



DATE: 6/1/21

Addendum # 1

BID NO.: **100971PH2**
OPENING: 6/11/21 – 2:00 PM
COMMODITY: Ryan Institute Lab Renovations

Attached please find the following:

- The sign-in sheet from the Mandatory Pre-Bid Meeting held on 6/1/21
- Additional specifications as presented by TLC Architecture which are hereby incorporated into the bid specifications.

The deadline for questions remains June 2, 2021 at 4:00 pm. Another addendum will be issued as a result of any questions submitted.

Tracey Angell, Director
Purchasing Department
The University of Rhode Island

Rev. 9-1-15

THE
UNIVERSITY
OF RHODE ISLAND

DIVISION OF
ADMINISTRATION
AND FINANCE

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PURCHASING DEPARTMENT

10 Tootell Road, Suite 3, Kingston, RI 02881 USA p: 401.874.2171 f: 401.874.2306 uri.edu/purchasing



PAGE 1 OF: 1

"MANDATORY" PRE-BID CONFERENCE SIGN-IN SHEET

Mandatory pre-bid conference: Any vendor who intends to submit a bid proposal in response to this solicitation must have its designated representative attend the mandatory pre-bid conference. The representative must register at the pre-bid conference and disclose the identity of the vendor whom he/she represents. Because attendance at the pre-bid conference is mandatory, a vendor's failure to attend and register at the pre-bid conference shall result in disqualification of the vendor's bid proposal as non-responsive to the solicitation.

BID NUMBER:	100971PH2	PURCHASING REPRESENTATIVE:	Tracey Angell
BID TITLE:	Ryan Institute Lab Renovation		
LOCATION:	CBLS		
PRE BID DATE AND TIME:	6/1/21 - 9:30AM	PRE BID END TIME:	10:30 AM

Company Name:	Representative:	Email Address:	Phone Number
URI	Tracey Angell	tracey@uri.edu	401-874-2324
A/Z	ROB PEPIN	pepin@az-corp.com	860-934-6580
BVA	JOE DESIMONE	JOED@BVHIS.COM	860-490-0747
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URI	Bill Thudley		401-279-2131
A/Z Corp.	Renee Driscoll	rdriscoll@az-corp.com	401 330-7366
STEPHEN TURNER	JOE WAGNER	joe@sturnerinc.com	401.612.6432
EW Burman	Amy Burman	estimating@ewburman.com	401 738-5100
Ahlborg Construction	Drew Serdakowski	DSerdakowski@Ahlborg.com	401.215.6080
Ahlborg construction	Dylan Pratt	Dpratt@Ahlborg.com	774 437 9708
Jones J O'Rourke Elec	Zachary Vadencis	zvadencis@jjoel.com	401-378-1197
Justin Corbeil		JCorbeil@connecticutpoint.com	401-408-9250

ADDENDUM No. 1
May 13, 2021

**RYAN INSTITUTE LABORATORY PHASE 1 RENOVATIONS
CENTER FOR BIOTECHNOLOGY and LIFE SCIENCES**

University of Rhode Island
Kingston Campus

Project Number: KC.G.CBLS.2020.001

The following changes and/or clarifications are hereby made to the Contract Documents dated 4/30/21 for the above captioned project.

PROJECT MANUAL

- 1) **Replace the following Specification Sections in their entirety with the attached updated sections:**
 - a) 00 0110 Table of Contents
 - b) 08 7100 Door Hardware
 - c) 23 0900 Instrumentation and Control for HVAC
 - d) 27 0010 General Conditions for Electrical
 - e) 27 0528 Pathways for Communications Systems
 - f) 27 0529 Hangers and Supports for Communications Systems
- 2) **Add the following attached Specification Sections in their entirety:**
 - a) 27 0536 Cable Trays for Communications Systems
 - b) 27 0544 Sleeves & Sleeve Seals for Communications Pathways & Cabling
 - c) 27 1513 Communications Copper Horizontal Cabling

DRAWINGS

- 3) **Replace the following drawings with the attached revised sheets. Changes are clouded and identified as Revision 3.**
 - a) S1.00
 - b) HD1.01
 - c) H1.02
 - d) H5.01
 - e) H5.02
 - f) EPS1.01
 - g) EPS1.02
 - h) E4.01
 - i) E4.02

ATTACHMENTS

1. 00 0110 Table of Contents
2. 08 7100 Door Hardware
3. 23 0900 Instrumentation and Control for HVAC
4. 27 0010 General Conditions for Electrical
5. 27 0528 Pathways for Communications Systems
6. 27 0529 Hangers and Supports for Communications Systems
7. 27 0536 Cable Trays for Communications Systems
8. 27 0544 Sleeves & Sleeve Seals for Communications Pathways & Cabling
9. 27 1513 Communications Copper Horizontal Cabling
10. S1.1, Rev 3 dated 5/10/21
11. HD1.01, Rev 3 dated 5/10/21
12. H1.02, Rev 3 dated 5/10/21
13. H5.01, Rev 3 dated 5/10/21
14. H5.02, Rev 3 dated 5/10/21
15. EPS1.01, Rev 3 dated 5/10/21
16. EPS1.02, Rev 3 dated 5/10/21
17. E4.01, Rev 3 dated 5/10/21
18. E4.02, Rev 3 dated 5/10/21

END OF ADDENDUM NO. 1

DOCUMENT 00 0110 - TABLE OF CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS (Section added)

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

00 0010	Cover
00 0050	Title Page
00 0110	Table of Contents
00 0115	List of Drawings
00 5200	Agreement Form
00 6140	Waiver of Lien Form
00 7000	General Conditions
00 7200	URI Standard Documents

SPECIFICATIONS

DIVISION 01 - GENERAL REQUIREMENTS (Section added)

01 1000	Summary
01 1010	Attachment A – Site Utilization
01 1020	Attachment B – Fire Protection Impairment Form
01 2000	Price and Payment Procedures
01 2010	Attachment A - Price and Payment Procedures
01 2020	Attachment B - MBE Utilization Form
01 3000	Administrative Requirements
01 3010	Attachment A – Administrative Requirements
01 3300	Submittal Procedures
01 3310	Attachment A – Submittal Procedures
01 4000	Quality Requirements
01 4010	Attachment A – Quality Requirements
01 5000	Temporary Facilities and Controls
01 5010	Attachment A – Temporary Facilities and Controls
01 6000	Product Requirements
01 6010	Attachment A – Product Requirements
01 7000	Execution Requirements
01 7010	Attachment A – Execution Requirements
01 7320	Waste Management
01 7330	Attachment A – Waste Management
01 7800	Closeout Requirements
01 7810	Attachment A – Closeout Requirements
01 9113	General Commissioning Requirements

DIVISION 02 – EXISTING CONDITIONS

02 41 19	Selective Demolition
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DIVISION 03 – CONCRETE

03 3000 Cast-In Place Concrete

DIVISION 04 – MASONRY - Not Used

DIVISION 05 – METALS - Not Used

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

06 1053 Miscellaneous Rough Carpentry

06 4023 Interior Architectural Woodwork (Section Renamed)

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 2200 Acoustical Insulation

07 81 00 Applied Fire Protection (Section Added)

07 9200 Joint Sealants

DIVISION 08 – OPENINGS

08 1213 Hollow Metal Frames

08 1400 Wood Doors

08 1433 Stile and Rail Wood Doors

08 7100 Door Hardware (Revised – Addendum No. 1)

08 8000 Glazing

DIVISION 09 – FINISHES

09 2216 Non-structural Metal Framing

09 2116.23 Gypsum Board Shaft Wall Assemblies (Previously Missing from TOC)

09 2900 Gypsum Board

09 3013 Ceramic Tiling

09 5113 Acoustical Panel Ceilings

09 6513 Resilient Base and Accessories

09 6519 Resilient Tile Flooring (Section Added)

09 6543 Linoleum Flooring

09 9123 Interior Painting

DIVISION 10 – SPECIALTIES

10 14 19 Dimensional Letter Signage (Section Added)

10 14 23 Room Identification Signage

10 26 00 Impact-resistant Wall Protection (Section Added)

10 44 13 Fire Protection Cabinets (Section Added)

10 44 16 Fire Extinguishers (Section Added)

10 51 23 Plastic Laminate Clad Lockers

DIVISION 11 – EQUIPMENT

- 11 5300 Laboratory Equipment
- 11 5313 Laboratory Fume Hoods

DIVISION 12 – FURNISHINGS

- 12 2413 Roller Window Shades
- 12 3213 Flexible Laboratory Furniture
- 12 3213 Wood Veneer Faced Laboratory Casework
- 12 3653 Laboratory Work Surfaces

DIVISION 13 - SPECIAL CONSTRUCTION - Not Used

DIVISION 14 - CONVEYING EQUIPMENT – Not Used

DIVISION 21 – FIRE SUPPRESSION

- 210010 General Conditions for Fire Suppression
- 210517 Sleeves and Sleeve Seals for Fire-Suppression Piping
- 210518 Escutcheons for Fire-Suppression Piping
- 210523 General-Duty Valves for Water-Based Fire-Suppression Piping
- 210529 Hangers and Supports for Fire Suppression Piping and Equipment
- 210553 Identification for Fire-Suppression Piping and Equipment
- 211313 Wet-Pipe Sprinkler Systems

DIVISION 22 - PLUMBING

- 220010 General Conditions for Plumbing
- 220517 Sleeves and Sleeve Seals for Plumbing Piping
- 220518 Escutcheons for Plumbing Piping
- 220519 Meters and Gages for Plumbing (section added)**
- 220523.12 Ball Valves for Plumbing Piping
- 220523.14 Check Valves for Plumbing Piping
- 220529 Hangers and Supports for Plumbing Piping and Equipment
- 220553 Identification for Plumbing Piping and Equipment
- 220719 Plumbing Piping Insulation
- 220800 Commissioning of Plumbing (section added)**
- 221116 Domestic, Laboratory Non-Potable and Tempered Water Piping
- 221119 Domestic Water Piping Specialties
- 221316 Sanitary Waste and Vent Piping
- 221319 Sanitary Waste Piping Specialties
- 221319.13 Sanitary Drains
- 224216.16 Commercial Sinks
- 224500 Emergency Plumbing Fixtures
- 226313 Gas Piping for Laboratory Facilities
- 226600 Chemical-Waste Systems for Laboratory Facilities

DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING

230010	General Conditions for Heating, Ventilating, and Air Conditioning
230130.52	Existing HVAC Air Distribution System Cleaning
230513	Common Motor Requirements for HVAC Equipment
230517	Sleeves and Sleeve Seals for HVAC Piping
230518	Escutcheons for HVAC Piping
230519	Gages for HVAC Piping
230523.11	Globe Valves for HVAC Piping
230523.12	Ball Valves for HVAC Piping
230523.13	Butterfly Valves for HVAC Piping
230523.14	Check Valves for HVAC Piping
230523.15	Gate Valves for HVAC Piping
230529	Hangers and Supports for HVAC Piping and Equipment
230548	Vibration and Seismic Controls for HVAC
230553	Identification for HVAC Piping and Equipment
230593	Testing, Adjusting, and Balancing for HVAC
230713	Duct Insulation
230716	HVAC Equipment Insulation (section deleted)
230719	HVAC Piping Insulation
230800	Commissioning of HVAC (section added)
230900	Instrumentation and Control for HVAC (Revised – Addendum No. 1)
230910	Instrumentation and Control for Laboratory
231123	Facility Natural-Gas Piping
232113	Hydronic Piping
232116	Hydronic Piping Specialties
232213	Steam and Condensate Piping (section deleted)
232216	Steam and Condensate Heating Piping Specialties
233113	Metal Ducts
233300	Air Duct Accessories
233346	Flexible Ducts
233416.1	Laboratory Exhaust Fans and Energy Recovery (section added)
233600	Air Terminal Units (section added)
233610	Laboratory Air Terminal Units
233713.13	Air Diffusers
233713.23	Registers and Grilles
234100	Particulate Air Filtration
238219	Fan Coil Units (section added)

DIVISION 26 - ELECTRICAL

260010	General Conditions for Electrical
260519	Low-Voltage Electrical Power Conductors and Cables
260523	Control-Voltage Electrical Power Cables
260526	Grounding and Bonding for Electrical Systems

260529	Hangers and Supports for Electrical Systems
260533	Raceway and Boxes for Electrical Systems
260548.13	Vibration Controls for Electrical Systems
260553	Identification for Electrical Systems
260573.13	Short-Circuit Studies
260573.16	Coordination Studies
260573.19	Arc-Flash Hazard Analysis
260800	Commissioning of Electrical (section added)
260923	Lighting Control Devices
260936	Digital Standalone Lighting Controls
262213	Low-Voltage Distribution Transformers
262416	Panelboards
262726	Wiring Devices
262813	Fuses
262923	Variable-Frequency Motor Controllers (section replaced)
265119	LED Interior Lighting
265213	Emergency and Exit Lighting

DIVISION 27 - COMMUNICATIONS

270010	General Conditions for Electrical (Revised – Addendum No. 1)
270528	Pathways for Communications Systems (Revised – Addendum No. 1)
270529	Hangers and Supports for Communications Systems (Revised – Addendum No. 1)
270536	Cable Trays for Communications Systems (Added – Addendum No. 1)
270544	Sleeves & Sleeve Seals for Communications Pathways & Cabling (Added – Addendum No. 1)
271513	Communications Copper Horizontal Cabling (Added – Addendum No. 1)

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

280010	General Conditions for Electronic Safety and Security
280800	Commissioning of Electronic Safety and Security (section added)
284621.11	Addressable Fire-Alarm Systems

END OF DOCUMENT

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
2. Cylinders for door hardware specified in other Sections.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Door hardware schedule.
- C. Keying schedule.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 1. Scheduling Responsibility: Preparation of door hardware and keying schedule.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
 - a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1 as amended by the Rhode Island state Building Code.

2.2 SCHEDULED DOOR HARDWARE

- A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.
 1. Door hardware is scheduled in Part 3.

2.3 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Preferred: Stanley Commercial Hardware; a division of Stanley Security Solutions.
 - b. Acceptable Substitution: McKinney Products Company; an ASSA ABLOY Group company.
 - c. Acceptable Substitution: PBB, Inc
 2. Provide swing clear type at all doors greater than 36" wide.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Provide the following locksets in accordance with University standards (no substitutions allowed): Schlage Allegion ND Series, Grade 1. Athens lever type, 626 finish.
- B. Lock Functions: As indicated in door hardware schedule.
- C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum ½" latchbolt throw.
 2. Mortise Locks: Minimum ¾-inch latch bolt throw.
 3. Deadbolts: Minimum 1-inch bolt throw.
- D. Wireless Locks shall be Schlage WA5200-MG-17-KD-REN and shall be equipped (standard) with "RF" Transceivers. Provide all necessary Software and Training required. Furnish all units with required Batteries (AA)
- E. Where Hardwired Electrified Hardware is specified, furnish compatible Schlage Wireless Readers (and associated peripherals) for proper interface.
- F. Lock Backset: 2-¾ inches unless otherwise indicated.
- G. Lock Trim:
1. Description: Athens design
 2. Levers: Cast.
 3. Escutcheons (Roses): Cast.
 4. Dummy Trim: Match lever lock trim and escutcheons.
 5. Finish: 626
- H. Strikes: Provide manufacturer's standard strike for each lock bolt or latch bolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
1. Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.
- I. Bored Locks: BHMA A156.2; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.5 AUXILIARY LOCKS

- A. Bored Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.
- B. Narrow Stile Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

2.6 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

- A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum ¾-inch (19-mm) throw; with dust-proof strikes; designed for mortising into door edge.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Preferred: Ives brand by Allegion plc
 - b. Acceptable Substitution: Burns Manufacturing Incorporated.
 - c. Acceptable Substitution Rockwood Manufacturing Company; an ASSA ABLOY Group company.

2.7 LOCK CYLINDERS

- A. Provide the following lock cylinders in accordance with University standards (no substitutions allowed): Schlage Everest 29 T Series Keyway, no interchangeable cores, compatible with D Series, requires letter of authorization from URI Access Control.

