REPAIRED, REPLACED OR RESTORED TO THE ORIGINAL CONDITION AND SATISFACTION OF THE OWNER.

14. THIS CONTRACTOR SHALL VERIFY WITH BUILDING ENGINEER IF PLUMBING FIXTURES SHOULD BE SALVAGED. BUILDING ENGINEER HAS FIRST CHOICE FOR SALVAGED ITEMS.

15. ITEMS REJECTED BY THE OWNER SHALL BE DISPOSED OF IN A LEGAL MANNER IN ACCORDANCE WITH LOCAL AUTHORITIES.

16. ALL EQUIPMENT SHALL BE CLEANED AND ADJUSTED AS REQUIRED TO OPERATE SATISFACTORILY AND WITNESSED BY BUILDING PERSONNEL.

17. ALL PENETRATIONS THROUGH FIRE RATED FLOORS AND WALLS SHALL BE MADE FIRE SAFE IN COMPLIANCE WITH THE 2021 CITY OF CHICAGO BUILDING CODE. RATING SHALL MEET OR EXCEED RATING OF FLOOR OR WALL.

18. NOT IN USE

19. THIS CONTRACTOR SHALL VERIFY ALL PIPING CONNECTIONS TO BE PROPERLY INSTALLED AND CONNECTED IN OPERATING MANNER FOR ITS INTENDED PURPOSE.

20. THIS CONTRACTOR SHALL FURNISH, INSTALL AND CONNECT ALL EQUIPMENT IN ACCORDANCE WITH 2021 CHICAGO BUILDING CODE. AFTER EACH WORK DAY, CONTRACTOR SHALL CLEAN ALL WORK AREAS AND REMOVE ALL DEBRIS.

21. NOT IN USE

22. THIS CONTRACTOR SHALL VERIFY EXISTING STRUCTURAL CONDITIONS PRIOR TO FLOOR CORING AND WALL CUTTING TO AVOID ANY CONFLICTS.

23. ALL WALL OR CEILING PATCHING SHALL BE AT THE EXPENSE OF THE CONTRACTOR WHOSE WORK IS BEING INSTALLED. INSTALLATION OF THE FLOOR COVERING SHALL BE BY THE GENERAL CONTRACTOR.

24. ANY PIPING THAT IS BEING ABATED AND REMAINING SHALL BE REINSULATED PER THE CONTRACT DOCUMENTS WITH NO EXCEPTIONS.

GENERAL PLUMBING DEMOLITION NOTES

1. DEMOLITION INFORMATION SHOWN ON THE CONTRACT DOCUMENTS IS INTENDED TO BE SCHEMATIC IN NATURE AND MAY NOT ILLUSTRATE ALL MISCELLANEOUS WORK NECESSARY TO COMPLETE THE DEMOLITION AND NEW WORK. REFER TO ARCHITECTURAL DRAWINGS FOR INTENT OF FINAL CONSTRUCTION.

2. DEMOLITION INFORMATION SHOWN ON THE CONTRACT DOCUMENTS IS BASED ON A CURSORY REVIEW OF THE EXISTING CONDITIONS. THE CONTRACTOR SHALL VISIT THE SITE AND EXAMINE EXISTING CONDITIONS PRIOR TO SUBMITTING A BID. THE CONTRACTOR SHALL NOTIFY THE ARCHITECT AND/OR ENGINEER OF ANY DISCREPANCIES BETWEEN THE PLANS AND ACTUAL FIELD CONDITIONS.

3. THE DEMOLITION SCOPE OF WORK SHALL INCLUDE PATCHING OF ALL HOLES LEFT BY THE DEMOLITION WORK ON EXPOSED SURFACES TO MATCH EXISTING.

4. THIS CONTRACTOR SHALL NOTIFY THE CONSTRUCTION MANAGER OF ANY DANGEROUS OR NON-CONFORMING CONDITIONS PRIOR TO PROCEEDING. EXISTING CONDITIONS SHOWN ARE CORRECT TO THE BEST KNOWLEDGE OF THE ARCHITECT/ENGINEER. IF ACTUAL CONDITIONS VARY, NOTIFY THE ARCHITECT IMMEDIATELY BEFORE PROCEEDING IN AFFECTED AREAS. WHERE EXISTING UTILITIES SHOWN ARE REQUIRED TO BE CAPPED, REMOVED, OR ALTERED, WORK SHALL COMPLY WITH THE APPLICABLE REQUIREMENTS OF THE PUBLIC UTILITY COMPANIES AND GOVERNMENTAL DEPARTMENTS. APPROPRIATE AUTHORITIES/AGENCIES SHALL BE NOTIFIED PRIOR TO BEGINNING ANY WORK.

5. THIS CONTRACTOR IS RESPONSIBLE FOR CLEAN UP AND REMOVAL FROM THE SITE OF ALL CONSTRUCTION DEBRIS, SALVAGE MATERIAL, ETC., ON A DAILY BASIS AND AT THE COMPLETION OF THE WORK. ANY OF SAID MATERIALS, DEVICES, OR EQUIPMENT THAT THE OWNER REQUESTS TO BE RETAINED SHALL BE RELOCATED TO AN AREA DESIGNATED BY THE OWNER.

6. REFER TO ARCHITECTURAL DRAWINGS FOR ADDITIONAL PLUMBING DEMOLITION/REMOVAL WORK AND FINISHING REQUIREMENTS.

7. PERFORM ALL CUTTING, CORING, AND PATCHING REQUIRED TO COMPLETE THE WORK. PERFORM ALL DEMOLITION AND REMOVAL OF DEBRIS RESULTING THEREFROM AND REQUIRED TO COMPLETE THE WORK. PATCH AND PAINT EXISTING FINISHED SURFACES AND BUILDING COMPONENTS USING NEW MATERIALS TO MATCH EXISTING TEXTURE AND THICKNESS USING EXPERIENCED INSTALLERS. RESTORE TO ORIGINAL CONDITION AFTER INSTALLATION.

8. PROTECT ALL EXISTING PIPING, EQUIPMENT, AND FIXTURES TO REMAIN DURING DEMOLITION AND NEW WORK CONSTRUCTION PERIOD.

9. ALL EQUIPMENT AND MATERIALS SHALL BE REMOVED FROM THE PREMISES. MATERIALS AND EQUIPMENT BECOMES THE PROPERTY OF THE CONTRACTOR AND SHALL BE LEGALLY DISPOSED OF.

10. PROVIDE SAFEGUARDS, INCLUDING WARNING SIGNS, BARRICADES, TEMPORARY FENCES, WARNING LIGHTS, AND OTHER SIMILAR ITEMS THAT ARE REQUIRED FOR PROTECTION OF ALL PERSONNEL DURING DEMOLITION AND REMOVAL OPERATIONS.

11. SEQUENCE OF ALL DEMOLITION WORK SHALL BE IN STRICT ACCORDANCE WITH THE SPECIFICATIONS, DRAWINGS, AND/OR AS DIRECTED BY THE CONSTRUCTION MANAGER.

12. THE CONTRACTOR SHALL BE HELD RESPONSIBLE FOR ANY DAMAGE CAUSED TO EXISTING INSTALLATIONS NOT PERTINENT TO THE CONTRACT. THE COST OF REPAIRS TO SUCH DAMAGED WORK SHALL BE CHARGED AGAINST THE CONTRACTOR.

13. PROVIDE ALL CUTTING, CORING, PATCHING, AND FIRE SEALING AS REQUIRED FOR DEMOLITION WORK.

14. PLUMBING DEMOLITION WORK SHALL INCLUDE PIPING, EQUIPMENT, VALVES, AND OTHER ACCESSORIES, ETC. IN SUPPORT OF HVAC EQUIPMENT BEING REMOVED.

15. CONTRACTOR SHALL COMPLY WITH ALL STATE, COUNTY, AND CITY PLUMBING CODES, RULES, REGULATIONS, AND ORDINANCES HAVING JURISDICTION OVER THE DEMOLITION WORK INDICATED.