2.8 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Brass.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."

2.9 ELECTROMAGNETIC STOPS AND HOLDERS

- A. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire-alarm system for labeled fire-rated door assemblies.
 - 1. LCN
 - 2. National Guard

2.10 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; match existing.

2.11 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force. Unless Specified otherwise, closers shall be mounted on room (pull) side of the opening. Provide parallel arm type at reverse bevel conditions. Furnish drop plates and accessories as required.

- B. Manufacturer: LCN (no substitutions allowed). 41100 Series. Provide hold open feature unless otherwise noted in Hardware Schedule

2.12 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; 8" high, fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 - 1. Ives Hardware Corp.
 - 2. Burns
 - 3. Rockwood

2.13 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.

2.14 STOPS AND STAYS (INTERIOR DOORS)

- A. Wall Stops shall be provided at 90-degree openings. Refer to Rough Carpentry for adequate blocking.
 - 1. Wall Stops shall be equal to Burns 560.

2.15 FLUSH BOLTS/COORDINATORS

- A. Flush Bolts shall be manufactured as follows:
 - 1. Ives Hardware Corp.
 - 2. Burns
 - 3. Rockwood
- B. Furnish DCI 81 Dustproof Strikes for all Flush Bolts.

2.16 GASKETING/AUTO, DOOR BOTTOMS

- A. Gasketing for interior doors shall be NGP 5G50B, applied at head and jambs.
- B. Door Bottoms shall be NGP 320/423 Series. If mortise type conflicts with material construction or with other hardware, furnish 520 Series, surface type.
- C. Sweeps shall be NGP 200SA.

- D. Furnish Gasketing as specified herein or as noted on the door schedule. Gasketing shall meet the requirements for Smoke, Air, Sight, Chemical and Pressure.

2.17 MISCELLANEOUS

- A. Silencers: Silencers shall be equal to Bums 500/501. Furnish for all interior Hollow Metal and Wood Frames.
- B. Kick Plates shall be 8" high, stile permitting. Width of plates shall be 2" LWOD for singles and 1" LWOD for pairs.
- C. Armor Plates shall be 36" High. Width of plates shall be determined as Kick Plates above.
- D. Coat Hooks shall be Rockwood 806.
- E. Head Jamb Stops shall be ABH 1801.
- F. Furnish (1) Knox Box, Model 3200R. Locate as directed.

2.18 FINISHES

- A. Unless noted otherwise, finish of hardware shall be as follows:
- B. Interior Butts, Locksets & Latchsets, Wyreless Locks, Cylinders, Floor Stops, Flush Bolts, shall be satin chrome finish (US26D).
- C. Exterior Butts, Continuous Hinges, Exit Devices, Door Pulls, Protection Plates, etc. shall be satin stainless steel (US32D). Plates shall be B.S, .062 ga.
- D. Thresholds, Sweeps and Door Bottoms shall be Aluminum.
- E. Closers shall be Sprayed to match other hardware.
- F. Adhesive Gasketing shall be charcoal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Furnish permanent cores to Owner for installation.
- E. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

3.2 ADJUSTING

- A. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.3 DOOR HARDWARE SCHEDULE

Door Hardware Group No. 1

Locations: Door numbers 1 and 4:

Qty.	Item	Basis of Design Product	Finish
3	Hinges	Stanley FBB268 swing clear (5 Knuckle Full Mortise heavy weight ball bearing)	BMHA 626
1	Lockset	Schlage WA5200-MG-17-KD-REN	BMHA 626
1	Card Reader	Schlage Wireless Reader (and associated peripherals)	
1	Closing Device	LCN 4110 Series Parallel Arm (push side) mounting	689
1	Floor Stop	Ives	BMHA 626
3	Silencers	Ives	

Door Hardware Group No. 2

Locations: Door number 2

Qty.	Item	Basis of Design Product	Finish
3	Hinges	Stanley FBB268 swing clear (5 Knuckle Full Mortise heavy weight ball bearing)	BMHA 626
1	Lockset	Schlage Allegion ND Series, Grade 1, ND53PD entrance lock (ANSI F109)	BMHA 626
1	Closing Device	LCN 4110 Series Parallel Arm mounting (pull side) – omit holding feature	689
3	Silencers	Ives	
1	Kick Plate	Ives	BMHA 626

Door Hardware Group No. 3

Locations: Door number 7 (Cross Corridor):

Qty.	Item	Basis of Design Product	Finish
2	Hinges	Syntegra edge mount cont. hinge EM Series	630
2	Flush Panic Electrified Exit Device	Syntegra XT-LC-ML	630
2	Automatic Operator	Dorma ED900	
2	Operator Paddle Button	Dorma 912	
2	Pocket Closer	Door Systems DSI -5051	689
2	Wall Magnet	LCN	628
1 Set	Smoke Seal	Syntegra SS	DBZ
2	Lockset	Schlage Allegion ND Series, Grade 1, ND53PD entrance lock (ANSI F109)	BMHA 626
1	Wire Transfer	Syntegra EPT-EM-105	
1	Power Supply	Syntegra PS-210	

Door Hardware Group No. 4

Locations: Door number 3

Qty.	Item	Basis of Design Product	Finish
6	Hinges	Stanley FBB168 (5 Knuckle Full Mortise heavy weight ball bearing)	BMHA 626
1	Lockset	Schlage WA5200-MG-17-KD-REN	BMHA 626
1	Dummy Lever		
1	Card Reader	Schlage Wireless Reader (and associated peripherals)	
1	Closing Device	LCN 4110 Series Parallel Arm (pull side) mounting on active leaf	689
1	Astragal	Ives	BMHA 626
1	Kick Plate	Ives	BMHA 626
2	Manual Flush Bolts	Ives	
2	Auto Door Bottoms		
2	Sets Gasketing		

Door Hardware Group No. 5

Locations: Door number 5

Qty.	Item	Basis of Design Product	Finish
3	Hinges	Stanley FBB268 swing clear (5 Knuckle Full Mortise heavy weight ball bearing)	BMHA 626
1	Lockset	Schlage Allegion ND Series, Grade 1, ND53PD entrance lock (ANSI F109)	BMHA 626
1	Closing Device	LCN 4110 Series Parallel Arm (pull side) mounting	689
3	Silencers	Ives	

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

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.
- B. See Division 01 Section "General Commissioning Requirements" for additional work associated with this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. DDC system for monitoring and controlling of HVAC systems.
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Work in this Section includes:
 - 1. A complete system including power and control wiring of all control system components and devices.
 - 2. Wiring circuits which are activated/de-activated by a control system component, such as but not limited to, EP/PE devices, high and low limit protective devices, solenoid air valves, relays, end switches, etc.
 - 3. Control panel wiring to control panels (unless noted otherwise) and to terminal strips, and field wiring from terminal strips to field-mounted devices.
 - 4. Wiring to the "auto" side of hand-off-auto switches on units being controlled by the controls contractor.
 - 5. Wiring of all electro-mechanical devices required to be located on or in temperature control panels.
 - 6. Power and control wiring to all control system equipment including, but not limited to, control panels, motorized dampers and valve actuators, control transformers, air terminal unit actuators, time clocks, relays, transformers, PE switches, remote switches, and all other control devices. Provide power wiring from electrical panel circuit breakers. Circuit breakers provided under Division 26 Section "Panelboards." Coordinate requirements with the Division 26 Contractor. Connect control panels to standby branch of power.
 - 7. Control equipment and devices that are provided with a voltage rating readily available at the location of installation. Coordinate with Contract Documents and Division 26 Contractor.
 - 8. Wiring between components of packaged equipment (i.e., humidifier to airflow proving switch, etc.).

9. Provision and wiring of all remote manual control devices, including but not limited to, on/off switches, on/off switches with pilot lights, manual time switches, variable speed control switches.
 10. Wiring of all smoke dampers and combination fire/smoke dampers including power wiring to damper; wiring between fire alarm system interface device and smoke dampers including all necessary control relays, contacts, and devices, rated for voltages and amperages involved; wiring of smoke damper end switches for control sequencing. Coordinate with Division 28 Section "Digital, Addressable Fire Alarm System."
 11. Interlock wiring from a fire alarm system interface device and/or duct-mounted smoke detector relay contact to unit control circuit for system shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 Section "Digital, Addressable Fire Alarm System."
 12. Interlock wiring from a fire alarm system interface device to unit control circuit for system emergency shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 Section "Digital, Addressable Fire Alarm System."
 13. All line voltage wiring and conduit. Comply with the requirements of Division 26 Section "Wires and Cables." A licensed electrician shall perform all work in strict accordance with the NEC and other local codes.
 14. All control wiring and cable. A licensed electrician shall perform all work in strict accordance with the NEC and other local codes.
 15. Integration with balancing work to provide support and calibration.
 16. Alternate wall mounted device locations as selected by the Architect and/or Engineer up to 15 feet from locations shown on plans.
 17. Ethernet devices, hardware and coordination as required to access LAN and Internet.
- C. Work By Others: The following work shall be performed by the associated division contractor under the supervision and coordination of this subcontractor.
1. Division 23 Sections "Hydronic Piping" and "Steam and Condensate Heating Piping" contractor shall be responsible for:
 - a. Installation of all line size and non-line size automatic valves and separable wells furnished under this contract.
 - b. Furnish and install all necessary valved pressure taps, steam, water and drain wells and overflow connections to piping.
 - c. Furnish and install all necessary piping connections required for flow indicating devices.
 2. Division 23 Section "Metal Ducts" contractor shall be responsible for:
 - a. Install all control and smoke dampers and combination fire/smoke dampers and provide safing as required to install non-duct size dampers.
 - b. Assemble multiple section dampers with required interconnecting linkages and extend the required number of shafts through the ducts of externally mounted damper motors.

- c. Provide and locate sheet metal baffle plates in ductwork, units, mixing boxes, plenums, etc., as required to eliminate stratification. Affix baffles permanently in place after stratification problem has been eliminated.
 - d. Provide access doors or other approved means of access through ducts for service to control equipment.
 - e. Mount airflow measuring stations and static pressure sensors in ductwork as directed under this contract.
 - f. Mount air valves in ductwork as directed by this contractor.
 - g. Install all duct smoke detectors as furnished under Division 28.
3. Division 26 contract shall be responsible for:
- a. Furnishing, installing and terminating all feeder and/or branch circuit wiring to major equipment including:
 - 1) Wiring to and between all disconnects, starters, drives and equipment motors.
 - b. Furnishing and installing of circuit breakers (20 A-1 phase) in power panels for use by the ATCS Contractor to power the ATCS.
 - c. Furnishing duct smoke detectors specified under Division 28. The installation of the detectors shall be under Division 23 Section "Metal Ducts" and as supervised by this Contractor. The Division 26 Contractor shall furnish and install all wiring between the detector and the fire alarm system.

1.3 DEFINITIONS

- A. Backbone: A facility (e.g., pathway, cable, or conductors) between automation system cabinets or between buildings.
- B. BICSI: Building Industry Consulting Service International.
- C. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- F. COV: Changes of value.
- G. DDC: Direct digital control.
- H. EMI: Electromagnetic interference.

- I. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- J. HLC: Heavy load conditions.
- K. Horizontal Cabling: Cabling between, and including, the building automation system outlet or the first mechanical terminations on the horizontal connection point and the horizontal cross-connect.
- L. IDC: Insulation displacement connector.
- M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- N. LAN: Local area network.
- O. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- P. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- Q. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- R. Modbus TCP/IP: An open protocol for exchange of process data.
- S. MS/TP: Master-slave/token-passing, IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- T. MTBF: Mean time between failures.
- U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- W. PC: Personal computer.
- X. PID: Proportional plus integral plus derivative.
- Y. RAM: Random access memory.

- Z. RCDD: Registered Communications Distribution Designer.
- AA. RF: Radio frequency.
- BB. RMC: Rigid metallic conduit.
- CC. Router: Device connecting two or more networks at network layer.
- DD. RTD: Resistance temperature detector.
- EE. Server: Computer used to maintain system configuration, historical and programming database.
- FF. TCP/IP: Transport control protocol/Internet protocol.
- GG. UPS: Uninterruptible power supply.
- HH. UTP: Unshielded twisted pair.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site prior to any installation but after acceptance of submittals. Attendees shall include the General Contractor/Construction Manager, Architect, Engineer, Commissioning Agent, Mechanical Contractor, Testing, Adjusting, and Balancing Contractor, any affected sub-contractors, and Owner or Owner's Representative.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.
 - 1. System Performance Objectives:
 - a. DDC system shall manage HVAC systems.
 - b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
 - c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
 - d. DDC system shall operate while unattended by an operator and through operator interaction.
 - e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

C. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy: The system shall report all values with an end to end minimum accuracy as follows:
 - a. Water Temperature: Plus or minus 1 deg. F.
 - b. Water Pressure: Plus or minus 2 percent of full scale.
 - c. Space Temperature: Plus or minus 1 deg. F.
 - d. Ducted Air Temperature: Plus or minus 1 deg. F.
 - e. Outside Air Temperature: Plus or minus 2 deg. F.
 - f. Dew Point Temperature: Plus or minus 3 deg. F.
 - g. Temperature Differential: Plus or minus 0.25 deg. F.
 - h. Relative Humidity: Plus or minus 5 percent.
 - i. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - j. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - k. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - l. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - n. Electrical: Plus or minus 5 percent of reading.
9. Stability and Accuracy of Control: Control loops shall maintain measured variable at setpoint within the following minimum tolerances:
 - a. Liquid Pressure (Greater Than 1 psig): Plus or minus 1.5 psig.
 - b. Liquid Pressure (Less Than 50-Inch wg): Plus or minus 1.0 inch wg.
 - c. Air Pressure (0-6 Inch wg Range): Plus or minus 0.2 .
 - d. Air Pressure (0.01-0.1 Inch wg Range): Plus or minus 0.0.1 inch wg.
 - e. Air Flow: Plus or minus 10% of full range.
 - f. Space Temperature: Plus or minus 2 deg. F.
 - g. Duct Temperature: Plus or minus 3 deg. F.
 - h. Relative Humidity: Plus or minus 5 percent.

D. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.

E. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by instrument and application.

F. Electric Power Quality:

1. Power-Line Surges:

- a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
- b. Do not use fuses for surge protection.
- c. Test protection in the normal mode and in the common mode, using the following two waveforms:
 - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

- a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
 - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.

- 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

G. UPS:

1. DDC system products and devices powered by UPS units shall include the following:
 - a. Desktop workstations.
 - b. Printers.
 - c. Servers.
 - d. Gateways.
 - e. DDC controllers.
 - f. Air handling equipment isolation damper actuators (including motorized dampers, smoke dampers, and combination fire and smoke dampers).

H. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

1.6 TECHNICAL PROPOSAL

A. Technical proposals shall be prepared in accordance with these specifications. Four copies of the proposal shall be submitted at the time of Bid. Proposals that are unbound, loose, in a file folder, or stapled in a file folder will not be acceptable. The technical proposal shall include the following data/information as a minimum.

1. Information on organizational capabilities to handle this project (project management, personnel and staffing, single source responsibility, etc.).
2. Information and description of training program.
3. Description of system architecture including schematic block diagram showing building front end workstation, MER touch screen displays, DDC panels, interface with existing campus BAS network, and future interface with the laboratory control system.
4. Describe system operation, functions and control techniques.
5. A full description of system modularity.
6. Provisions against obsolescence due to technological advancements.
7. Provide hardware and software technical data sheets on system interfaces and integration requirements.
8. Provide a detailed narrative description of how the new building wide BAS (including future laboratory fit-out) will interface with the existing campus wide system. Include a

- description of all hardware and software upgrades (including web-based enhancements) required for the existing campus wide system for seamless integration.
9. Detailed description of all operating, command, application and energy management software provided for this project.
 10. Provide a detailed narrative description of approach to complying with the LEED measurement and verification requirements described in this Specification. Include a description of hardware, software and energy usage color graphic pages. Describe in detail the proposed approach to graphical pages, navigation, energy usage calculations, historical trending, and hyperlinks to main building graphical user interface. Provide a list and description of other installed and operating BAS projects with LEED requirements.
 11. Provide a written guarantee of how long the system proposed will be a standard product backed by ongoing parts availability and factory/field technical support.
 12. A signed certificate stating that the BAS Contractor has read the performance and functional requirements, understands them, and that the technical proposal shall conform with all parts of the Specification. Provide a line-by-line concordance summary stating compliance with every specification section herein.
 13. Provide a recommended spare parts list, which the Owner shall maintain at the site with the associated cost of each part. The BAS Contractor shall provide a separate spare parts list for both the warranty period and beyond for the post-warranty period. All spare parts recommended shall be made available 10 years beyond the warranty period.
 14. Provide detailed information on the web server browser package proposed for this project.