16. CONTRACTOR SHALL FIELD VERIFY EXACT PIPE LOCATIONS, SIZES, AND FIXTURE LOCATIONS.

17. ALL WORK SHALL BE PHASED TO MINIMIZE DISRUPTION OF ALL EXISTING FACILITY OPERATIONS. PROVIDE TEMPORARY PIPE CAPS AND CONNECTIONS AS REQUIRED TO MAINTAIN OPERATION OF EXISTING PLUMBING SYSTEMS. SHUTDOWN OF EXISTING SERVICES SHALL BE COORDINATED WITH THE OWNER AND SHALL OCCUR AT SUCH A TIME AS IS CONVENIENT FOR THE OWNER.

18. WHERE DEMOLITION OF FIXTURE AND REMOVAL OF PIPING OR OTHER ACCESSORY LEAVES AN OPENING IN THE FLOOR, WALL, OR CEILING, THE SAME SHALL BE PATCHED TO MATCH EXISTING ADJACENT SURFACE(S).

19. CONTRACTOR SHALL PROTECT ALL EXISTING BUILDING COMPONENTS FROM DAMAGE AT ALL TIMES. DAMAGE TO EXISTING BUILDING COMPONENTS RESULTING FROM DEMOLITION OR CONSTRUCTION WORK BEING PERFORMED SHALL BE REMEDIED AT THIS CONTRACTOR'S EXPENSE.

PLUMBING PIPING MATERIAL

SANITARY WASTE, VENT, AND STORM WATER PIPING

A. ABOVEGROUND, SOIL AND WASTE PIPING NPS 3" AND SMALLER SHALL BE ANY OF THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.
2. COPPER TUBE, COPPER DRAINAGE FITTINGS, AND SOLDERED JOINTS.

B. ABOVEGROUND, SOIL WASTE, AND STORM WATER PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.

C. ABOVEGROUND, VENT PIPING NPS 3" AND SMALLER SHALL BE ANY OF THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.
2. COPPER TUBE, COPPER DRAINAGE FITTINGS, AND SOLDERED JOINTS.

D. ABOVEGROUND, VENT PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.

E. UNDERGROUND, SOIL WASTE, VENT, AND STORM WATER PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS EXTRA-HEAVY (WHERE REQUIRED TO CONNECT TO EXISTING), CAST-IRON SOIL PIPING; GASKETS; AND GASKETED JOINTS.

DOMESTIC WATER PIPING

A. DOMESTIC WATER PIPING ON SERVICE SIDE OF WATER METER INSIDE THE BUILDING: USE THE FOLLOWING PIPING MATERIALS FOR EACH SIZE RANGE:

1. NPS 4" AND SMALLER: HARD COPPER TUBE, TYPE K; COPPER PRESSURE FITTINGS; AND SOLDERED JOINTS.
2. NPS 4" AND LARGER: STEEL PIPE; GRAY-IRON, THREADED FITTINGS; AND THREADED JOINTS.

B. ABOVEGROUND DOMESTIC WATER PIPING: USE THE FOLLOWING PIPING MATERIALS FOR EACH SIZE RANGE:

1. NPS 3" AND SMALLER: HARD COPPER TUBE, TYPE L; COPPER PRESSURE FITTINGS; AND SOLDERED JOINTS.
2. NPS 4" TO NPS 6": STEEL PIPE; GRAY-IRON, THREADED FITTINGS; AND THREADED JOINTS.

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION OF CHICAGO

Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
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CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCM 1031)

Title
PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS

Sheet
P000-LNK

ABBREVIATIONS LIST

ABBREVIATION	DESCRIPTION
AC	AIR COMPRESSOR
AD	AREA DRAIN
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHJ	AUTHORITY HAVING JURISDICTION
ANB	ACID NEUTRALIZING BASIN
AP	ACCESS PANEL
ARCH	ARCHITECTURE, ARCHITECTURAL
AS	AUTOMATIC SPRINKLER
ASSY	ASSEMBLY
ATM	ATMOSPHERE
AUTO	AUTOMATIC
AUX	AUXILIARY
AV	ACID VENT
AVTR	ACID VENT THRU ROOF
AW	ACID WASTE
B/W	BETWEEN
BC	BALANCING COCK OR VALVE
BFP	BACKFLOW PREVENTER
BHP	BRAKE HORSEPOWER
BOB	BOTTOM OF BEAM
BOP	BOTTOM OF PIPE
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNIT PER HOUR
BV	BUTTERFLY VALVE W/TAMPER SWITCH
BV	BALL VALVE
BWV	BACKWATER VALVE
CALC	CALCULATIONS
CAP	CAPACITY
CC	CEILING COLUMN
CCD	CHICAGO CITY DATUM
CD	CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CG	COMPOUND GAUGE
CI	CAST IRON
CLG	CEILING
CM	CENTIMETER
CO2	CARBON DIOXIDE
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CO	CLEAN OUT
CONT	CONTINUATION
CV	CHECK VALVE
CW	COLD WATER
DCV	DOUBLE CHECK VALVE
DDCV	DOUBLE DETECTOR CHECK VALVE
DF	DRINKING FOUNTAIN
DI	DUCTILE IRON
DIA	DIAMETER
DIM	DIMENSION
DER	DEIONIZED WATER RECIRCULATING
DN	DOWN
DR	DRAIN
DPV	DRY PIPE VALVE
DS	DOWNSPOUT
DV	DRAIN VALVE
DW	DISHWASHER
DWG	DRAWING
DWH	DOMESTIC WATER HEATER
E	EXISTING
EC	ELECTRICAL CONTRACTOR
EEW	EMERGENCY EYEWASH
EFF	EFFICIENCY
EL	ELEVATION
ELEC	ELECTRICAL
EQUIP	EQUIPMENT
ES	EMERGENCY SHOWER
ES/EEW	EMERGENCY SHOWER/EYEWASH
ET	EXPANSION TANK
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EXIST OR E	EXISTING
EXP	EXPANSION
FBO	FURNISHED BY OTHERS
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FIN.	FINISHED
FFE	FINISHED FLOOR ELEVATION
FIXT	FIXTURE
FLR OR FL	FLOOR
FP	FIRE PROTECTION
FPC	FIRE PUMP CONTROLLER
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FS	FLOW SWITCH, FLOOR SINK
FT	FEET
FV	FLUSH VALVE
FHYD	FIRE HYDRANT
G	NATURAL GAS
GALV	GALVANIZED
GCO	GRADE CLEANOUT
GC	GENERAL CONTRACTOR
GD	GARAGE DRAIN
GGB	GUY GRAY BOX
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GT	GREASE TRAP
GV	GATE VALVE
GW	GARAGE WASTE
GW	GREASE WASTE
GW	GLASSWASHER
H	HYDROGEN
HB	HOSE BIBB
H.PT.	HIGH POINT
HD	HEAD
HD	HUB DRAIN
HP	HORSEPOWER
HVAC	HEATING/VENTILATING/AIR CONDITIONING
HW	DOMESTIC HOT WATER
HWR	DOMESTIC HOT WATER RECIRCULATING
HYD	HYDRAULIC
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCHES
INSUL	INSULATION
ITC	INSPECTOR TEST CONNECTION
IW	INDIRECT WASTE
IC	INSULATING COUPLING
JMB	JANITOR MOP BASIN
KW	KITCHEN WASTE, KILOWATT
L	LITER
LAV	LAVATORY
LA	LAB AIR
LBS	POUNDS
LP	LOW POINT

ABBREVIATION	DESCRIPTION
LPA	LINE PRESSURE ALARM
LPG	LIQUID PROPANE GAS
LPM	LITERS PER MINUTE
LSK	LAB SINK
LV	LAB VENT
LVAC	LAB VACUUM
LW	LAUNDRY WASTE
LWH	LAB WATER HEATER
LT	LAUNDRY TRAY
MD	MAIN DRAIN
MAX	MAXIMUM
MB	MOP BASIN
MBH	1000 BRITISH THERMAL UNITS
MECH	MECHANICAL
MH	MANHOLE
MIN	MINIMUM
MINS	MINUTES
MR	MOP RECEPTOR
MVP	MEDICAL VACUUM PUMP
MM	MILLIMETER
NFWH	NON-FREEZE WALL HYDRANT
N&C	NIPPLE AND CAP
N/A	NOT APPLICABLE
NB	NEUTRALIZING BASIN
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NPW	NON POTABLE WATER
NS	NOT SPRINKLERED
NTS	NOT TO SCALE
OD	OVERFLOW DRAIN OR OUTSIDE DIAMETER
OBV	OIL BASIN VENT
OHD	OPEN HUB DRAIN
OS & Y	OUTSIDE SCREW AND YOKE
OSD	OPEN SITE DRAIN
OST	OVERFLOW STORM WATER
OW	OIL WASTE
PBV	PRESSURE BALANCING VALVE
PC	PLUMBING CONTRACTOR
PD	PUMP DISCHARGE, PLANTER DRAIN
PG	PRESSURE GAUGE
PH	PENTHOUSE, PHASE
PIV	POST INDICATOR VALVE
PKG	PACKAGE
PLBG	PLUMBING
POC	POINT OF CONNECTION
PPM	PARTS PER MILLION
PP	PLUMBING PUMP
PRESS	PRESSURE
PRV	PRESSURE REDUCING VALVE
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAUGE
PS	PLUMBING STACK
QTY	QUANTITY
RD	ROOF DRAIN
RO	REVERSE OSMOSIS, ROD OUT BASIN
ROR	REVERSE OSMOSIS RETURN
RPBP	REDUCED PRESSURE BACKFLOW PREVENTER
RPM	REVOLUTIONS PER MINUTE
RP	RECIRCULATING PUMP
S	VACUUM BOTTLE SLIDE
S, OR SAN	SANITARY
SCSK	SCRUB SINK
SCV	SECTIONAL CONTROL VALVE W/TAMPER SWITCH
SD	SHOWER DRAIN
SE	SEWAGE EJECTOR
SF	SQUARE FEET
SH	SHOWER
SK	SINK
SL	SLOPE
SLSK	SLOP SINK
SP	SUMP PUMP
SP	STANDPIPE
SS	SERVICE SINK
SSD	SUB SOIL DRAINAGE
SSK	SCULLERY SINK
ST	STORM WATER
SUB	SUBCONTRACTOR
SYS	SYSTEM
SW	STORM WATER (FROM DETENTION TANK)
TB	THRUST BLOCK
TD	TRENCH DRAIN
T&P	TEMPERATURE AND PRESSURE
TEMP	TEMPERATURE
THERM OR T	THERMOMETER
TOB	TRIPLE OIL BASIN
TMV	THERMOSTATIC MIXING VALVE
TS	TAMPER SWITCH
TW	TEMPERED WATER
TYP	TYPICAL
UG	UNDERGROUND
UNO	UNLESS NOTED OTHERWISE
UR	URINAL
V	VENT
VAC	VACUUM
VACC	VACUUM CLEANING
VACV	VACUUM VENT
VB	VACUUM BREAKER
VIF	VERIFY IN FIELD
VEL	VELOCITY
VERT	VERTICAL
VTR	VENT THROUGH ROOF
W	WASTE
WBN	WASHBASIN
W/O	WITHOUT
WCO	WALL CLEANOUT
WC	WATER CLOSET
WIP	WALL INDICATOR POST
WF	WATER FILTER
WFS	WATER FLOW SWITCH
WFN	WASH FOUNTAIN
WM	WATER METER
WH	WATER HEATER
WH	WALL HYDRANT
WHA	WATER HAMMER ARRESTOR
WSB	WASHER SUPPLY BOX
ZVB	ZONE VALVE BOX
(X)	FIXTURE OR EQUIPMENT TO BE REMOVE

SYMBOLS LIST

SYMBOL	DESCRIPTION
SUSPENDED PIPING	
SAN OR S	SANITARY
ST	STORM
KW	KITCHEN WASTE
LW	LAUNDRY WASTE
IW	INDIRECT WASTE
CD	CONDENSATE DRAIN
	DOMESTIC COLD WATER
OR CW	DOMESTIC COLD WATER
	DOMESTIC HOT WATER SUPPLY
OR HW	DOMESTIC HOT WATER SUPPLY
	DOMESTIC HOT WATER RECIRCULATING
V OR	SANITARY VENT
AV	ACID VENT
	NEW PIPING
(E)	EXISTING PIPE/EQUIPMENT TO REMAIN
(E)	EXISTING PIPE/EQUIPMENT TO BE REMOVED
	EXISTING PIPE/EQUIPMENT TO BE ABANDONED
	POINT OF NEW CONNECTION TO EXISTING
	BALL VALVE
	BALL VALVE ON VERTICAL
	GENERAL OR GATE VALVE (SEE SPECIFICATIONS FOR TYPE)
	OS & Y GATE VALVE
	CHECK VALVE
	TERMINAL VALVE
	CHECK VALVE ON VERTICAL
	COMBINATION OF BALANCING VALVE (SEE SPECIFICATIONS FOR TYPE), SHUT-OFF VALVE, AND CHECK VALVE
	GAS COCK
	PRESSURE AND TEMPERATURE RELIEF VALVE
	BUTTERFLY VALVE WITH TAMPER SWITCH
RPBP	REDUCED PRESSURE BACKFLOW PREVENTER ASSEMBLY
	PRESSURE REDUCING VALVE
	PRESSURE REDUCING VALVE STATION
	3-WAY VALVE (THERMOSTATIC MIXING VALVE)
	STRAINER (SEE SPECIFICATIONS FOR TYPE)
	FLOAT OPERATED VALVE
	PLUG VALVE
	SOLENOID VALVE
	ANGLE VALVE
	AIR CHAMBER
	AIR VENT OR VTR
	BRANCH-TOP CONNECTION
	BRANCH-BOTTOM CONNECTION
	BRANCH-SIDE CONNECTION
	RISER DOWN (ELBOW)
	RISER UP (ELBOW)
	WASTE PIPE WITH TRAP
CCO	GROUND CLEAN OUT
PITCH	PITCHES DOWN OR UP IN DIRECTION OF ARROW
	PLUG OR CAP PIPE
	REDUCER
WHA	WATER HAMMER ARRESTER
	PRESSURE GAUGE
	THERMOMETER
HB-#	HOSE BIBB (SEE SPECIFICATIONS FOR TYPE)
NFWH-#	NON-FREEZE WALL HYDRANT (SEE SPECIFICATIONS FOR TYPE)
NFPH-#	NON-FREEZE POST HYDRANT
DH-#	DECK HYDRANT
FCO	FLOOR CLEANOUT
	SUSPENDED CLEANOUT
	WALL CLEANOUT

SYMBOL	DESCRIPTION
SB-#	SETTLING BASIN
SE-#	SEWAGE BASIN W/SELF PRIMING PIPING
SP-#	SUMP PUMP
RD	ROD-OUT BASIN
	EXTERIOR WALL SLEEVE
	INTERIOR WALL SLEEVE/BEAM PENETRATION
	UNION
	PIPE ANCHOR
	ALIGNMENT GUIDE
EJ	EXPANSION JOINT
	FLEXIBLE CONNECTION
BWV	BACK WATER VALVE
M OR	WATER METER
ANB	ACID NEUTRALIZING BASIN
	EXPANSION LOOP
	CAPPED PIPE
	BLIND FLANGE
	FLOW DIRECTION OF ARROW
	ELECTRICAL HEAT TRACED PIPING
	DROP AT ANGLE
VTR (AVTR)	VENT THRU ROOF OR ACID VENT THRU ROOF
	SHOCK ABSORBER
	PRESSURE SWITCH
P	PLUMBING RISER OR STACK DESIGNATION
DS	DOWNSPOUT OR RAIN LEADER DESIGNATION
1 P1.1	DETAIL NUMBER / DRAWING NUMBER
A B	EQUIPMENT DESIGNATION A – TYPE OF EQUIPMENT B – TAG NUMBER
#	KEYNOTE TAG
#	KEYNOTE TAG

FIXTURE SYMBOLS

SYMBOL	DESCRIPTION
WC-#	WATER CLOSET (TYPE INDICATED)
UR-#	URINAL (TYPE INDICATED)
LAV-#	LAVATORY (TYPE INDICATED)
EWC-#	ELECTRIC WATER COOLER (TYPE INDICATED)
DF-#	DRINKING FOUNTAIN (TYPE INDICATED)
SS-#	SCULLERY SINK (TYPE INDICATED)
MB-#	MOP BASIN (TYPE INDICATED)
SH-#	SHOWER (TYPE INDICATED)
SK-#	SINK (TYPE INDICATED)
FD-#	FLOOR DRAIN (TYPE INDICATED)
FS-#	FLOOR SINK (TYPE INDICATED)
AD-#	AREA DRAIN (TYPE INDICATED)

NOTES: 1. THIS IS A GENERAL SYMBOL LIST THEREFORE SOME ITEMS MAY NOT DIRECTLY APPLY TO THIS PROJECT AND DRAWINGS.
2. EXISTING PIPING SHOWN WITH THIN LINE WEIGHT. NEW PIPING SHOWN WITH THICK LINE WEIGHT.
3. DISREGARD SYMBOLS AND ABBREVIATIONS WHICH DO NOT APPLY TO THIS PROJECT.
4. THIS IS A GENERAL ABBREVIATION LIST THEREFORE SOME ITEMS MAY NOT DIRECTLY APPLY TO THIS PROJECT AND RELATED DRAWINGS.