1.7 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, operator notations, and a graphics tree showing how graphics are organized and linked.
10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.

C. Delegated-Design Submittal: For DDC system products and installation.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Face velocity at Project design and minimum airflow conditions.
 - c. Pressure drop across damper at Project design and minimum airflow conditions.
 - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
 - e. Maximum close-off pressure.
 - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.
3. Schedule and design calculations for control valves and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure-differential drop across valve at Project design flow condition.
 - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.

- d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.
 - 4. Schedule and design calculations for selecting flow instruments.
 - a. Instrument flow range.
 - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - d. Pressure-differential loss across instrument at Project design flow conditions.
 - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.
 - D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
 - E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
 - F. Software and Firmware Operational Documentation: Include the following:
 - 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.
 - 5. Software license required by and installed for DDC workstations and control systems.
 - G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Coordination Drawings:
 - 1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Product installation location shown in relationship to room, duct, pipe and equipment.
 - b. Structural members to which products will be attached.

- c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
 - d. Size and location of wall access panels for products installed behind walls and requiring access.
 - 2. Reflected ceiling 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:
 - a. Ceiling components and items penetrating finished ceilings.
 - b. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
- B. Qualification Data:
 - 1. Systems Provider Qualification Data:
 - a. Resume of project manager assigned to Project.
 - b. Resumes of application engineering staff assigned to Project.
 - c. Resumes of installation and programming technicians assigned to Project.
 - d. Resumes of service technicians assigned to Project.
 - e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
 - f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
 - g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
 - h. Owner contact information for past project including name, phone number, and e-mail address.
 - i. Contractor contact information for past project including name, phone number, and e-mail address.
 - j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.
 - 2. Manufacturer's qualification data.
 - 3. Testing agency's qualifications data.
- C. Product Test Reports.
- D. Preconstruction Test Reports: For each separate test performed.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Testing and Commissioning Reports and Checklists: Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3 "Demonstration and Acceptance."

H. Sample Warranty: For manufacturer's warranty.

1.9 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - g. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
 - j. List of recommended spare parts with part numbers and suppliers.
 - k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - m. Licenses, guarantees, and warranty documents.
 - n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - o. Owner training materials.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. Moisture Sensor and Transmitter: One of each type.
 - 2. Room Temperature Sensor and Transmitter: One of each type.

1.11 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Installer Qualifications: Cabling installer must have on staff personnel certified by BICSI.
 - 1. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, who shall be present at all times when Work of this Section is performed at the project site.
- C. Electrical Installer: Line voltage wiring for the automatic control system shall be done by a Licensed Electrician.
- D. 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.
- E. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- F. Comply with ASHRAE 135 for DDC system components.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory-mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.13 COORDINATION

- A. Coordinate and confirm location of thermostats, humidistats, and other exposed control sensors with Architect/Engineer and plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system, including power/control voltage ratings and control sequence requirements.
- C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation, including emergency power to all control components necessary to assure proper operation of HVAC equipment on the emergency power distribution system.
- D. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- E. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- F. Coordinate equipment with Division 26 Sections "Enclosed Controllers" and "Variable-Frequency Motor Controllers" to achieve compatibility with controllers and annunciation devices.
- G. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- H. Coordinate support of balancing requirements and system component calibration requirements with Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

1.14 LICENSING

- A. Software: Owner has full license of use of all software programming, including the right to change and edit programming to suit needs.
- B. Protocols: Owner has full license to all system and networking protocols.
- C. Points: Owner has full license to all system points to change, modify or otherwise alter to suit needs.

PART 2 - PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

- A. DDC system shall be an expansion of the existing DDC system. Campus vendor shall provide all necessary hardware and software upgrades necessary to support the proposed system modifications.

2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 - 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- 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.

2.3 COMMUNICATION AND ARCHITECTURE

- A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to ANSI/ASHRAE Standard 135-1995, BACnet.
- B. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this Section.
- C. The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.
- D. All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.
- E. Remote operator interface shall be via web-based server software for remote operator interface using the BACnet PTP Data Link/Physical layer protocol. Remote operator interface via this software shall allow for communication with any and all controllers on this network as described below.
- F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
 - 1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly

- connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.
- G. The time clocks in all controllers shall be automatically synchronized daily via the internetwork. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the internetwork.
- H. The internetwork shall have the following minimum capacity for future expansion:
1. Each building controller shall have routing capacity for 50 controllers.
 2. The building controller network shall have capacity for 50 building controllers.
 3. The system shall have an overall capacity for 12,500 building controllers, custom application controller, and application specific controller input/output objects.
- I. Building Controllers: Provide an adequate number of building controllers to achieve the performance specified in Part 1 article on "System Performance." Each of these panels shall meet the following requirements:
1. The Building Automation System (BAS) shall be composed of one or more independent, standalone, microprocessor-based building controllers to manage the global strategies of the system.
 2. The building controller shall have sufficient memory to support its operating system, database, trending, and programming requirements.
 3. Data shall be shared between networked building controllers.
 4. The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 5. Each building controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol. Each building controller also shall perform BACnet routing to a network of custom application and application specific controllers.
 6. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
- J. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, power and control wiring, and accessories to control mechanical systems.

2.4 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded.
6. Security Access:
 - a. Operator access to DDC system shall be under password control.
 - b. An alphanumeric password shall be field assignable to each operator.
 - c. Operators shall be able to access DDC system by entry of proper password.
 - d. Operator password shall be same regardless of which computer or other interface means is used.
 - e. Additions or changes made to passwords shall be updated automatically.
 - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
 - g. Software shall have at least five access levels.
 - h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.

- i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
7. Data Segregation:
- a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
 - b. Include at least 32 segregation groups.
 - c. Segregation groups shall be selectable.
 - d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
 - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
 - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
8. Operators shall be able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday schedules.
 - k. Change time and date.
 - l. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
9. Reporting:
- a. Generated automatically and manually.
 - b. Sent to displays, printers and disk files.
 - c. Types of Reporting:
 - 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.

- 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
 - 7) List of items defined in a "Follow-Up" file.
 - 8) List weekly schedules.
 - 9) List holiday programming.
 - 10) List of limits and deadbands.
10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.

17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
 - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
 - c. Keyboard equivalent shall be available for those operators with that preference.
20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:
 - a. On-line context-sensitive help utility to facilitate operator training and understanding.
 - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
 - 1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
 - c. Available for Every Menu Item:
 - 1) Index items for each system menu item.
22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.
 - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols.
 - b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
 - 1) Define background screens.
 - 2) Define connecting lines and curves.
 - 3) Locate, orient and size descriptive text.
 - 4) Define and display colors for all elements.
 - 5) Establish correlation between symbols or text and associated system points or other displays.

- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
 2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
 - a. Room layouts with room identification and name.
 - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
 - c. Location and identification of each hardware point being controlled or monitored by DDC system.
 3. Control schematic for each of following, including a graphic system schematic representation, with point identification, set point and dynamic value indication, sequence of operation, and control logic diagram.
 4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
 5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, operator workstations, and other network devices.
- E. Customizing Software:
1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
 2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
 3. As a minimum, include the following modification capability:
 - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
 - b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
 - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
 - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
 - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.

- f. Point related change capability shall include the following:
 - 1) System and point enable and disable.
 - 2) Run-time enable and disable.
 - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
 - 4) Assignment of alarm and warning limits.
- g. Application program change capability shall include the following:
 - 1) Enable and disable of software programs.
 - 2) Programming changes.
 - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
- 4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
- 5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
- 6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
 - a. Proportional control (P).
 - b. Proportional plus integral (PI).
 - c. Proportional plus integral plus derivative (PID).
 - d. Adaptive and intelligent self-learning control.
 - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
 - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
- 7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
- 8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
- 9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
- 10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
 - a. Class 1:
 - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.
 - c. Class 3:
 - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
 - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.

- 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
- d. Class 4:
- 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
 10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Each report shall be definable as to data content, format, interval and date.
3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation or server for historical reporting.
4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Reports and logs shall be stored on workstation or server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.

H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.

- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Standard Trends:
 - 1. Trend all I/O point present values, set points, and other parameters indicated for trending.
 - 2. Trends shall be associated into groups, and a trend report shall be set up for each group.
 - 3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
 - 4. Preset trend intervals for each I/O point after review with Owner.
 - 5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
 - 6. When drive storage memory is full, most recent data shall overwrite oldest data.
 - 7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
 - 1. Each trend shall include interval, start time, and stop time.
 - 2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on [workstation] [server] hard drives.
 - 3. Data shall be retrievable for use in spreadsheets and standard database programs.
- L. Programming Software:
 - 1. Include programming software to execute sequences of operation indicated.
 - 2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
- M. Database Management Software:
 - 1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
 - 2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
 - 3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
 - a. Backup.
 - b. Purge.
 - c. Restore.

4. Database management software shall support the following:
 - a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
 - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
 - c. Backup: Include means to create a database backup file and select a storage location.
 - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
 - a. Ready.
 - b. Purging record from a database.
 - c. Action failed.
 - d. Refreshing statistics.
 - e. Restoring database.
 - f. Shrinking a database.
 - g. Backing up a database.
 - h. Resetting Internet information services.
 - i. Starting network device manager.
 - j. Shutting down the network device manager.
 - k. Action successful.
6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
 - a. Allow operator to set and review scan intervals and start times.
 - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
 - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
 - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
 - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.

2.5 OFFICE APPLICATION SOFTWARE

- A. Product: Microsoft Office.

- B. Include current version of office application software at time of Substantial Completion.
- C. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."
 - 1. Database.
 - 2. E-mail.
 - 3. Presentation.
 - 4. Publisher.
 - 5. Spreadsheet.
 - 6. Word processing.

2.6 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg. F.
 - 3. Controllers located outdoors shall be rated for operation at -40 to 150 deg. F.
- F. Power and Noise Immunity:
 - 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- G. DDC Controller Spare Processing Capacity:
 - 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 60 percent.
 - c. Application-Specific Controllers: Not less than 70 percent.

2. Memory shall support DDC controller's operating system and database and shall include the following:
 - a. Monitoring and control.
 - b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.
- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
 1. Ten percent of each AI, AO, BI, and BO point connected to controller.
 2. Minimum Spare I/O Points per Controller:
 - a. AIs: Two.
 - b. AOs: Two.
 - c. BIs: Three.
 - d. BOs: Three.
- I. Maintenance and Support: Include the following features to facilitate maintenance and support:
 1. Mount microprocessor components on circuit cards for ease of removal and replacement.
 2. Means to quickly and easily disconnect controller from network.
 3. Means to quickly and easily access connect to field test equipment.
 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- J. Input and Output Point Interface:
 1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
 2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
 3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
 4. AIs:
 - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
 - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection shall be provided for each AI.
 - e. Capable of being individually calibrated for zero and span.

- f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
- 5. AOs:
 - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.
 - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
- 6. BIs:
 - a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
 - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
 - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
 - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
- 7. BOs:
 - a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
 - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
 - b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
 - c. BOs shall be selectable for either normally open or normally closed operation.

2.7 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.
2. Retain "Local Keypad and Display" Subparagraph below to require a local keypad and display. Requirement adds cost and is unnecessary for most applications. Local Keypad and Display:
 - a. Equip controller with local keypad and digital display for interrogating and editing data.
 - b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

2.8 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.
2. Local Keypad and Display:
 - a. Equip controller with local keypad and digital display for interrogating and editing data.
 - b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.9 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.

2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Serviceability:
 1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.10 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
 1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
 2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
 3. Control functions shall be executed within controllers using DDC algorithms.
 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 1. Operator access shall be secured using individual security passwords and user names.
 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
 3. Operator log-on and log-off attempts shall be recorded.
 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
 1. Weekly Schedule:
 - a. Include separate schedules for each day of week.

- b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
 - c. Each schedule may consist of up to 10 events.
 - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
- 2. Exception Schedules:
 - a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
- 3. Holiday Schedules:
 - a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Schedules may be placed on scheduling calendar and will be repeated each year.
 - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
 - 1. Include standard application for proper coordination of equipment.
 - 2. Application shall include operator with a method of grouping together equipment based on function and location.
 - 3. Group may then be used for scheduling and other applications.
- E. Binary Alarms:
 - 1. Each binary point shall be set to alarm based on operator-specified state.
 - 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 - 1. Each analog object shall have both high and low alarm limits.
 - 2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
 - 1. Operator shall be able to determine action to be taken in event of an alarm.
 - 2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
 - 3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication:
 - 1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:
 - a. Reset air-handling unit supply temperature set points.
 - b. Reset space temperature set points.
 - c. De-energize equipment based on priority.
4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum shutoff time for equipment.
 - e. Minimum shutoff time for equipment.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence fans and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
 - e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI and BO points.
2. A high run-time alarm shall be assigned, if required, by operator.

2.11 ENCLOSURES

A. General Enclosure Requirements:

1. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
2. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
3. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
4. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.

3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

2.12 RELAYS

A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg. F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.

4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
 - d. Repeatability: Within 2 percent.
 - e. Recycle Time: 45 ms.
 - f. Minimum Pulse Width Control: 50 ms.
 - g. Power Consumption: 5 VA or less at 120-V ac.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg. F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg. F.
7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.

3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Description:
 - a. On-off control and status indication in a single device.
 - b. LED status indication of activated relay and current trigger.
 - c. Closed-Open-Auto override switch located on the load side of the relay.
2. Performance:
 - a. Ambient Temperature: Minus 30 to 140 deg. F.
 - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
3. Status Indication:
 - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
 - b. Current Sensor Range: As required by application.
 - c. Current Set Point: Fixed or adjustable as required by application.
 - d. Current Sensor Output:
 - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
 - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
 - 3) Analog, zero- to 5- or 10-V dc.
 - 4) Analog, 4 to 20 mA, loop powered.
4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
5. Enclosure: NEMA 250, Type 1 enclosure.

2.13 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. 250 through 1000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

- a. UPS shall provide a minimum of five minutes of battery power.
 3. Performance:
 - a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
 - b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
 - d. On Battery Output Voltage: Sine wave.
 - e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
 - f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
 - g. Transfer Time: 6 ms.
 - h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
 4. UPS shall be automatic during fault or overload conditions.
 5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
 6. Include front panel with power switch and visual indication of power, battery, fault and temperature.
 7. Unit shall include an audible alarm of faults and front panel silence feature.
 8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
 9. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
 10. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
 11. Include tower models installed in ventilated cabinets to the particular installation location.
- B. 1000 through 3000 VA:
1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
 2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
 - a. UPS shall provide a minimum of five minutes of battery power.
 3. Performance:
 - a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
 - b. Power Factor: Minimum 0.97 at full load.
 - c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
 - d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
 - e. Recharge time shall be a maximum of eight hours to 90 percent capacity.

4. UPS bypass shall be automatic during fault or overload conditions.
5. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
6. Batteries shall be sealed lead-acid type and be maintenance free.
7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

2.14 INPUT DEVICES

A. General Requirements:

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors:

1. Manufacturers:

- a. Primary controls manufacturer.
- b. Ashcroft, Inc.
- c. MAMAC Systems, Inc.
- d. Vaisala Group.
- e. Veris Industries.

2. General Requirements:

- a. The temperature sensor shall be of the resistance type and shall be 2-wire 1000 ohm RTD.