PLUMBING GENERAL NOTES

1. GENERAL NOTES INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS SHALL BE CONSIDERED A PART OF THE CONTRACT.

2. PROVIDE ALL LABOR AND MATERIALS, EQUIPMENT, FACILITIES, TRANSPORTATION AND SERVICES NECESSARY TO FURNISH, INSTALL AND COMPLETE THE SCOPE OF WORK AS INDICATED ON THE CONTRACT DOCUMENTS AND SPECIFICATIONS. THE WORKMANSHIP SHALL BE COMPLETE IN EVERY RESPECT, BE TESTED AND APPROVED, AND BE SATISFACTORY TO THE ARCHITECT, ENGINEER AND OWNER, AND IN ACCORDANCE WITH LOCAL, COUNTY AND STATE LAWS GOVERNING THIS INSTALLATION, INCLUDING THE FIRE MARSHALL.

3. ALL PLUMBING WORK SUPPLIED BY THIS CONTRACTOR SHALL BE IN COMPLIANCE WITH THE 2019 BUILDING CODE OF THE CITY OF CHICAGO AND OTHER LOCAL AUTHORITIES HAVING JURISDICTION.

4. CONTRACTOR SHALL INSTALL ALL EQUIPMENT AND MATERIAL IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS.

5. CONTRACTOR SHALL PROVIDE FIRESTOPPING AROUND ALL WALL AND FLOOR PENETRATIONS AS REQUIRED TO MAINTAIN THE RATING OF WALLS AND FLOORS. ALL HOLES THROUGH FLOORS SHALL BE CAULKED AND SEALED AIR AND WATERTIGHT TO RESTRICT THE PASSAGE OF SMOKE, SOUND OR FLAMES.

6. WHERE DRAWINGS, SPECIFICATIONS, AND NOTES CONFLICT WITH ONE ANOTHER THE CONTRACTOR SHALL IMMEDIATELY ADVISE THE ENGINEER OF SUCH CONFLICTS. FOR PURPOSES OF BIDDING, AND PENDING UPON WRITTEN RECEIPT OF ANY DIRECTION TO THE CONTRARY, THE CONTRACTOR SHALL INCLUDE IN HIS PROPOSAL THE MORE EXPENSIVE ALTERNATE DESCRIBED.

7. ALL CUTTING, PATCHING, REPAIRING, REPLACEMENT, PAINTING, AND REFINISHING OF EXISTING BUILDING MATERIALS AS REQUIRED TO ACCOMMODATE INSTALLATION OF NEW WORK AND/OR DEMOLITION IN ALL AREAS OF THE BUILDING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR WHOSE SPECIFIC WORK IS INVOLVED. ALL PATCHING, REPAIRING, REPLACEMENT, PAINTING, REFINISHING, AND CAULKING SHALL MATCH THE EXISTING CONSTRUCTION AS NEARLY AS POSSIBLE.

8. ALL WORK PERFORMED BY THIS CONTRACTOR, INCLUDING ALL NECESSARY CUTTING OR DRILLING OPERATIONS, SHALL BE PERFORMED SO AS TO CAUSE A MINIMUM OF INTERFERENCE TO BUILDING OPERATIONS. ANY INTERRUPTION OF FIRE ALARM SYSTEM FUNCTIONS SHALL NOT BE PERMITTED WITHOUT NOTIFICATION AND PERMISSION.

9. BUILDING SYSTEMS OPERATIONS AND UTILITY SERVICES SHALL CONTINUE IN SERVICE WITHOUT INTERRUPTION. ANY MANDATORY INTERRUPTION OF ANY SERVICE OR UTILITIES SHALL BE ARRANGED WITH THE OWNER'S ENGINEER. CONTRACTOR SHALL INFORM THE OWNER'S ENGINEER 10 DAYS IN ADVANCE PRIOR TO ANY BUILDING'S SERVICE INTERRUPTION. ANY ADDITIONAL EXPENSE RESULTING FROM TEMPORARY SERVICE INTERRUPTIONS SHALL BE PAID BY THE CONTRACTOR.

10. NOT IN USE

11. CONNECTIONS OF NEW PIPING TO EXISTING SHALL UTILIZE CITY OF CHICAGO APPROVED METHODS AND FITTINGS. IN ALL CASES WHERE COPPER PIPE CONNECTIONS ARE MADE TO PIPING OR AN ITEM OF DISSIMILAR METAL, PROVIDE DIELECTRIC FITTINGS.

12. IN INSTANCES WHERE EXISTING PIPING INSULATION AT CONNECTION POINTS OR EXISTING AREAS IS DAMAGED DUE TO NEW WORK, THIS CONTRACTOR SHALL REPLACE SAME TO THE SATISFACTION OF THE OWNER AS SPECIFIED FOR NEW WORK.

13. PROTECT EXISTING BUILDING STRUCTURE AND GROUNDS FROM ANY DAMAGE WHICH MAY OCCUR DURING INSTALLATION OF NEW WORK. ANY DAMAGE TO EXISTING FACILITIES SHALL BE REPAIRED, REPLACED OR RESTORED TO THE ORIGINAL CONDITION AND SATISFACTION OF THE OWNER.

14. THIS CONTRACTOR SHALL VERIFY WITH BUILDING ENGINEER IF PLUMBING FIXTURES SHOULD BE SALVAGED. BUILDING ENGINEER HAS FIRST CHOICE FOR SALVAGED ITEMS.

15. ITEMS REJECTED BY THE OWNER SHALL BE DISPOSED OF IN A LEGAL MANNER IN ACCORDANCE WITH LOCAL AUTHORITIES.

16. ALL EQUIPMENT SHALL BE CLEANED AND ADJUSTED AS REQUIRED TO OPERATE SATISFACTORILY AND WITNESSED BY BUILDING PERSONNEL.

17. ALL PENETRATIONS THROUGH FIRE RATED FLOORS AND WALLS SHALL BE MADE FIRE SAFE IN COMPLIANCE WITH THE 2021 CITY OF CHICAGO BUILDING CODE. RATING SHALL MEET OR EXCEED RATING OF FLOOR OR WALL.

18. NOT IN USE

19. THIS CONTRACTOR SHALL VERIFY ALL PIPING CONNECTIONS TO BE PROPERLY INSTALLED AND CONNECTED IN OPERATING MANNER FOR ITS INTENDED PURPOSE.

20. THIS CONTRACTOR SHALL FURNISH, INSTALL AND CONNECT ALL EQUIPMENT IN ACCORDANCE WITH 2021 CHICAGO BUILDING CODE. AFTER EACH WORK DAY, CONTRACTOR SHALL CLEAN ALL WORK AREAS AND REMOVE ALL DEBRIS.

21. NOT IN USE

22. THIS CONTRACTOR SHALL VERIFY EXISTING STRUCTURAL CONDITIONS PRIOR TO FLOOR CORING AND WALL CUTTING TO AVOID ANY CONFLICTS.

23. ALL WALL OR CEILING PATCHING SHALL BE AT THE EXPENSE OF THE CONTRACTOR WHOSE WORK IS BEING INSTALLED. INSTALLATION OF THE FLOOR COVERING SHALL BE BY THE GENERAL CONTRACTOR.