3. Room Temperature Sensors:

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have the following options when specified:
 - 1) Setpoint reset slide switch providing a +/-3 degrees (adjustable) range.
 - 2) Individual heating/cooling setpoint slide switches.
 - 3) A momentary override request pushbutton for activation of after-hours operation.
 - 4) Analog thermometer.

4. Room Temperature Sensors with Integral Display:

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have an integral LCD display and a four button keypad with the following capabilities:
 - 1) Display room and outside air temperatures.

- 2) Display and adjust room comfort setpoint.
 - 3) Display and adjust fan operation status.
 - 4) Timed override request pushbutton with LED status for activation of after-hours operation.
 - 5) Display controller mode.
 - 6) Password selectable adjustment of setpoint and override modes.
5. Thermo Wells:
 - a. Thermo wells shall be pressure-rated and constructed in accordance with the system working pressure.
 - b. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
6. Outside Air Sensors:
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
7. Duct Mount Sensors:
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
8. Averaging Sensors:
 - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of four sensing points per 12 ft. long segment.
 - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
- C. Humidity Sensors:
 1. Manufacturers:
 - a. Primary controls manufacturer.

- b. MAMAC Systems, Inc.
 - c. Setra Systems, Inc.
 - d. Vaisala Group.
 - e. Veris Industries.
- 2. The sensor shall be a solid-state type, relative humidity sensor of the bulk polymer design. The sensor element shall resist service contamination.
 - 3. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a two-wire isolated loop powered 4-20 mA, 0-100% linear proportional output.
 - 4. The humidity transmitter shall meet the following overall accuracy, including lead loss and analog to digital conversion. Three percent between 20% and 80% RH at 77 deg. F unless specified elsewhere.
 - 5. Outside air relative humidity sensors shall be installed with a rainproof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
 - 6. A single point humidity calibrator shall be provided for field calibration. Transmitters shall be shipped factory pre-calibrated.
 - 7. Duct type sensing probes shall be constructed of 304 stainless steel and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

D. Differential Pressure Transmitters/Transducers:

- 1. Manufacturers:
 - a. Ashcroft, Inc.
 - b. MAMAC Systems, Inc.
 - c. Setra Systems, Inc.
 - d. Veris Industries.
- 2. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with tee fittings and shutoff valves in the high and low sensing pickup lines to allow the Balancing Contractor and Owner permanent, easy-to-use connection.
 - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
- 3. Low Differential Water Pressure Applications (0" to 20" w.c.):
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.

- b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) 0.01 to 20" w.c. input differential pressure range.
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
- 4. Low Differential Air Pressure Applications (0" to 5" w.c.):
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) 0.00 - 1.00" to 5.00" w.c. input differential pressure ranges (select range appropriate for system application).
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
- E. Flow Monitoring:
 - 1. Air Flow Monitoring:
 - a. Manufacturers:
 - 1) Air Monitor Corp.
 - 2) Ebtron, Inc.
 - 3) Tek-Air Systems, Inc.
 - b. Fan Inlet Air Flow Measuring Stations:
 - 1) At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.
 - 2) Each traverse probe shall be of a dual manifolded, cylindrical, Type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as +20 deg. in the approaching air stream.

- 3) The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with ASHRAE Standards for duct traversing.

c. Duct Air Flow Measuring Stations:

- 1) Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of Fundamentals, as well as in the Industrial Ventilation Handbook.
- 2) Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 degree connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.
- 3) The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
- 4) The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
- 5) The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
- 6) Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
- 7) Installation Considerations:
 - a) The maximum allowable pressure loss through the flow and static pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.
 - b) The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.
 - c) Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of

the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

- d) Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.
- e) Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

2. Static Pressure Traverse Probe:

a. Manufacturers:

- 1) Ebtron, Inc.
- 2) MAMAC Systems, Inc.
- 3) Veris Industries.

b. The probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe.

c. Size: 75% of duct width.

3. Shielded Static Air Probe:

a. Manufacturers:

- 1) Ebtron, Inc.
- 2) MAMAC Systems, Inc.
- 3) Veris Industries.

b. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

F. Power Monitoring Devices:

1. Current Measurement (amps):

a. Manufacturers:

- 1) Schneider Electric.
- 2) Setra Systems, Inc.
- 3) Veris Industries.

b. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5-amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

- c. Current Transformer: A split core current transformer shall be provided to monitor motor amps.
 - 1) Operating Frequency: 50 to 400 Hz.
 - 2) Insulation: 0.6 kV Class 10Kv BIL.
 - 3) UL recognized.
 - 4) Five amp secondary.
 - 5) Select current ration as appropriate for application.
- d. Current Transducer: A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
 - 1) 6X input over amp rating for AC inrushes of up to 120 amps.
 - 2) Manufactured to UL 1244.
 - 3) Accuracy: +.5%, ripple +1%.
 - 4) Minimum Load Resistance: 30 kOhm.
 - 5) Input: 0-20 amps.
 - 6) Output: 4-20 mA.
 - 7) Transducer shall be powered by a 24 Vdc regulated power supply (24 Vdc +5%).

G. Status and Safety Switches:

1. General Requirements:

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches:

- a. Manufacturers:
 - 1) Schneider Electric.
 - 2) Setra Systems, Inc.
 - 3) Veris Industries.
- b. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- c. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- d. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Filter Status Switches:
 - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120 Vac.
 - b. A complete installation kit shall be provided, including static pressure tops, tubing, fittings, and air filters.
 - c. Provide appropriate scale range and differential adjustment for intended service.
4. Air Flow Switches:
 - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
5. Air Pressure Safety Switches:
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 Vac.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
6. Low Temperature Limit (Freeze) Switches:
 - a. The low temperature limit switch shall be of the manual reset type with double pole/single throw snap acting contacts rated for 16 amps at 120 Vac.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturer's recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.15 MISCELLANEOUS DEVICES

A. Local Control Panels:

1. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices such as relays, transducers, and so forth that are not required to be located external to the control panel due to function. Where specified the display module shall be flush-mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provided via removable or fixed screw terminals.

4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 Vac duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies:

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 Vac +10%, 60 Hz.
3. Output: 24 Vdc.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

2.16 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell or comparable product by one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole).

C. Pilot Light Switches, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell or comparable product by one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell or comparable product by one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.17 BREAK-GLASS EMERGENCY SWITCHES

A. Comply with NEMA WD 1, NEMA 4X and UL A600.

B. Switches, 600 V, 10 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Intec Controls, I-EBG1-2 or comparable product by one of the following:
 - a. Honeywell Analytics H8-EMBG
 - b. Intec Controls, I-EBG1
 - c. Veris, ST120
2. Accessories:
 - a. Hammer on a secure chain
 - b. NO and NC contacts
 - c. 5 spare discs, minimum

2.18 ACTUATORS

A. Manufacturers:

1. Belimo Aircontrols (USA), Inc.

B. Electronic Damper Actuators:

1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Paralleling: Mechanically and electrically paralleled to increase torque as required.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
5. Fail-Safe Operation: Mechanical, spring-return mechanism or internal capacitors.
6. Power Requirements (Two-Position): 24 Vac.
7. Power Requirements (Proportional): Maximum 10 VA at 24 Vac or 8 W at 24 Vdc.

8. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through an EEPROM without the use of actuator-mounted switches.
9. Temperature Rating: -22 to +122 deg. F.
10. Housing: Minimum requirement NEMA Type 2 / IP54 mounted in any orientation.
11. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.

C. Electronic Valve Actuators:

1. Size for torque required for valve close off at 150% of total system (head) pressure for two-way valves; and 100% of pressure differential across the valve or 100% of total system (pump) head differential pressure for 3-way valves.
2. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
3. Paralleling: Mechanically and electrically paralleled to increase torque as required.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism or internal capacitors.
6. Power Requirements: Maximum 10 VA at 24 Vac or 8 W at 24 Vdc.
7. Maximum 1 VA at 24 Vac or 1 W at 24 Vdc.
8. Temperature Rating: -22 to +122 deg. F.
9. Housing: Minimum requirement NEMA Type 2 / IP54 mounted in any orientation.
10. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.

D. Terminal Unit Valve Actuators:

1. Close-Off (Differential) Pressure Rating: 200 psi.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle or an ISO-style direct-coupled mounting pad.
3. Power Requirements: Maximum 1 VA at 24 Vac or 1 W at 24 Vdc.
4. Temperature Rating: -22 to +122 deg. F -30 to +50 deg. C.
5. Housing Rating: Minimum UL94-5V(B) flammability.
6. Agency Listing: CE, UL 60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE according to 89/336/EEC.

2.19 CONTROL VALVES

A. Manufacturers:

1. Belimo Aircontrols (USA), Inc.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Select control valves, except wafer types, with the following end connections:

1. For Piping, NPS 2 and Smaller: Threaded ends.

2. For Piping NPS 2-1/2 to NPS 4: Flanged ends.

D. Characterized Control Valves:

1. NPS 3 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ~~ball trim~~ and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
2. NPS 3/4" and Smaller for Terminal Units: Nickel-plated forged brass body rated at no less than 600 psi, ~~chrome-plated brass ball and~~ **stainless steel trim**, blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats.

E. Sizing for Hydronic Valves:

1. Two-Position: Line size or size using a pressure differential of 1 psi.
2. Two-Way Modulating: 5 psig or twice the load pressure drop, whichever is more.
3. Three-Way Modulating: Twice the load pressure drop, but not more than 3 psig.

F. Sizing for Steam Valves:

1. Two-Position: Line size or size using 10 percent of inlet gauge pressure.
2. Modulating:
 - a. 15 psig or Less Inlet Steam Pressure: The pressure drop shall be 80 percent of the inlet gauge pressure.
 - b. Higher than 15 psig Inlet Steam Pressure: The pressure drop shall be 42 percent of the inlet absolute pressure.
3. Close-Off Pressure Rating: 100 psi. For NPS 3/4" and smaller terminal units, 200 psi.
4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.

G. Hydronic System Pressure Independent Control Valves:

1. NPS 2 and Smaller: Forged brass body rated at 400 psi, ~~chrome-plated brass ball and stem~~ **stainless steel trim**, female NPT union ends, dual EPDM lubricated O-rings and a ~~brass or TEFZEL~~ **stainless steel** characterizing disc.
2. NPS 2-1/2 and Larger: Cast-iron body according to ANSI Class 125, standard Class B, stainless steel ~~ball trim~~ and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
3. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 psi differential across the valve with a valve body accuracy of +/-5% variance due to differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
4. Flow Characteristics: Equal percentage characteristics.

H. Steam system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: ANSI Class 250 bronze body; stainless steel seat, stem and plug; and a TFE packing.
2. NPS 2-1/2 and Larger: ANSI Class 125 cast-iron body; stainless steel seat, stem and plug; and a TFE V-ring packing.
3. Flow Characteristics: Linear or equal percentage characteristics.
4. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of operating (inlet) pressure.

I. Butterfly Valves, Resilient Seat:

1. NPS 2 to 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. External mechanical methods to achieve this mechanical connection, such as pins or screws, are not acceptable. The shaft shall be supported at four locations by RPTFE bushings.
- ~~2. NPS 14 and Larger: Valve body shall be full lugged cast iron 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc to stem connection shall utilize a dual pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.~~
3. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
 - b. Modulating: 3 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree open-position with the design velocity less than 12 feet per second.
4. Close-Off Pressure Rating: NPS 2-12, 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

J. Two-Position (On/Off) Valves:

1. NPS 1 and Smaller: Forged brass body rated at no less than 300 psi, stainless steel stem, female, NPT union or sweat with a stainless steel stem and EPDM seals.
2. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
3. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for two-way valves and 125% of the design pressure differential across the 3-way valves.
4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory.

K. Pre-Piped Coil Connection Kits: Where utilized in lieu of individual components, valves and accessories must match functionality of details on drawings and meet the individual component requirements specified in Division 23.

1. Control valves must be an individual component and shall not serve multiple purposes.
2. Supply inlet and return outlet shall have individual shut-off valves that serve no other purpose than to isolate the remaining components from the system for repair or removal. Shut-off valves may be installed separately if not integrated into the coil connection kit.

2.20 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Ruskin Company.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Ratings:

1. Leakage: Damper shall have a maximum leakage of 10 cfm/sq. ft. at 1" w.g. for a 12" wide damper and shall be AMCA licensed as Class 1A.
2. Differential Pressure: Damper shall have a maximum differential pressure rating of 13" w.g. for a 12" blade.
3. Velocity: Damper shall have a maximum velocity rating of 6,000 fpm.
4. Temperature: Damper shall be rated for 250 deg. F.

C. Construction:

1. Frame: 5 inches x minimum 16 gage roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage U-channel.
2. Blades:
 - a. Style: Airfoil-shaped, single-piece.
 - b. Action for Two Position Dampers: Parallel.
 - c. Action for Modulating Dampers: Opposed.
 - d. Orientation: Horizontal.
 - e. Material: Minimum 16 gage equivalent thickness, galvanized steel.
 - f. Width: Nominal 6 inches.
3. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.
4. Seals:
 - a. Blade: Extruded neoprene type for ultra-low leakage from 250 deg. F. Mechanically attached to blade edge.
 - b. Jamb: Flexible metal compression type.
5. Linkage: In frame.
6. Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.
7. Finish: Mill galvanized.

2.21 DAMPER ACCESSORIES

- A. End Switch Package:
 - 1. Two-position indicator switches linked directly to damper blade to remotely indicate damper blade position.
- B. Flange Frame: Minimum 6 inches x 1-3/8 inches x 0.125 inch aluminum, bolt holes in corners.
 - 1. Mates To: TDC, TDF, Ductmate, Nexus, Ward, and other T-flange duct connections.
 - 2. Performance: Maximum free area and lowest pressure drop.
- C. Factory Sleeve: Minimum 20 gage thickness, minimum 12 inches length.
- D. Duct Transition Connection: Round, oval or rectangular to match duct connections.

2.22 UNSHIELDED TWISTED-PAIR CABLING

- A. Cable Manufacturers:
 - 1. Avaya Inc.
 - 2. Belden Inc.; Electronics Division.
 - 3. CommScope Properties, LLC.
 - 4. General Cable Technologies Corporation.
 - 5. Helix/HiTemp Cables, Inc.
 - 6. KRONE Incorporated.
 - 7. Mohawk/CDT; a division of Cable Design Technologies.
 - 8. Nordex/CDT; a Subsidiary of Cable Design Technologies.
 - 9. Remeo Products Corp.
 - 10. Superior Essex; Superior Telecommunications Inc.
 - 11. West Penn Wire/CDT; a division of Cable Design Technologies.
- B. Terminal and Connector Component Manufacturers:
 - 1. AMP; a Tyco International Ltd. Company.
 - 2. Amphenol Corporation.
 - 3. Avaya Inc.
 - 4. Connect-Tech Products.
 - 5. Cooper Wiring Devices; a division of Cooper Industries, Inc.
 - 6. Homaco.
 - 7. Hubbell Premise Wiring.
 - 8. KRONE Incorporated.
 - 9. Leviton Voice & Data Division.
 - 10. Lucent Technologies; Global Service Provider.
 - 11. Mohawk/CDT; a division of Cable Design Technologies.
 - 12. Molex Premise Networks; a division of Molex, Incorporated.
 - 13. Nordex/CDT; a Subsidiary of Cable Design Technologies.
 - 14. Panduit Corp.

- 15. Thomas & Betts Corporation.
 - C. 100-Ohm UTP: Comply with UL 444.
 - D. Backbone Copper Cable:
 - 1. No. 24 AWG.
 - 2. Comply with ICEA S-80-576 and TIA/EIA-568 B.2, Categories 5e and 6.
 - 3. NFPA 70, Type CMR complying with UL 1666.
 - 4. Cable Jacket Color: Blue.
 - E. Horizontal Copper Cable:
 - 1. No. 24 AWG, 100 ohm, four pair.
 - 2. Comply with TIA/EIA-568-B.2, Categories 5e and 6.
 - 3. NFPA 70, Types CMG and CMP.
 - 4. Cable Jacket Color: Blue.
 - F. Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, using modules designed for punch-down caps or tools.
 - 1. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jackets where indicated.
 - 2. IDC Connecting Hardware: Consistent throughout Project.
 - G. Patch Panel: Comply with TIA/EIA-568-B.2, meeting or exceeding cable performance. Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to satisfy specified expansion criteria.
 - H. Jack and Jack Assemblies: Modular, color-coded, RJ-45 receptacle units with integral IDC-type terminals. Use keyed jacks for data service.
 - I. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with RJ-45 plug at each end. Use keyed plugs for data service.
- 2.23 RACEWAYS
- A. Comply with requirements in Division 26 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.
 - B. Comply with requirements in Division 27 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.24 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate the following according to industry standards for each product, and to verify DDC system reliability specified in performance requirements:
 - 1. DDC controllers.
 - 2. Gateways.
 - 3. Routers.
 - 4. Operator workstations.
- B. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 - 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 - 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Verify that power supply is available for control units and operator workstation.
- E. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.
- F. Examine pathway elements intended for cables.
 - 1. Verify proposed routes of pathways. Check raceways, cable trays, 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.
- G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control where specified.
- B. Communication Interface to Other Building Systems:
1. DDC system shall have a communication interface with systems having a communication interface where specified.

3.3 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

- A. Interface with Existing Systems:
1. DDC systems shall interface existing systems to achieve integration.
 2. Monitoring and Control of DDC System by Existing Control System:
 - a. DDC system performance requirements shall be satisfied when monitoring and controlling DDC system by existing control system.
 - b. Operator of existing system shall be able to upload, download, monitor, trend, control and program every input and output point in DDC system from existing control system using existing control system software and operator workstations.
 - c. Remote monitoring and control from existing control system shall not require operators of existing control system to learn new software.
 - d. Interface of DDC system into existing control system shall be transparent to operators of existing control system and allow operators to program, monitor, and control DDC system from any operator workstation connected to existing control system.
- B. Connect to campus central control and monitoring systems. Provide all hardware, software, protocols and cabling required for a complete interface.
- C. All interface, alarms, graphics, system control, editing, and other functionalities of this system shall be fully operable at the campus head end system.

- D. Confirm restrictions and requirements with Owner for any campus IT backbone, campus standards, campus interfacing, etc.

3.4 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways per code requirements.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Division 07 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Division 07 "Joint Sealants."
- H. Welding Requirements:
 - 1. Restrict welding and burning to supports and bracing.
 - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
 - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams.
2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Division 26 "Raceways and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.5 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units where indicated.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 2. Install controllers in a protected location that is easily accessible by operators.
 3. Top of controller shall be within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 2. Install controllers in a protected location that is easily accessible by operators.
 3. Top of controller shall be within 72 inches of finished floor. Where controllers are mounted directly to equipment, mount in a protected location that is easily accessible to operators.
- G. Application-Specific Controllers:
1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators

3.6 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices. Where existing system is established, match existing naming and numbering.

3.7 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.

- B. Wire and Cable Installation:

1. Comply with installation requirements in Division 26 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Division 27 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Division 27 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg. C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
5. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in junction box.
 - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

- C. Conduit Installation:

1. Comply with Division 26 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.
2. Comply with Division 26 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.8 INSTALLATION STANDARDS

- A. Comply with BICSI TCI, TIA/EIA-568-B.1, TIA/EIA-568-B.2, TIA/EIA-568-B.3, and TIA/EIA-569-A.

3.9 TAB SUPPORT

- A. Pre-TAB Meeting: Approximately two weeks prior to the initiation of Division 23 "Testing, Adjusting and Balancing for HVAC" services on site, schedule a meeting giving notice to the Construction Manager, Architect, and Engineer and facilities representative(s).
 - 1. Publish an agenda with a minimum of the following discussion items:
 - a. "Instrumentation and Controls for HVAC" sequence of upcoming construction.
 - b. "Testing, Adjusting and Balancing for HVAC" sequence of upcoming construction.
 - c. TAB for support from "Instrumentation and Controls for HVAC."
 - d. "Instrumentation and Controls for HVAC" requirements for support from TAB.
 - e. Timing, support and documentation procedures.
 - f. Operation, diversities and setpoints of systems and equipment.
- B. Division 23 "Testing, Adjusting and Balancing for HVAC" shall fully support Division 23 "Instrumentation and Controls for HVAC" in the testing and calibration of all devices with fluid flow, motor transformers, static pressures and the like and shall coordinate work so as to not interfere with instrumentation and controls installation and setup activities.
- C. Division 23 "Instrumentation and Controls for HVAC" shall fully support Division 23 "Testing, Adjusting and Balancing for HVAC" in the operation, start and stop of all systems as well as the setting of values required for proper balancing and shall coordinate work so as to not interfere with TAB activities.

3.10 CONSTRUCTION/COMMISSIONING ACCESS ACCOUNT

- A. Individual read/view only web based access accounts shall be provided to the Engineer and to the Commissioning Agent. Account shall be set up once on-site server/workstation is active and pertinent access username, password, information and instructions shall be emailed to the Engineer and to the Commissioning Agent as early in the project as possible. Minimum read/view only access shall be provided to the following:
 - 1. Graphics.
 - 2. Programming.
 - 3. Trend Data.
 - 4. Alarms.

3.11 SYSTEM EQUIPMENT AND DEVICE INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- H. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."
- I. Pre-Piped Coil Connection Kits:
 - 1. Install components per respective requirements for individual components specified in Division 23.
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.12 APPLICATION OF MEDIA

- A. Backbone Cable for Data Service: Use UTP Category 6 for runs between cabinets.
- B. Horizontal Cable for Data Service: Use UTP Category 5e cable for runs between cabinets and peripheral equipment.

3.13 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Comply with NECA 1.

- B. Wiring Method: Install wiring and optical fiber in raceway within the following areas: mechanical rooms, electrical rooms, exposed areas, within walls and above inaccessible ceilings. Conceal raceway except in mechanical rooms and areas where other raceway and piping are exposed.
- C. Wiring Method: Install wiring and optical fiber in raceway except consoles, cabinets, desks, and counters, and except in accessible ceiling spaces where unenclosed wiring method may be used for systems that are not part of life safety systems, including but not limited to, smoke exhaust systems, stair pressurization systems, smoke control systems, or hazardous exhaust systems, or systems on emergency/standby power, or main communications systems cable. Use UL listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in mechanical rooms and areas where other raceway and piping are exposed.
- D. Cable Installation:
 - 1. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
 - 2. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 3. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. 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.
 - 4. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 6. Install UTP cables using techniques, practices, and methods that are consistent with Category 5e or 6 rating of components and that ensure Category 5e or 6 performance of completed and linked signal paths, end to end.
 - a. Do not untwist more than 1/2 inch of Categories 5e and 6 cables at connector terminations.
- E. Separation from EMI Sources: Comply with BICSI TDM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
 - 1. Separation between unshielded power lines or electrical equipment in proximity to open cables or cables in nonmetallic raceways is as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: 24 inches.

2. Separation between unshielded power lines or electrical equipment in proximity to cables in grounded metallic raceways is as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: 12 inches.
3. Separation between power lines and electrical equipment located in grounded metallic conduits or enclosures in proximity to cables in grounded metallic raceways is as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: 6 inches.
4. Electrical Motors and Transformers, 5 kVA or HP and Larger: 48 inches.
5. Fluorescent Fixtures: 5 inches.

F. Conduit:

1. Comply with TIA/EIA-569-A for maximum length of conduit and bends between pull points, and for pull-box sizing.
 2. Use manufactured conduit sweeps and long-radius ells whenever possible.
 3. In mechanical rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of plywood) or in the corner of room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead. Extend conduits 1 to 3 inches in finished floor.
 4. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 5. Install exposed cable in raceway.
 6. Install concealed cable in raceway.
 7. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 8. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 9. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 10. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- G. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- H. Identify electrical systems according to Division 26 "Identification for Electrical Systems."
- I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

- J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.14 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with TIA/EIA 607.
- B. Grounding Points:
 - 1. Locate grounding terminals in each equipment room, wiring closet, rack, and cabinet.
 - 2. Telecommunications Grounding Busbars: Mount on wall of equipment room and closet, with standoff insulators.
- C. Bonding Conductors:
 - 1. Extend from telecommunications entrance facility to grounding busbars.
 - 2. Extend from grounding busbars to ground terminals in cabinets.
- D. Special Requirements:
 - 1. Bonding conductors shall be insulated copper, No. 6 AWG minimum.
 - 2. Install only in nonmetallic conduit, unless specifically required for protection of conductor. Metallic conduit, if used, shall be RMC. For RMC that exceeds 36 inches in length, conductors shall be bonded at each end of conduit.
 - 3. Bonding conductors shall be installed without splices unless approved by Architect because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.

3.15 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Testing:
 - 1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.

2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.16 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. For pneumatic products, verify that air supply for each product is properly installed.
- F. Control Damper Checkout:
 1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
 2. Verify that control dampers are installed correctly for flow direction.
 3. Verify that proper blade alignment, either parallel or opposed, has been provided.
 4. Verify that damper frame attachment is properly secured and sealed.
 5. Verify that damper actuator and linkage attachment is secure.
 6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 7. Verify that damper blade travel is unobstructed.
- G. Control Valve Checkout:
 1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
 2. Verify that control valves are installed correctly for flow direction.

3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
 - a. Verify sensing element type and proper material.
 - b. Verify length and insertion.

3.17 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
 - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
 - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
 - 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Control Valves:
 - 1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
 - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
 - 4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
- O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.18 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.19 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each binary point.

9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.20 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 3. HVAC equipment motors operate below full-load amperage ratings.
 4. Required DDC system components, wiring, and accessories are installed.
 5. Installed DDC system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. DDC system network communications function properly, including uploading and downloading programming changes.
 9. Using BACnet protocol analyzer, verify that communications are error free.
 10. Each controller's programming is backed up.
 11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
 12. All I/O points are programmed into controllers.
 13. Testing, adjusting and balancing work affecting controls is complete.
 14. Dampers and actuators zero and span adjustments are set properly.
 15. Each control damper and actuator goes to failed position on loss of power.
 16. Valves and actuators zero and span adjustments are set properly.
 17. Each control valve and actuator goes to failed position on loss of power.
 18. Meter, sensor and transmitter readings are accurate and calibrated.
 19. Control loops are tuned for smooth and stable operation.
 20. View trend data where applicable.
 21. Each controller works properly in standalone mode.
 22. Safety controls and devices function properly.
 23. Interfaces with fire-alarm system function properly.
 24. Electrical interlocks function properly.
 25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
 26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation at least 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

- a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
5. Passing test is contingent on the following:
 - a. All alarms, both binary and analog, are reported and printed; none are lost.
 - b. Compliance with response times specified.
6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.21 FINAL REVIEW

- A. Submit written request to Architect and General Contractor/Construction Manager when DDC system is ready for final review. Written request shall state the following:
 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.
- B. Review by Architect and General Contractor/Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
 - 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
 - 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
 - 3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
 - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
 - f. Trends, summaries, logs and reports set-up for Project.
 - g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
 - h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
 - i. Software's ability to edit control programs off-line.
 - j. Data entry to show Project-specific customizing capability including parameter changes.
 - k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - l. Execution of digital and analog commands in graphic mode.
 - m. Spreadsheet and curve plot software and its integration with database.
 - n. Online user guide and help functions.

- o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- p. System speed of response compared to requirements indicated.
- q. For Each Controller:
 - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
 - 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.
 - 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
 - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
 - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
 - 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.

- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
 - a) Display of network device status.
 - b) Display of BACnet Object Information.
 - c) Silencing devices transmitting erroneous data.
 - d) Time synchronization.
 - e) Remote device re-initialization.
 - f) Backup and restore network device programming and master database(s).
 - g) Configuration management of routers.

3.22 GRAPHICS ORGANIZATION

A. General:

1. Graphics shall be full color with motion utilizing floor plans wherever possible to indicate location of applicable information and fully accessible through the web-based software.
2. A general color scheme shall be utilized to indicate status of equipment and information.
 - a. BLUE: Equipment/system normal, off; point normal.
 - b. GREEN: Equipment/system normal, on.
 - c. YELLOW: Equipment/system alarm, operating; point minor alarm.
 - d. RED: Equipment failure; point major alarm.
 - e. PURPLE: Operator override.
3. Provide the following links in a block in the same general location on every graphic:
 - a. Primary graphic.
 - b. All screens associated with the current graphic.
 - c. As-Built Sequence of Operation.
 - d. Back to previous.
 - e. Forward to next.
4. Organize graphics in easily understandable levels to minimize search time for desired information.
 - a. There shall be at least two levels and no more than four levels.
 - b. Smaller systems can have one primary graphic with links to all other graphics.

- c. Larger systems can be organized with one primary graphic, a secondary set of categorized graphics to organize like specific graphics (i.e., zones, air systems, chilled water systems, hot water systems, etc.), then a third layer to take the user to specific graphics.

B. Primary Graphic:

1. The primary graphic will show well organized links to all other graphic levels with short descriptive labels.
2. Import the Owner's logo and clearly show the project name.

C. Zone Graphics:

1. Provide floor plan based graphics to show zones. Organize in a similar fashion to Contract Drawings and provide a sufficient scale so all information is easily readable and understandable.
2. Provide links to all other zone graphics.
3. Provide links to all individual zone terminal equipment.
4. Show all zone terminal equipment information with blocks in the associated zone. Each block shall change color to indicate normal/alarm modes.

D. System Graphics:

1. Each discreet system shall have a single graphic organized in schematic form accurately representing the installation configuration.
2. Each system or piece of equipment that has been provided with two-way communications such as through an RS 485 connection shall be provided with a dedicated graphic regardless of which contract it was provided under or if it was Owner/tenant provided.
3. Provide links to all associated graphics (i.e., AHU to other AHU's and to exhaust systems, chilled water system to cooling tower system and hot water system).
4. Locate pertinent information next to its associated graphic representation.
5. Provide a link to a separate page that displays the system as-built sequence of operation.

E. Monitoring Graphics:

1. Where equipment is monitored for specific information and no two-way communication is available, it may be grouped on a floor plan or multiple plans.

F. Energy Usage Graphics:

1. Provide separate graphics pages for the ongoing accountability of building energy usage and consumption over time. Building energy usage graphics shall be provided with hyperlinks to the main building graphics homepage to facilitate "user friendly" operations.
2. Provide dynamic historical trending and totalization of each piece of equipment (energy use of each component). Totalize data for the continuous monitoring of metering equipment for constant and variable motor loads, VFD operation, cooling loads, AHU energy usage (air-side), air and water-side economizers, air distribution static pressure and air ventilation volumes.

3. Monitor electrical system power and lighting system power consumption through each switchboard circuit breaker connection. Provide dynamic historical trending and totalization of each circuit.
 4. Coordinate data (run-time hours, electrical consumption, kW hours, kW/ton, kWh/year, \$savings/year, etc.) with building energy model and the Commissioning Agent.
- G. Show the block in its general location with an equipment label and normal and alarm color changing.
- H. Custom Graphics: Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
- I. Graphics Library: Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

3.23 PROGRAMMING

- A. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- B. Software Programming:
1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Organized in single purpose blocks of programming.
 - 2) Must provide actions for all possible situations.
 - 3) Must be modular and structured.
 - 4) Must be commented with a description and purpose.
 - b. Graphic-based:
 - 1) Organized in single purpose functional blocks.
 - 2) Must provide actions for all possible situations.
 - 3) Organize blocks in a neat flowing structure.

- 4) Blocks must be annotated with a description and purpose in a text block.
- 5) Must be documented.