24. ANY PIPING THAT IS BEING ABATED AND REMAINING SHALL BE REINSULATED PER THE CONTRACT DOCUMENTS WITH NO EXCEPTIONS.

PLUMBING PIPING MATERIAL

SANITARY WASTE, VENT, AND STORM WATER PIPING

A. ABOVEGROUND, SOIL AND WASTE PIPING NPS 3" AND SMALLER SHALL BE ANY OF THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.
2. COPPER TUBE, COPPER DRAINAGE FITTINGS, AND SOLDERED JOINTS.

B. ABOVEGROUND, SOIL WASTE, AND STORM WATER PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.

C. ABOVEGROUND, VENT PIPING NPS 3" AND SMALLER SHALL BE ANY OF THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.
2. COPPER TUBE, COPPER DRAINAGE FITTINGS, AND SOLDERED JOINTS.

D. ABOVEGROUND, VENT PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS, CAST-IRON SOIL PIPE AND FITTINGS; LEAD AND OAKUM JOINTS.

E. UNDERGROUND, SOIL, WASTE, VENT, AND STORM WATER PIPING NPS 4" AND LARGER SHALL BE THE FOLLOWING:

1. SERVICE CLASS EXTRA-HEAVY (WHERE REQUIRED TO CONNECT TO EXISTING), CAST-IRON SOIL PIPING; GASKETS; AND GASKETED JOINTS.

DOMESTIC WATER PIPING

A. DOMESTIC WATER PIPING ON SERVICE SIDE OF WATER METER INSIDE THE BUILDING: USE THE FOLLOWING: PIPING MATERIALS FOR EACH SIZE RANGE:

1. NPS 4" AND SMALLER: HARD COPPER TUBE, TYPE K; COPPER PRESSURE FITTINGS; AND SOLDERED JOINTS.

B. ABOVEGROUND DOMESTIC WATER PIPING: USE THE FOLLOWING PIPING MATERIALS FOR EACH SIZE RANGE:

1. NPS 3" AND SMALLER: HARD COPPER TUBE, TYPE L, COPPER PRESSURE FITTINGS; AND SOLDERED JOINTS.

INSULATION

1. DOMESTIC HOT WATER PIPING SHALL BE INSULATED WITH 1" THICK 7# DENSITY, GLASS FIBER PRE-FORMED, ALL PURPOSE FLAME RETARDANT JACKET.

2. COLD WATER PIPING SHALL BE INSULATED WITH AS FOLLOWING:

A) PIPING LESS 1 1/2" – WITH 1/2" THICK, 7# DENSITY, GLASS FIBER, PRE-FORMED ALL PURPOSE FLAME RETARDANT VAPOR BARRIER JACKET.

B) PIPING 1 1/2" TO 4" – WITH 1" THICK, 7# DENSITY, GLASS FIBER, PRE-FORMED ALL PURPOSE FLAME RETARDANT VAPOR BARRIER JACKET.

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615
CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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872 216 9819

Landscape Architect:
Site Design
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Chicago, IL 60605
312 427 7240

Structural Engineer:
Milhouse Engineering, Inc.
333 South Wabash Avenue
Suite 2901
Chicago, IL 60604
312 924 4584

Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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223 West Jackson Boulevard
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Chicago, IL 60606
312 663 3700

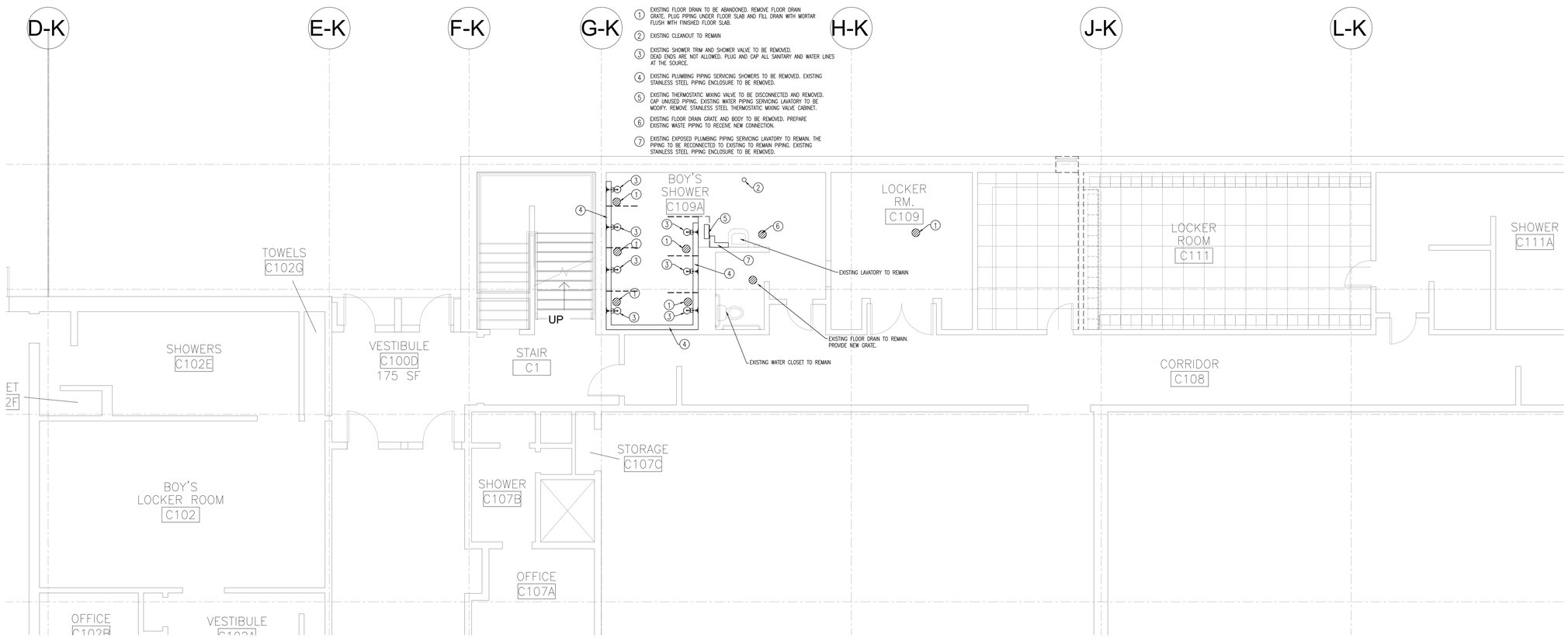
No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MOM 5031)

Title
PLUMBING SYMBOLS, NOTES, AND ABBREVIATIONS

Sheet
P000-MEP

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

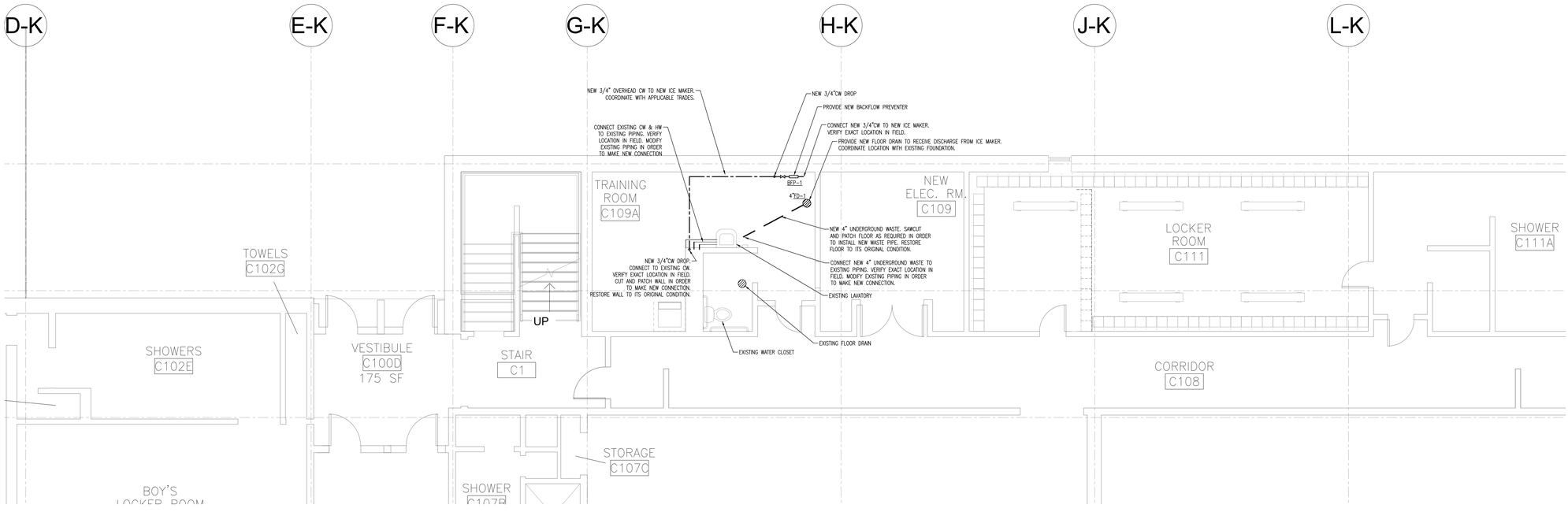


1 PLUMBING FIRST FLOOR DEMOLITION/REMOVAL PLAN - KENWOOD (BUILDING C)

1/4" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-MEP.