C. Operator Interface:

1. Standard Graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
3. The Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this Section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

3.24 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.25 STABILITY TRENDING SET-UP

- A. Set up trending of points for confirmation of stability and control.
- B. Trend three weeks of data as follows:
1. Trend all analog input values on a 30-minute basis.
 2. Trend all digital input points on a change of value basis.
 3. Trend all analog virtual points on a 60-minute basis.
- C. Test network capacity according to standards indicated during trending tests.
- D. When trending indicates system instability for certain points, set-up additional trending for one week as follows to facilitate tuning and trouble-shooting:
1. Trend all associated analog input points on a 10-minute basis.
 2. Trend all associated digital input points on a change of value basis.
 3. Trend all associated analog outputs on a 10-minute basis.
 4. Trend all associated digital outputs on a change of value basis.
 5. Trend all associated virtual analog points on a 10-minute basis.
 6. Trend all associated virtual digital points on a change of value basis.

- E. Reporting system shall automatically email trend reports to the Engineer and the Commissioning Agent on a daily basis.
- F. Continue trending as long as required to enable system stability and trouble shooting. Owner's representative must sign off.
- G. Leave trending of point as directed by Owner's representative for long term information gathering.

3.26 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than **10**days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
- C. Training Schedule:
 - 1. Schedule training with Owner 20 business days before expected Substantial Completion.
 - 2. Schedule training to provide Owner with at least 10business days of notice in advance of training.
 - 3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
 - 4. Provide staggered training schedule as requested by Owner.
- D. Instructor Requirements:
 - 1. One or multiple qualified instructors, as required, to provide training.
 - 2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

E. Training Outline:

1. Submit training outline for Owner review at least 10 business days before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

F. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

G. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.

19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

H. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting and modifying alarms including annunciation and routing.
3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.

13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.

I. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

J. Video of Training Sessions:

1. Provide a professional digital video and audio recording of each training session. Create a separate recording file for each session. Refer to Division 01 for additional requirements.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230900

05/11/2021

SECTION 270010 - GENERAL CONDITIONS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

1.2 SUMMARY

- A. This Section includes the following when associated with Division 27 work:

- 1. Permits and fees.
- 2. Code requirements.
- 3. Work restrictions.
- 4. Work under other contracts.
- 5. Minor changes in the work.
- 6. Coordination.
- 7. Coordination drawings.
- 8. Requests for Information (RFIs).
- 9. Submittal procedures.
- 10. Submittal schedules.
- 11. Submittal requirements.
- 12. Delegated design services.
- 13. Conflicting requirements.
- 14. Quality assurance and control.
- 15. Product delivery, storage, and handling.
- 16. Contractor's minimum commissioning responsibilities.
- 17. Product warranties.
- 18. Submittal of project warranties.
- 19. Closeout submittals.
- 20. Format of operations and maintenance manuals.
- 21. Requirements for emergency, operation, and maintenance manuals.
- 22. Operation and maintenance documentation directory manual.
- 23. Emergency manuals.
- 24. Systems and equipment operation manuals.
- 25. Systems and equipment maintenance manuals.
- 26. Product maintenance manuals.
- 27. Record closeout submittals.
- 28. Record drawings.

29. Record specifications.
30. Record product data.
31. Training and instruction program.

1.3 PERMITS AND FEES

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of work. File all necessary drawings, prepare all documents and obtain all necessary approvals of all governmental and state departments having jurisdiction, obtain all required certificates of inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

1.4 CODE REQUIREMENTS

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
 1. Means and Methods.
 2. Equipment and Devices.
 3. Materials and Work Product.

1.5 WORK RESTRICTIONS

- A. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services:
 1. Notify Construction Manager / General Contractor or Owner not less than 10 days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Construction Manager's / General Contractor's or Owner's written permission.

1.6 WORK UNDER OTHER CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.7 MINOR CHANGES IN THE WORK

- A. Engineer / Architect will issue through the Construction Manager / General Contractor, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
 - 1. A reasonable distance is considered to be 15 feet at no additional cost.

1.8 COORDINATION

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Maintain maximum headroom; where space conditions appear inadequate to maintain proposed ceiling heights or code clearances, notify Architect / Engineer with proposed solutions.
- B. Utility Coordination: Contractor shall coordinate all final specific utility requirements.

1.9 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
- B. Coordination Drawing Process:
 - 1. Participate in the coordination drawing process per the requirements of Division 01 and the General Contract Conditions.
 - 2. Submit shop drawing electronic files to the project coordinator based on submission standards required by the General Contractor / Construction Manager.
 - 3. Coordinate with other trades to adjust location and routing of systems and equipment to coordinate with other trades.

4. The installing contractor is responsible for the satisfactory adjustment, without additional cost to the Owner, of any conflicts that arise from the installation of work prior to completion of the coordination drawing process.
5. Regular Contractor Coordination Meetings of all Contractors involved shall be held to resolve all conflicts, assure accessibility, coordinate sequences and make adjustment to the layout to achieve the architectural / engineering design intent of spaces, ceiling heights, accessibility, and serviceability and to maximize headroom clearances.
6. Where input from the Architect / Engineer is required to resolve conflicts, forward a preliminary electronic copy, in Adobe .pdf format, and Naviswork NWD file, of proposed solutions to the Architect and Engineer for review. Where coordination with the Architect / Engineer will occur at a live or web-based meeting, provide information to the Architect and Engineer for review one (1) week prior to the Architect / Engineer Review Meeting identifying all unresolved conflicts.
7. Coordination drawing creation is an iterative process. Submit multiple options and configurations at no additional cost until the Engineer's and Architect's acceptance is given.
8. Upon resolution of all outstanding conflicts, drawings shall be completed and all trades shall sign acceptance of the drawings.

C. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts, but no less than 1/4" equals 1'-0". Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Indicate manufacturer's minimum clearance requirements.
 - f. Show location and size of access doors required for access to concealed equipment, devices, junction boxes.
 - g. Indicate required installation sequences.
 - h. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
2. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire protection, fire alarm, and electrical work. Show locations of

- visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Project scope of work.
3. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 4. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.
 5. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 6. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 7. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 8. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inch diameter and larger and racks of multiple conduit larger than 2 inches in any dimension.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.
 - c. Panelboard, switchboard, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 9. Fire Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 10. Review: Architect / Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Architect determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Architect will so inform the Contractor, who shall make changes as directed and resubmit.
 11. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of this Section "Submittal Procedures."

- D. Coordination Digital Data Files: Prepare coordination digital data files in accordance with the following requirements:
1. BIM Execution Plan: Submit BIM execution plan describing use of digital files and coordination process prior to commencement of coordination.
 2. File Preparation Format: Autodesk Revit .rvt file format in Microsoft Windows operating system, Autodesk AutoCAD .dwg file format in Microsoft Windows operating system, or Autodesk Navisworks .nwd file format in Microsoft Windows operating system.
 3. File Submittal Format: Submit or post coordination digital data files in the Autodesk Navisworks .nwd file format and in Adobe .pdf format.
 4. Construction Building Information Model (BIM) File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 5. Subject to the following conditions, Engineer / Architect may furnish digital data files for use in preparing coordination digital data files to the contractor upon written request.
 - a. Engineer / Architect makes no representations as to the accuracy or completeness of digital data files as they relate to the drawings.
 - b. Digital Data Software Program: Drawings are available in AutoCAD.
 - c. Contractor shall execute a data licensing agreement included at the end of this specification section.

1.10 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Engineer, Architect, and General Contractor / Construction Manager.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution.

12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
1. Requests for approval of submittals.
 2. Requests for approval of substitutions.
 3. Requests for coordination information already indicated in the Contract Documents.
 4. Requests for adjustments in the Contract Time or the Contract Sum.
 5. Requests for interpretation of Architect's actions on submittals.
 6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

1.11 SUBMITTAL PROCEDURES

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
1. Initial Submittal: Within 30 days after date of commencement of the Work, submit initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: If permitted by contract elsewhere, submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitution: A submittal shall be considered a substitution when the Engineer / Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
 2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
 3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.

- b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- D. Mass Submittals: Where submittals to the Architect / Engineer exceed six (6) submittals per day or twenty (20) submittals per week, the Engineer reserves the right to prioritize submittal review based on priority determined after consultation with the Owner, Architect, and Construction Manager in order to return only prioritized submittals within the contract review time. Remaining submittals will be reviewed within a reasonable time period once critical submittals are returned.
- E. Submittal Resubmission: When a submittal is reviewed and returned by the Architect / Engineer requiring a resubmittal, the revised submittal shall be submitted to the Architect / Engineer within twenty (20) business days of the return of the original submittal.
- 1. Revised submittal shall contain direct responses to Architect / Engineer review comments from the previous submittal.
 - 2. Revisions from the previous submittal shall be clouded, highlighted, or otherwise identified.

3. Architect / Engineer contractual submittal review time will not be reduced for re-submittals.
4. Architect / Engineer reserves the right to seek compensation from the contractor for review of more than three (3) submittals due to the contractor's inability to provide a submittal meeting the requirements of the Contract Documents.

1.12 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager or General Contractor and additional time for handling and reviewing submittals required by those corrections.
 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.13 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- D. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

E. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

F. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.

- d. Product and manufacturers' names.
- e. Description of product.
- f. Test procedures and results.
- g. Limitations of use.

1.14 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM Incorporation: Incorporate delegated-design drawing and data files into BIM established for Project.

1.15 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect / Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.16 QUALITY ASSURANCE AND CONTROL

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.

- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. Associated Services: Cooperate with agencies performing required commissioning, tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

7. Security and protection for samples and for testing and inspecting equipment at Project site.
 - I. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
 - J. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
 - K. Acceptance of Work: Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.
- 1.17 PRODUCT DELIVERY, STORAGE, AND HANDLING
- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions, individual product specifications, and generally accepted construction practice.
 - B. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Store cementitious products and materials on elevated platforms.
 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 7. Protect stored products from damage and liquids from freezing.
 8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.18 MINIMUM CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
 - 1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 - 2. Cooperate with the Commissioning Authority for resolution of issues recorded in the Issues Log.
 - 3. Attend commissioning team meetings held on a weekly basis.
 - 4. Integrate and coordinate commissioning process activities with construction schedule.
 - 5. Review and accept construction checklists provided by the Commissioning Authority.
 - 6. Complete paper or electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
 - 7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 - 8. Complete commissioning process test procedures.
- B. Refer to related information in other sections for additional requirements.

1.19 PRODUCT WARRANTIES

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
 - 1. During the warranty period specified in Division 00 or Division 01, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1.20 SUBMITTAL OF PROJECT WARRANTIES

- A. Submit all warranties per the requirements in this and other trade specification sections in addition to requirements indicated in Division 01.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. Warranties in Paper Form:
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

1.21 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections and Division 01, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
 - 2. Submit paper copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.

1.22 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 - 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 - 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.23 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Architect.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.24 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.25 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.26 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name and contact information for manufacturer and local vendor.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.

8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.27 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.

4. List of items recommended to be stocked as spare parts.
 - E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
 - F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
 - G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 - H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
 - I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 1. Include procedures to follow and required notifications for warranty claims.
 - J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 1. Do not use original project record documents as part of maintenance manuals.
- 1.28 PRODUCT MAINTENANCE MANUALS
- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
 - B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

1.29 RECORD CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit record digital data files and one set of plots.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit record digital data files and record digital data file hard copies (minimum three copies, unless defined otherwise in Division 01).
 - 2) Plot hard copies of each drawing file, whether or not changes and additional information were recorded.

1.30 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Revisions to routing of piping and conduits.
 - e. Revisions to electrical circuitry.
 - f. Actual equipment locations.
 - g. Duct size and routing.
 - h. Locations of concealed internal utilities.
 - i. Changes made by Change Order or Change Directive.
 - j. Changes made following Architect's written orders.
 - k. Details not on the original Contract Drawings.
 - l. Field records for variable and concealed conditions.
 - m. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: AutoCAD DWG and Navisworks NWD format, Microsoft Windows operating system.

2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.31 TRAINING AND INSTRUCTION PROGRAM

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
1. Basis of System Design and Operational Requirements.
 2. Documentation.
 3. Emergencies.
 4. Adjustments.
 5. Troubleshooting.
 6. Maintenance.
 7. Repairs.
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- D. Video Record: Training shall be professionally recorded as video.
1. Format: Standard DVD format.
 2. Quantity: Three discs of each individual DVD.
 3. Labeling: Label each DVD with its library of training sections based on equipment type and system type.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect, whose determination is final.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
 3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."

4. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 2. Evidence that proposed product provides specified warranty.
 3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 4. Samples, if requested.
- B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 DEMOLITION

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.

- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.
- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.
- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
 - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
 - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
 - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

3.4 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager / General Contractor in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. All equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may

exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.

2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect / Engineer and to allow for proper access.
3. Allow for building movement, including thermal expansion and contraction.
4. Coordinate installation of anchorages. 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 or masonry. Deliver such items to Project site in time for installation.

- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.5 CUTTING AND PATCHING

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 SCAFFOLDING, RIGGING, HOISTING

- A. Excavation and backfilling shall be done per Division 02 of the Specifications.
- B. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

3.7 EXCAVATION AND BACKFILLING

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

3.8 ACCESSIBILITY AND ACCESS PANELS

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Access doors shall be furnished for accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- D. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- E. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- F. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

3.9 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.11 CORRECTION OF THE WORK

- A. The cost of corrective work shall be included under the contract.
- B. Repair or remove and replace defective construction.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.

- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

3.12 DIGITAL MODEL AND CAD FILE LICENSE (FOR REFERENCE)

The parties agree to the following terms and conditions:

Granted Uses:

This License shall allow the conditional use of The Model and/or CAD Files provided by The Licensor and its consultants. The Licensor and its consultants are providing these files for the convenience of The Licensee for reference only, to enhance The Licensee's general understanding of the design intent for the project. Use of the digital model and CAD files is subject to the terms and conditions noted herein and in the Contract Documents.

Excluded Uses:

Any use of The Model or CAD Files not explicitly granted, including but not limited to, technical analysis, clash detection, cost estimating, quantity assessment, dimensional interpretation, site or building layout, shop drawing preparation, direct or indirect fabrication, coordinating equipment locations, systems routing or any other direct or indirect analysis, is strictly prohibited.

Contract Documents:

The Model and CAD Files are Instruments of Service and protected as such. The Model and CAD Files are not an element of the Contract Documents. The Model and CAD Files are among a number of tools that The Licensor and its consultants used to prepare the Contract Documents. The Contract Documents, in some cases, contain carefully extracted and enhanced elements of this file(s). However, The Licensee should never assume that all elements of The Model and CAD Files are accurate or identical to the Contract Documents. It is at the sole discretion of The Licensor as to which portions of the design are modeled, which are not and to what degree each portion of the design requires detailed coordination to convey design intent for contractual purposes. The Licensee accepts that elements of The Model and CAD Files may conflict with the Contract Documents. In the event that a conflict arises between the paper copy Contract Documents and The Model or CAD Files, the paper copy Contract Documents shall govern.

Risk of Use:

The Licensee's use of The Model and/or CAD Files for any use is at The Licensee's sole risk.

Licensee Responsibilities:

The Design Intent Model is not a substitute for the contractors' coordination process as outlined in the Contract Documents. The Licensee and its subcontractors shall be solely responsible for verifying the accuracy of all results created with the use of the Design Intent Model, including verification of any existing conditions.

Forwarding of Model and CAD Files:

The Licensee may transfer copies of the CAD Files in electronic or paper form to its Subcontractors or material suppliers having direct involvement in the Project without any further license or waiver. The Licensor and its consultants make no representation as to the compatibility of the CAD Files with any hardware or software used by the Subcontractors and material suppliers.

The Licensee may not transfer The Model provided by The Licensor to its Subcontractors or material suppliers without explicit written consent from The Licensor. Any party requesting The Model must execute and transmit to The Licensor a copy of this License.

As a condition to transferring The Model or CAD Files, The Licensee shall, prior to any such transfer, advise the Subcontractors and material suppliers receiving The Model and/or CAD Files of the appropriate and licensed use(s) of The Model and CAD Files.

The Model shall not be uploaded, posted, or transferred to any website, information exchange software application, or hosting website without the prior consent of The Licensor.

Any transfer of The Model and CAD Files to parties other than The Licensee's Subcontractors and material suppliers is strictly forbidden.

Corruption / Interoperability / Drafting Error:

The information in The Model and CAD File(s) may be incomplete, inaccurate, corrupted, or defective due to many causes including, but not limited to, drafting errors, unforeseen alterations, program translation, or interoperability conflicts.

Indemnity:

The Licensee agrees to waive all claims against The Licensor, defend, indemnify, and hold The Licensor and its consultants harmless from any claims, suits, or losses (including reasonable attorney's fees and all legal expenses) arising out of or in any way related to The Licensee's use of The Model and/or CAD Files provided by The Licensor.

The Licensee shall require the indemnity of The Licensor and its consultants by the Licensee's Subcontractors and material suppliers receiving The Model and/or CAD Files prior to any transfer.

Duration / Termination:

This License shall terminate upon Final Completion of the Project as defined in the Contract Documents. This license may be revoked by The Licensor in the event Licensee does not comply with the terms of this agreement.

Agreed to by the Licensee:

Signatory is an authorized representative of The Licensee's organization, understands the terms of this license and is authorized to bind the organization by the terms herein.

Signature: _____ **Date:** _____

Printed Name and Title: _____

Company: _____

END OF SECTION 270010

05/11/2021

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

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:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetallic wireways and auxiliary gutters.
 - 5. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets and suspension system with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, fire suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Alpha Wire.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 6. Picoma Industries, Inc.
 - 7. Republic Conduit.
 - 8. Robroy Industries.
 - 9. Southwire Company.
 - 10. Thomas & Betts Corporation, A Member of the ABB Group.
 - 11. Western Tube and Conduit Corporation.
 - 12. Wheatland Tube Company.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Carlon; a brand of Thomas & Betts Corporation.
 2. Crouse-Hinds, an Eaton business.
 3. EGS/Appleton Electric.
 4. FSR Inc.
 5. Hoffman; a brand of Pentair Equipment Protection.
 6. Milbank Manufacturing Co.
 7. Molex Industrial Products Group; Woodhead Brand.
 8. MonoSystems, Inc.
 9. Oldcastle Enclosure Solutions.
 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
 11. Quazite: Hubbell Power Systems, Inc.
 12. RACO; Hubbell.
 13. Spring City Electrical Manufacturing Company.
 14. Thomas & Betts Corporation, A Member of the ABB Group.
 15. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 1. Comply with TIA-569-B.
 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Gangable boxes are prohibited.
- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - b. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Damp or Wet Locations: GRC.
- B. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Comply with NEMA FB 2.10.
 - a. Utilize steel compression fittings in the following locations:
 - 1) Damp locations.
 - 2) Boiler rooms.
 - 3) Mechanical rooms.
 - 4) Within block walls.
 - b. Utilize steel set-screw fittings in the following locations:
 - 1) Dry locations.
 - 2) Above suspended ceilings.
 - 3) Within stud walls.

- C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- D. Install surface pathways only where indicated on Drawings.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
 - 1. Whenever any raceway crosses an expansion or seismic joint, provide a pull box on each side of the joint with sufficient length of flexible raceway to accommodate movement in all directions. See section regarding seismic control for electrical work for additional requirements. Coordinate movement requirements at expansion and seismic joints with Structural Engineer of Record.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction.
- G. Conceal pathway and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support pathway within 12 inches of enclosures to which attached.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors. Within return air plenums, utilize plenum rated bushings.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- O. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Within return air plenums, utilize a #10 AWG conductor in place of a plastic line. Cap underground pathways designated as spare above grade alongside pathways in use.
- P. Surface Pathways:
 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Q. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- R. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- S. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

- U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

05/11/2021

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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:

1. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Aluminum slotted-channel systems.
 - 4. Nonmetallic slotted-channel systems.
 - 5. Equipment supports.
 - 6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for communications systems.
 - 1. Include design calculations and details of trapeze hangers.
 - 2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) 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. Suspended ceiling components.
 - 2. Ductwork, piping, fittings, and supports.
 - 3. Structural members to which hangers and supports will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
 - 1. Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Design supports for multiple raceways, capable of supporting combined weight of support systems and its contents.
 - 3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 4. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ABB (Electrification Products Division).
 - b. Atkore International (Allied Tube & Conduit).
 - c. Atkore International (Unistrut).
 - d. Eaton (B-line).
 - e. Flex-Strut Inc.
 - f. Gripple Inc.
 - g. GS Metals Corp.
 - h. G-Strut.
 - i. Haydon Corporation.
 - j. Metal Ties Innovation.
 - k. MIRO Industries.
 - l. nVent (CADDY).
 - m. Wesanco, Inc.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: Hot-dip galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ABB (Electrification Products Division).
 - b. Atkore International (Unistrut).
 - c. Cooper Industries, Inc.
 - d. Flex-Strut Inc.
 - e. Haydon Corporation.
 - f. MKT Metal Manufacturing.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Material: 6063-T6 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 5. Channel Width: Selected for applicable load criteria.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- C. Conduit and Cable Support Devices: Steel and malleable-iron clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- 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:

1. Powder-Actuated Fasteners: Threaded-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.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: 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 where used.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) Eaton (B-line).
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 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 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101.
 - 5. NECA 105.
 - 6. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. 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.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, or spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. 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 by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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 Division 09 painting sections 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.

END OF SECTION 270529
05/11/2021

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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:
 - 1. Wire-basket cable trays.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
- C. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.

2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 WIRE-BASKET CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allied Tube & Conduit.
 2. Cablofil; Legrand.
 3. Chatsworth.
 4. Cooper Industries; Cooper B-Line; GS Metals Corp.
 5. Hoffman.
 6. Hubbell Incorporated; Wiring Device-Kellems.
 7. MonoSystems, Inc.
 8. Vutec Corporation.
- B. Description:
 1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.

2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch lengths.
 - b. Refer to drawings for cable tray sizing.
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: ASTM F 593, Type 316.

2.3 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Hot-dip galvanized after fabrication.
 - a. Standard: Comply with ASTM A 123/A 123M, Class B2.
 - b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Fasten cable tray supports to building structure and install seismic restraints.
- F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- K. Support wire-basket cable trays with center support hangers, trapeze hangers or wall brackets.

- L. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- M. Make changes in direction and elevation using manufacturer's recommended fittings.
- N. Make cable tray connections using manufacturer's recommended fittings.
- O. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- P. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- Q. Install cable trays with enough workspace to permit access for installing cables.
- R. Install barriers to separate cables of different communications systems.
- S. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications systems are separated by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 - 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536
05/11/2021

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

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:
 - 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve seal systems.
 - 4. Grout.
 - 5. Pourable sealants.
 - 6. Foam sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Wall Sleeves, Steel:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CCI Piping Systems.
 - c. Flexicraft Industries.
 - d. GPT; an EnPro Industries company.
 - 2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Benefast.
 - b. Specified Technologies, Inc.
2. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE SEAL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Advance Products & Systems, Inc.
 2. BWM Company.
 3. CALPICO, Inc.
 4. Flexicraft Industries.
 5. Metraflex Company (The).
 6. Pipeline Seal and Insulator, Inc.
 7. Proco Products, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Fiber-reinforced plastic.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. W.R. Meadows, Inc.
- B. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 POURABLE SEALANTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Carlisle SynTec Incorporated.
 2. GAF.
 3. Johns Manville; a Berkshire Hathaway company.
- B. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.5 FOAM SEALANTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Dow Chemical Company (The).
 2. Innovative Chemical Products (Building Solutions Group).
- B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves shall be fastened securely to the assembly that it penetrates.

C. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 INSTALLATION OF SLEEVES FOR FIRE-RATED COMMUNICATIONS PENETRATIONS

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."
- B. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- C. Fire-Rated Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

END OF SECTION 270544

05/11/2021

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

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:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Cable management system.
 - 4. Cabling identification products.
 - 5. Grounding provisions for twisted pair cable.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- G. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- H. RCDD: Registered Communications Distribution Designer.
- I. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by an RCDD.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of BICSI ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.8 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Panduit TX6A-28 Cat 6A UTP Patch Cord is constructed of 28 AWG, unshielded, twisted pair, solid, CM/LSZH cable with enhanced performance modular plugs. The use of 28 AWG cable ensures that this patch cord has a small diameter. P/N UTP28X5RD for Wireless and P/N UTP28X5BU Blue for Data.
- C. No substitutions permitted per campus standard.
- D. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- E. Contractor shall furnish an additional 20% spare patch cords. 50% of the patch cords shall be 5' in length and 50% of the patch cords shall be 7' in length part number. The standard colors are Red and Blue. Coordinate final counts, colors and spares with owner.

2.2 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. General Cable.
 - 2. Panduit.
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6 or Category 6a.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks:
 - 1. 110-style IDC for Category 6a.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.

G. Faceplate:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

H. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.3 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings indicate general arrangement of pathways and fittings.
- F. Comply NPFA 70 for pull-box sizing and length of conduit and number of bends between pull points.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information

- Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
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 dereeling. Heat lamps shall not be used for heating.
 11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper 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, 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.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.

3.6 IDENTIFICATION

- A. Coordinate names, abbreviations, and other designations used in telecommunications identification scheme with owner's desired identification scheme, regardless of numbering indicated on the drawings and specifications.
- B. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Administration Class: Class 2.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- D. Cable and Wire Identification:
 - 1. 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.
 - 2. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

- a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Performance Tests:

a. Test each outlet. Perform the following tests according to ANSI/TIA-568-C.2:

- 1) Wire map.
- 2) Length (physical vs. electrical, and length requirements).
- 3) DC loop resistance.
- 4) Return loss.
- 5) Insertion loss.
- 6) ACRF.
- 7) PSACRF.
- 8) Propagation delay skew.
- 9) PSANEXT loss.
- 10) Average PSANEXT loss.
- 11) PSAACRF.
- 12) Average PSAACRF loss.
- 13) Return loss.
- 14) Propagation delay.

B. Tests and Inspections:

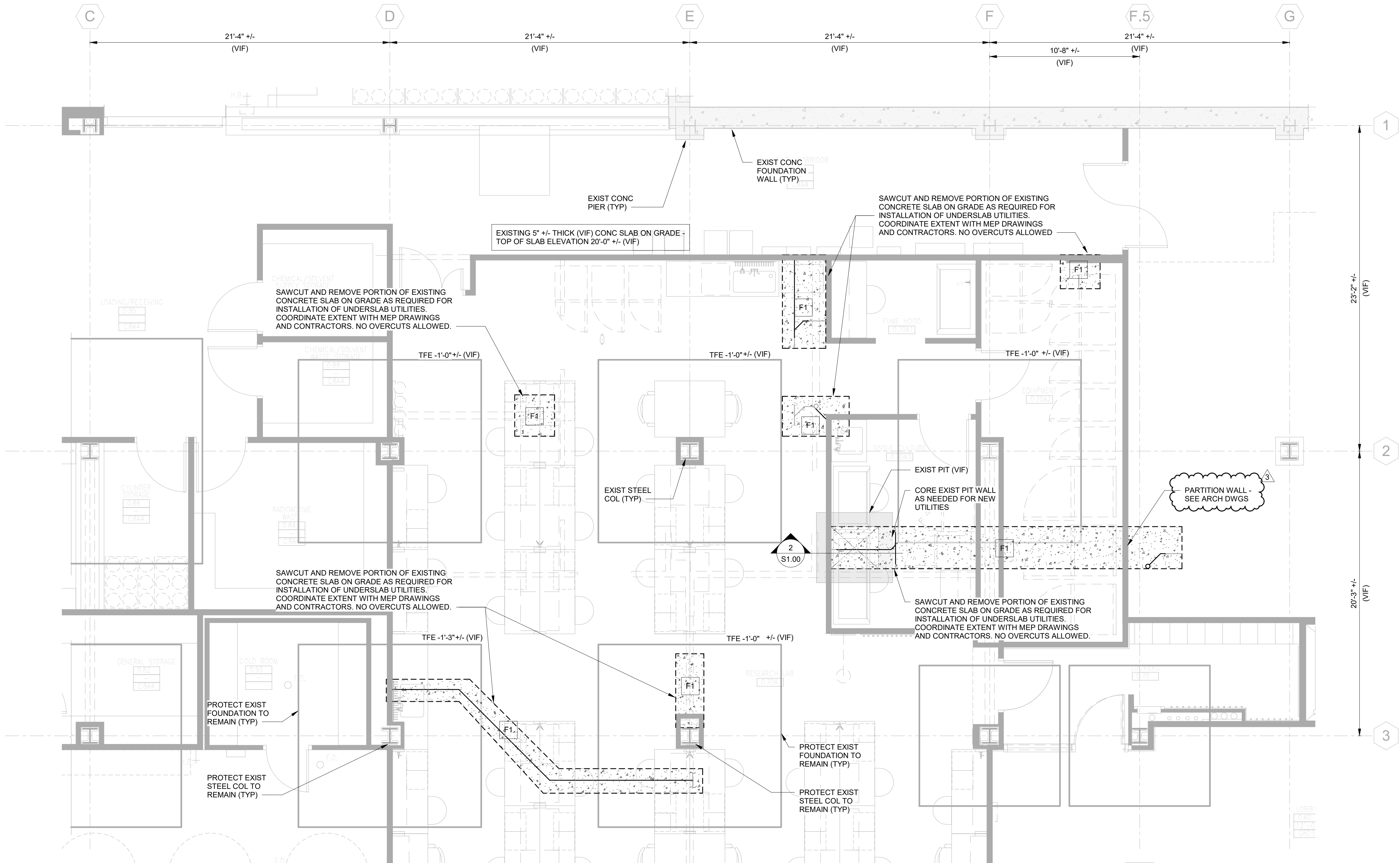
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications

Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 271513
05/11/2021

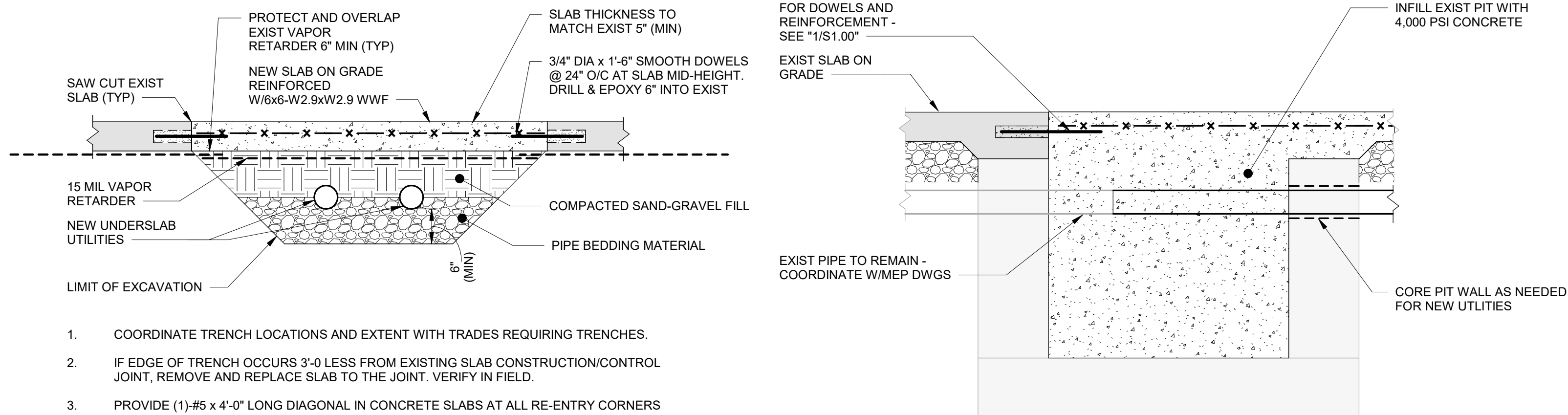


SLAB ON GRADE PLAN
1/4" = 1'-0"

- NOTES:
1. TOP OF NEW SLAB ON GRADE TO MATCH EXISTING.
 2. TOP OF EXISTING FOUNDATIONS IS NOTED BY (---) INDICATING THE DISTANCE RELATIVE TO THE TOP OF SLAB ON GRADE.
 3. PROVIDE SAWN CUT CONTROL JOINTS IN CONCRETE INFILL TO MATCH EXISTING SLAB CONTROL JOINT LOCATIONS.