Scale: 1/4" = 1'-0"

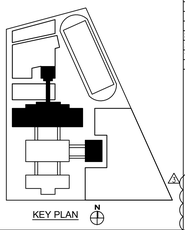


2 PLUMBING FIRST FLOOR PLAN - KENWOOD (BUILDING C)

1/4" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-MEP.

Scale: 1/4" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT
5015 SOUTH BLACKSTONE AVENUE
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CHICAGO PUBLIC SCHOOLS
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Mechanical, Electrical, Plumbing & Fire Protection Engineers:
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312 663 3700

No.	Date	Description
3	02.23.24	ADDENDUM # 1
2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

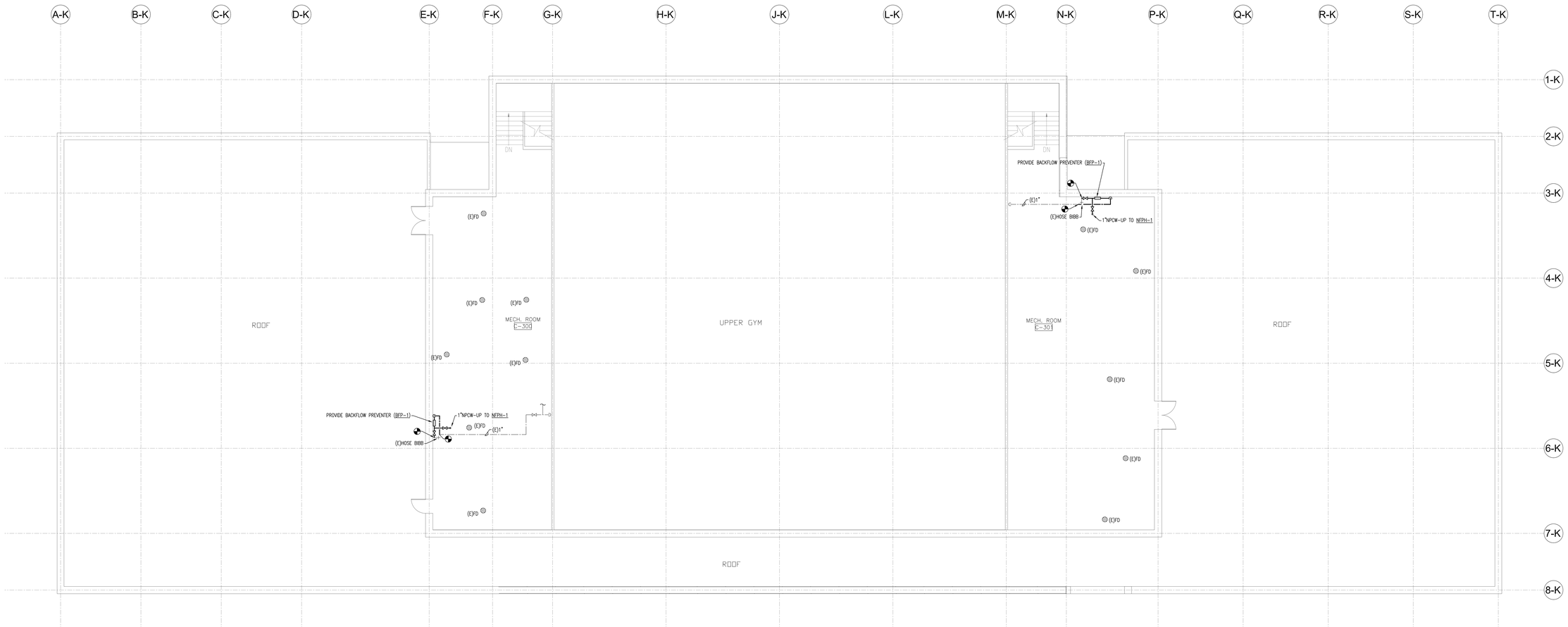
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 9331)

Title
PLUMBING FIRST FLOOR PLANS - KENWOOD (BUILDING C)

Sheet
P101-MEP

PLUMBING FIXTURE SCHEDULE

FIXTURE TAG.	MATERIAL	MANUFACTURER/MODEL NUMBER	ADDITIONAL REQUIREMENTS AND NOTES
NFPH-1	ROUGH BRONZE	WOODFORD FREEZELESS SANITARY ROOF HYDRANT MODEL #SRH-MS	DRAIN LINE IS NOT REQUIRED. WITH THE HOSE REMOVED, A VENTURI ACTION DRAWS WATER OUT OF THE INTERNAL RESERVOIR
BFP-1	LEAD FREE CAST COPPER BODY	WATTS SERIES LF007 DOUBLE CHECK VALVE ASSEMBLY.	
FD-1	DUCO CAST IRON BODY	JAY R. SMITH # 2010C-U-NB FLOOR DRAIN WITH ADJUSTABLE STRAINER HEAD, AND VANDAL PROOF SCREWS	REVERSIBLE FLASHING COLLAR PERMITS ADJUSTMENT TO MEET FINISHED FLOOR LEVEL. PROVIDE NICKEL BRONZE STRAINER.

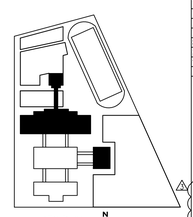


1 PLUMBING PENTHOUSE PLAN - KENWOOD (BUILDING C)

1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING E000.

0 4' 8' 16'
Scale: 1/8" = 1'-0"



KEY PLAN

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

PUBLIC BUILDING COMMISSION
Chicago Public Schools

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

5015 SOUTH BLACKSTONE AVENUE
CHICAGO, IL 60615

CHICAGO PUBLIC SCHOOLS
CITY OF CHICAGO, MAYOR BRANDON JOHNSON

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nia architects Inc
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312 663 3700

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2	02.08.24	ISSUED FOR BID
1	02.02.24	ISSUED FOR PERMIT

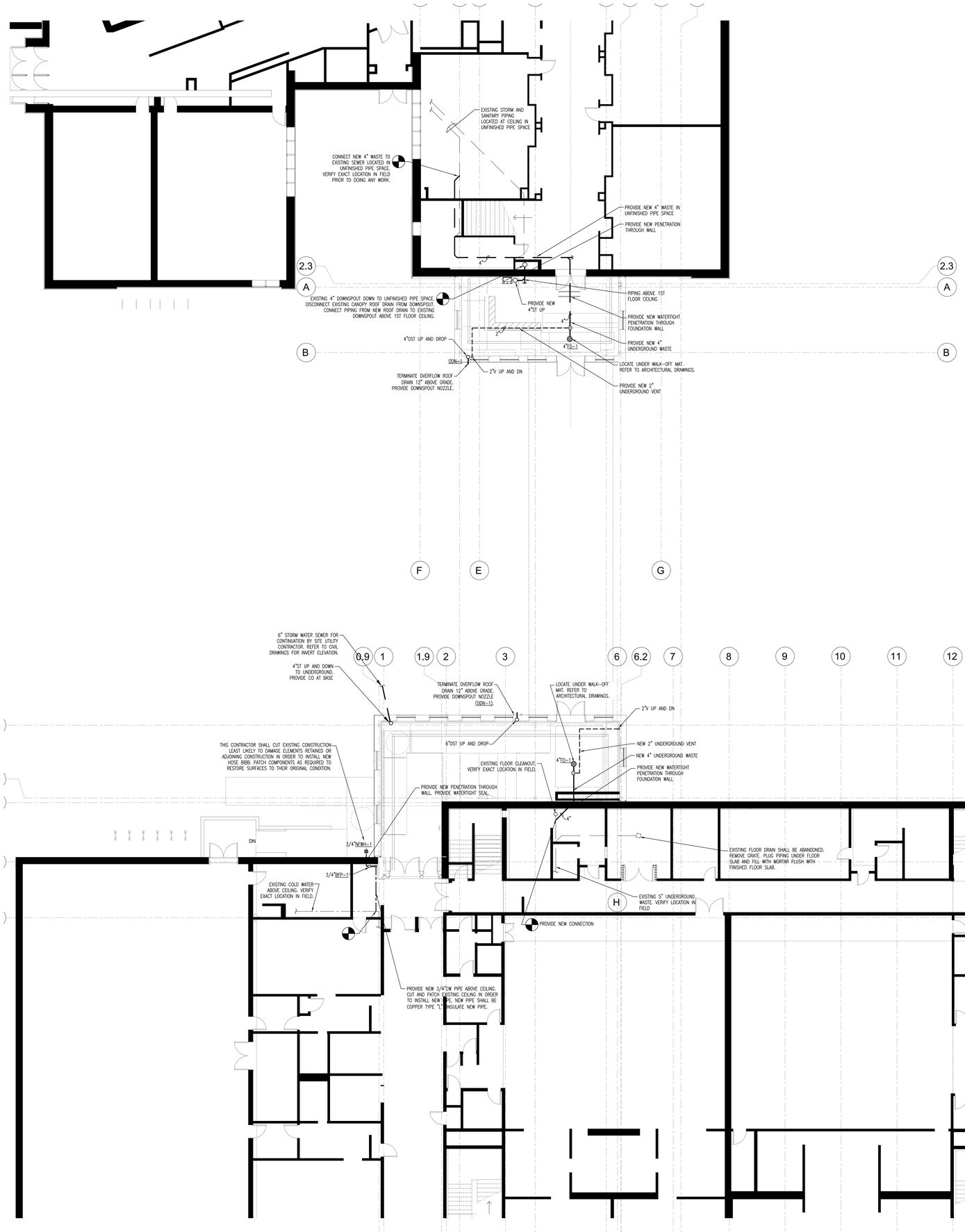
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCM 5031)

Title
PLUMBING PENTHOUSE PLAN - KENWOOD (BUILDING C)

Sheet
P103-MEP

PLUMBING FIXTURE SCHEDULE

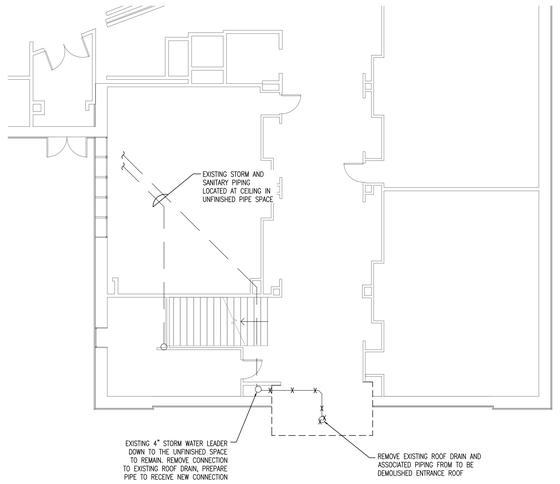
FIXTURE TAG.	MATERIAL	MANUFACTURER/MODEL NUMBER	ADDITIONAL REQUIREMENTS AND NOTES
RD-1	DUCO CAST IRON BODY	JAY R. SMITH MODEL NO. 1015C-CID MAIN ROOF DRAIN WITH ADJUSTABLE EXTENSION SLEEVE.	PROVIDE CAST IRON BODY AND COLLAR UNDERDECK CLAMP, FLASHING CLAMP, GRAVEL STOP, AND CAST IRON DOME.
ORD-1	DUCO CAST IRON BODY	JAY R. SMITH MODEL NO. 1070C-CID OVERFLOW ROOF DRAIN	PROVIDE CAST IRON BODY AND COLLAR UNDERDECK CLAMP, FLASHING CLAMP, GRAVEL STOP, CAST IRON DOME, AND CAST IRON 4" STAND PIPE.
ODN-1	CAST BRONZE NOZZLE	JAY R. SMITH OVERFLOW DOWNSPOUT NOZZLE AND WALL FLANGE, MODEL # 1771-BS	PROVIDE PROPER BACKING TO SECURE THE WALL FLANGE. PIPE MUST EXTEND PAST THE FACE OF THE WALL IN ORDER TO INSTALL WALL FLANGE AND ATTACH THE DOWNSPOUT NOZZLE.
NFWH-1	BRONZE NICKEL PLATED	JAY R. SMITH NON-FREEZE WALL HYDRANT ASSEMBLY MODEL #5609QT, BRONZE NICKEL PLATED QUARTER TURN HYDRANT WITH 3/4" HOSE CONNECTION, INTEGRAL VACUUM BREAKER AND VANDAL RESISTANT CAP AND "T" HANDLE KEY.	
BFP-1	LEAD FREE CAST COPPER SILICON ALLOY BODY	WATTS SERIES LF007 DOUBLE CHECK VALVE ASSEMBLY.	ASSE 1015
FD-1	DUCO CAST IRON BODY	JAY R. SMITH MODEL NO. 2215C FLOOR DRAIN WITH CAST IRON ADA GRATE AND SEDIMENT BUCKET	



N 1 FIRST FLOOR LINK PLAN - PLUMBING
1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-LNK.

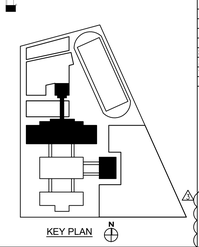
0 4' 8' 16'
Scale: 1/8" = 1'-0"



N 2 FIRST FLOOR DEMOLITION PLAN (CANTER BUILDING)
1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-LNK.

0 4' 8' 16'
Scale: 1/8" = 1'-0"



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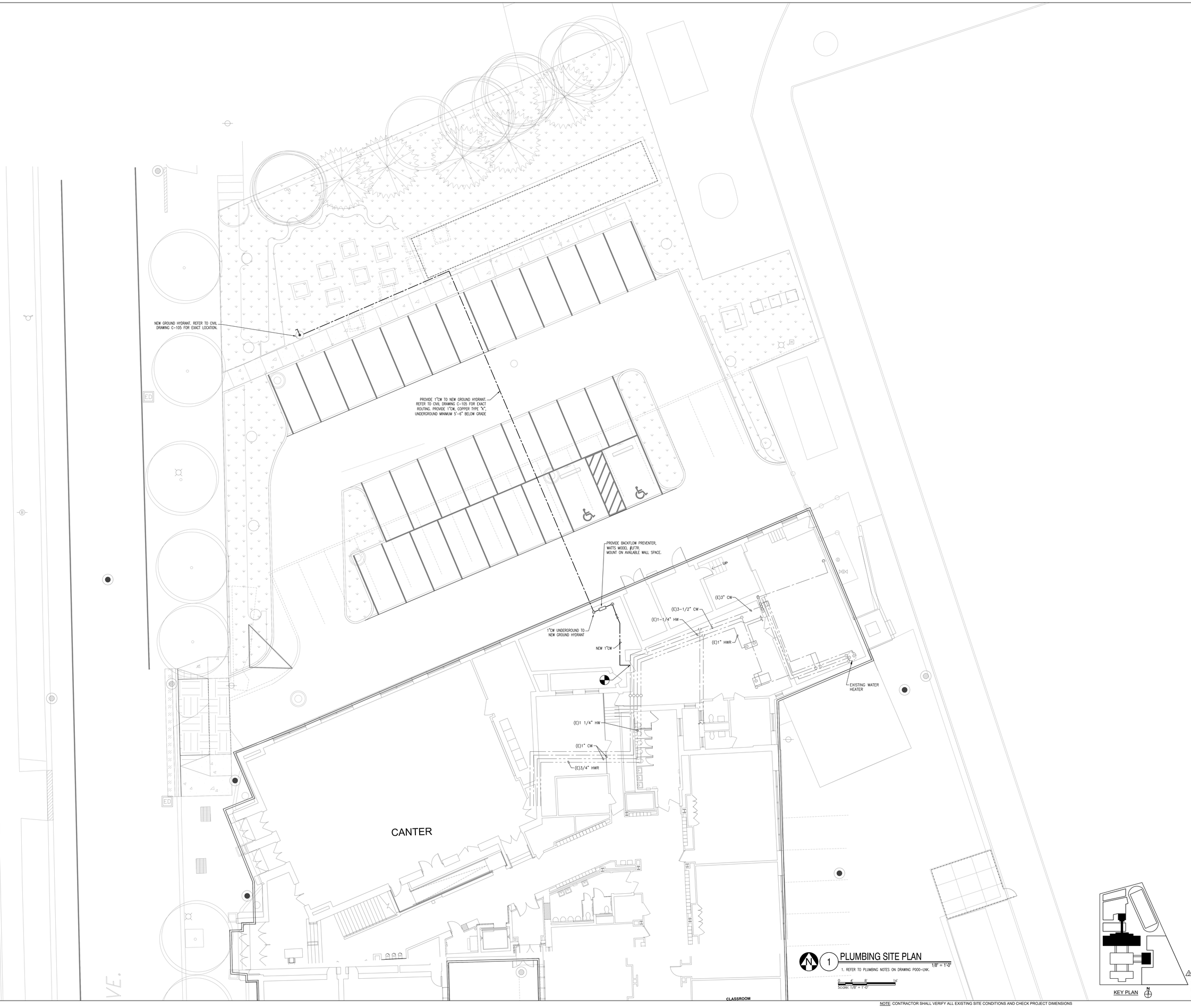
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (MCAA 10311)

Title: FIRST FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER

Sheet: P105-LNK



N 1 PLUMBING SITE PLAN
1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-LNK.

0 4' 8' 16'
Scale: 1/8" = 1'-0"

KENWOOD ACADEMY
LINK + MECHANICAL PROJECT

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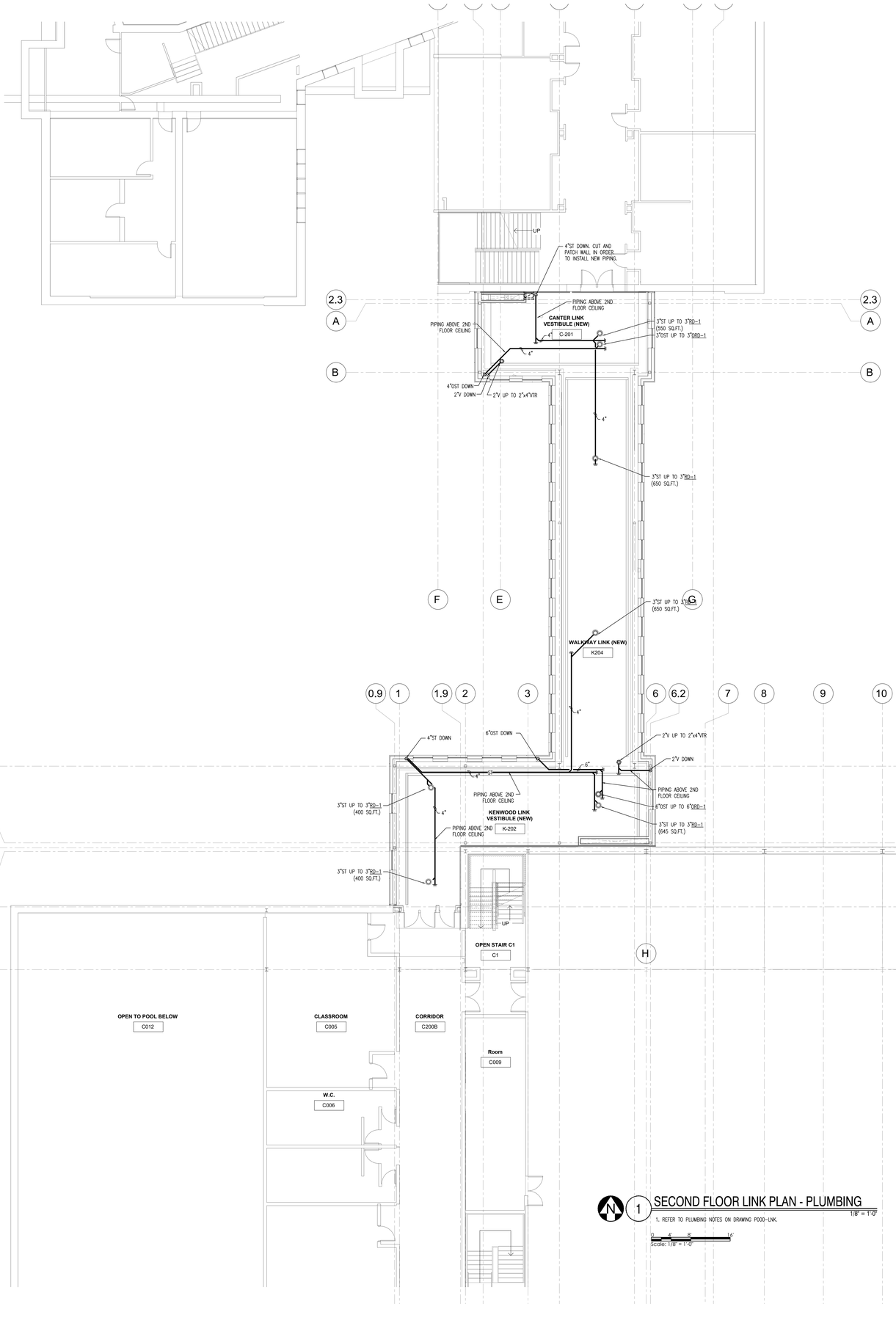
PBC Project Name: Kenwood Academy Link & Mechanical
PBC Contract No: C1602R
Project No.: 05326 (NCA# 5311)

Title
PLUMBING SITE PLAN

Sheet
P105A-LNK

NOTE: CONTRACTOR SHALL VERIFY ALL EXISTING SITE CONDITIONS AND CHECK PROJECT DIMENSIONS

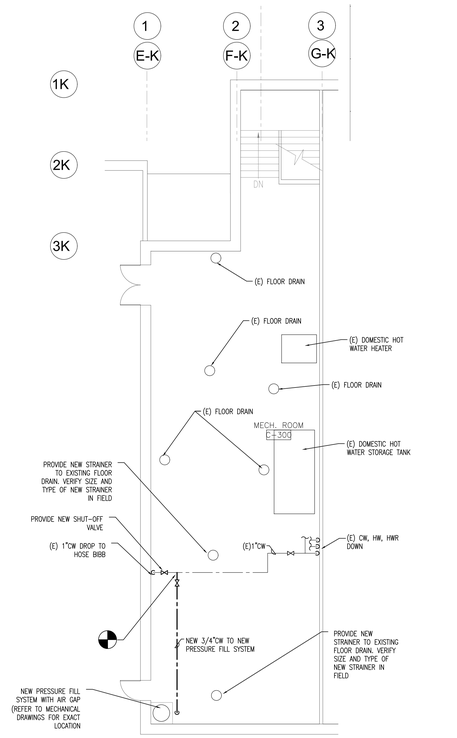


1 SECOND FLOOR LINK PLAN - PLUMBING

1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-LNK.

Scale: 1/8" = 1'-0"

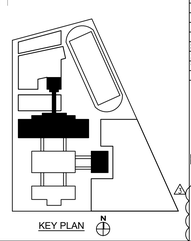


2 PENTHOUSE PLAN - PLUMBING

1/8" = 1'-0"

1. REFER TO PLUMBING NOTES ON DRAWING P000-LNK.

Scale: 1/8" = 1'-0"



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PBC Contract No: C1602R
Project No.: 05326 (MCM 5051)

Title: SECOND FLOOR LINK PLAN - KENWOOD (BUILDING C) AND CANTER, AND PENTHOUSE PLAN (BUILDING C)

Sheet: P106-LNK