SLAB ON GRADE SYMBOL LEGEND

F1 INDICATES 5" (MINIMUM, MATCH EXISTING (VIF)) CONCRETE SLAB PLACED OVER A VAPOR RETARDER, REINFORCED WITH 6x6-W2.9xW2.9 WWF, PLACED ON 3" HIGH x 4"x4" CONCRETE BLOCKS SPACED AT 3'-0" O/C. PLACE 6" MINIMUM OF COMPACTED SAND-GRAVEL BASE BENEATH VAPOR RETARDER. COORDINATE SLAB PITCH AND DRAIN LOCATION WITH ARCHITECTURAL AND PLUMBING DRAWINGS.



1 TYPICAL UTILITY TRENCH
S1.00 NOT TO SCALE

2 EXIST PIT INFILL DETAIL
S1.00 3/4" = 1'-0"

NOTE:
REFER TO MEP DRAWINGS FOR
ADDITIONAL INFORMATION.

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RYAN INSTITUTE LABORATORY
PHASE 1 RENOVATIONS

URI - CBL S
120 FLAGG RD
KINGSTON, RI 02881

DATE: 03/19/2021
PROJECT NO: 2020.021
DRAWN: APR
CHECKED: MA
ISSUED FOR:
BIDDING and CONSTRUCTION
REVISIONS:
1 3/29/21 OWNER'S REVIEW
2 4/30/21 BIDDING & CONSTRUCTION
3 5/10/21 ADDENDUM NO. 1

S1.00

SLAB ON GRADE PLAN

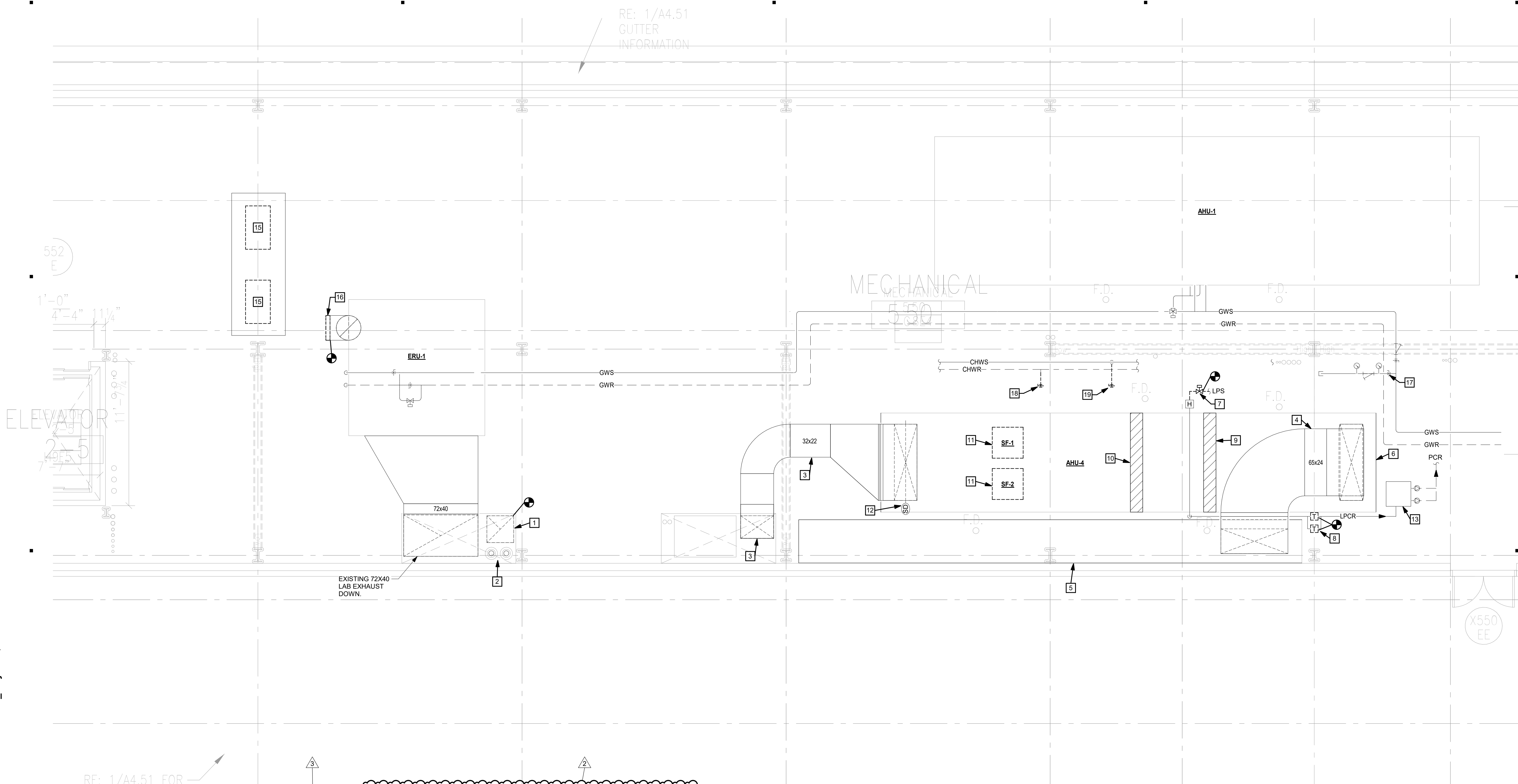
TLBA

TLB ARCHITECTURE, LLC
92 WEST MAIN STREET
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HVAC GENERAL NOTES:

- THE 2007 RECORD DRAWINGS AND ASSOCIATED AS-BUILTS SHALL BE USED FOR REFERENCE ONLY AND UNDERSTANDING OF THE ASSOCIATED HVAC SYSTEMS DURING THE PROJECT CONSTRUCTION. BVH TAKES NO RESPONSIBILITY FOR THE ACCURACY OF THE DOCUMENTATION.
- ALL MATERIALS AND WORK ASSOCIATED WITH AHU-4 INTERNAL MODIFICATIONS SHALL BE INCLUDED IN THE MECHANICAL CONTRACTOR'S SCOPE OF WORK AND BID PRICE. COMPONENTS SHALL BE SUPPLIED BY HAAKON AND WORK PERFORMED BY HTS NEW ENGLAND SERVICE, PEABODY MA. (AUTHORIZED HAAKON SERVICE REPRESENTATIVE).

HVAC PRE-DEMOLITION TESTING REQUIREMENTS

- CONTRACTOR SHALL TAKE PRE-DEMO MEASUREMENTS OF EXISTING CHILLED WATER PUMP (P-2.3 & P-2.4) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.
- CONTRACTOR SHALL TAKE PRE-DEMO MEASUREMENTS OF EXISTING GW PUMP (P-3.1, P-3.2 & P-3.3) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.
- CONTRACTOR SHALL TAKE PRE-DEMO MEASUREMENTS OF EXISTING ATRIUM SMOKE CONTROL FANS (F-13, F-14, F-15, F-16, F-17 & F-18) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.

HVAC PRE-DEMOLITION TESTING REQUIREMENTS

- CONTRACTOR SHALL TAKE PRE-DEMO MEASUREMENTS OF EXISTING CHILLED WATER PUMP (P-2.3 & P-2.4) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.
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HVAC & HYDRONIC PIPING DEMOLITION DRAWING...

- EXISTING 26"x26" WELDED STAINLESS STEEL LAB EXHAUST TO REMAIN DEDICATED TO THE PLAZA LEVEL RENOVATED SPACE. REMOVE EXISTING DUCT CAP AND PREP FOR NEW CONNECTION.
- EXISTING HWS&R RISERS TO PLAZA LEVEL TO REMAIN.
- EXISTING 32"x22" SUPPLY DUCTWORK DEDICATED TO THE PLAZA LEVEL RENOVATED SPACE TO REMAIN. THOROUGHLY CLEAN THE INTERIOR OF THE ACCESSIBLE FROM THE PENTHOUSE LEVEL.
- EXISTING 65"x24" OUTDOOR AIR DUCT TO REMAIN.
- EXISTING OUTDOOR AIR PLENUM TO REMAIN.
- THOROUGHLY CLEAN AND DISSINFECT ENTIRE INTERIOR OF AHU-4 AND ALL ASSOCIATED INTERNAL COMPONENTS. WORK TO BE PERFORMED BY HTS SERVICE GROUP.
- REPLACE EXISTING LPS AND LPCR PIPING AND VALVE ASSEMBLIES TO HUMIDIFIER WITH NEW OF SAME VALVE TYPE AND PIPE SIZES. REFER TO DETAIL.
- REPLACE EXISTING LPCR TRAPS WITH NEW OF SAME TYPE. SALVAGE EXISTING TRAP INSULATING COVERS AND STORE FOR REUSE.

HVAC & HYDRONIC PIPING DEMOLITION DRAWING...

- PRESSURE AND DISSINFECT EXISTING ENERGY RECOVERY COIL. FLUSH AND HYDROSTATICALLY AND PRESSURE TEST COIL TO TEST PRESSURE RECOMMENDED BY HAAKON. WORK TO BE PERFORMED BY HTS SERVICE GROUP.
- PRESSURE AND DISSINFECT EXISTING CHILLED WATER COIL. FLUSH AND HYDROSTATICALLY AND PRESSURE TEST COIL TO TEST PRESSURE RECOMMENDED BY HANKON. WORK TO BE PERFORMED BY HTS SERVICE GROUP.
- REPLACE EXISTING SUPPLY FANS IN THEIR ENTIRETY. WORK TO BE PERFORMED BY HTS SERVICE GROUP
- FULLY SERVICE AND REFURBISH SMOKE ISOLATION DAMPER INCLUDING LINKAGE, SEALS, ETC. WORK TO BE PERFORMED BY HTS SERVICE GROUP.
- ELECTRIC STEAM CONDENSATE PUMP/RECIEVER TO BE SERVICED BY AUTHORIZED SERVICE AGENT. PROVIDE \$2000 ALLOWANCE FOR SERVICE/REFURBISHMENT.
- DISPOSE OF OR STORE EXISTING EXHAUST FANS F-3A & F3B AT OWNER'S DISCRETION AND SPECIFIED LOCATION.
- EXISTING WELDED STAINLESS STEEL LAB EXHAUST STACK THROUGH THE ROOF TO REMAIN. REMOVE EXISTING DUCT CAP AND PREP FOR NEW CONNECTION.
- 2-1/2" GWS ISOLATION VALVE "GLS-018" TO REMAIN. CONTRACTOR TO EXERCISE VALVE TO ENSURE PROPER WORKING ORDER AND 100% POSITIVE CLOSE-OFF PRIOR TO CONNECTING NEW PIPING.
- REMOVE EXISTING 3" CHWS VALVE "CHWS-016".
- REMOVE EXISTING 3" CHWR VALVE "CHWR-012".

NOTE:
REFER TO MEP DRAWINGS FOR
ADDITIONAL INFORMATION.

WILL BE AT THE SOLE RISK OF THE PERSON OF FIRM MAKING SUCH UNAUTHORIZED ALTERATIONS AND IS ARCHITECTURE, LLC WILL NEITHER HAVE NOR ACCEPT ANY LIABILITY OR LEAD EXPOSURE ARISING FROM SUCH UNAUTHORIZED ALTERATIONS.

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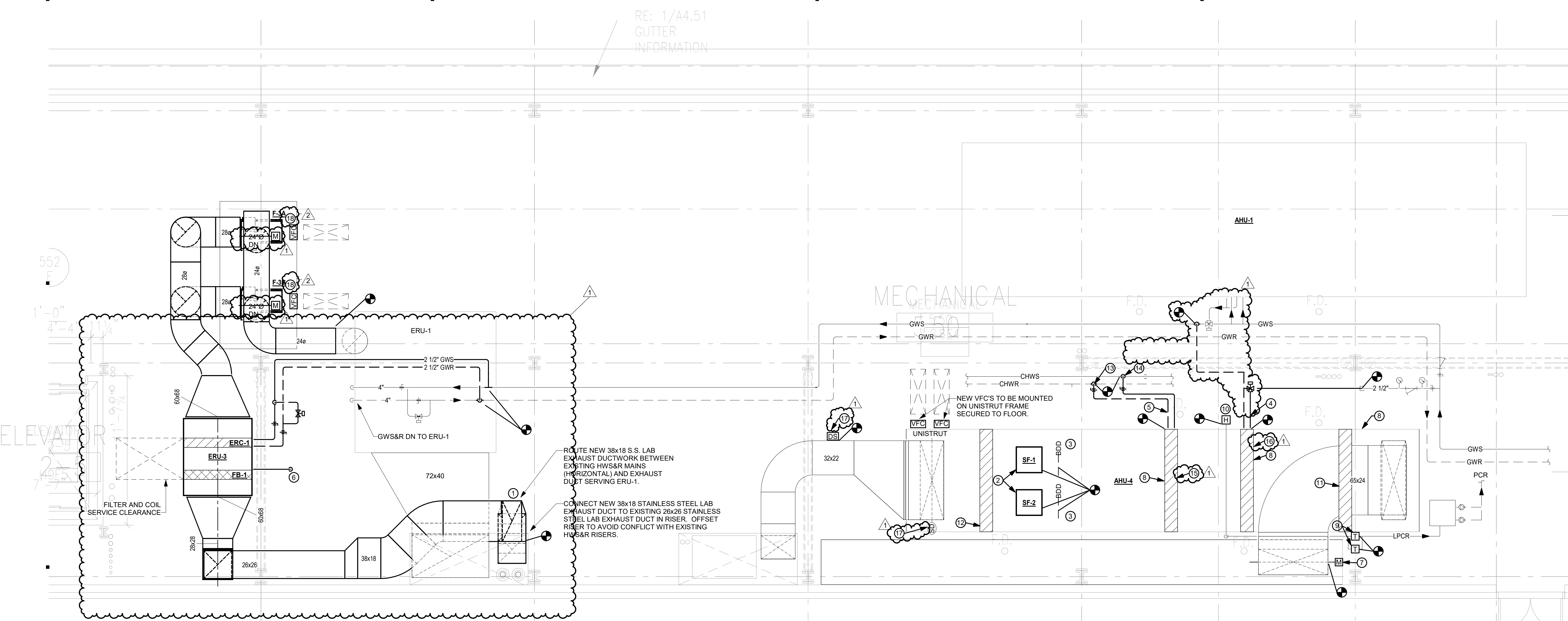
**RYAN INSTITUTE LABORATORY
PHASE 1 RENOVATIONS**
URI - CBLs

120 FLAGG RD
KINGSTON, RI 02881

DATE: 03/19/2021
PROJECT NO: 2020.021
DRAWN: TS
CHECKED: JRD
ISSUED FOR:
BIDDING and CONSTRUCTION
REVISIONS:
1 3/29/21 OWNER'S REVIEW
2 4/30/21 BIDDING & CONSTRUCTION
3 5/10/21 ADDENDUM NO. 1

HD1.02

**HVAC PENTHOUSE
DEMOLITION PLAN**



HVAC POST-CONSTRUCTION TESTING REQUIREMENTS

- CONTRACTOR SHALL TAKE POST CONSTRUCTION MEASUREMENTS OF EXISTING CHILLED WATER PUMP (P-2.3 & P-2.4) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.
- CONTRACTOR SHALL TAKE POST CONSTRUCTION MEASUREMENTS OF EXISTING GW PUMP (P-3.1, P-3.2 & P-3.3) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. PRIOR TO ANY SYSTEM MODIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD.
- CONTRACTOR SHALL TAKE POST CONSTRUCTION MEASUREMENTS OF EXISTING ATRIUM SMOKE CONTROL FANS (F-13, F-14, F-15, F-16, F-17 & F-18) SPEED, FLOW, OPERATING PRESSURES, AMPS, ETC. AS REQUIRED PER CONTRACT SPECIFICATIONS. SUBMIT FOR ENGINEER REVIEW AND RECORD. CX AGENT SHALL BE RESPONSIBLE FOR CONFIRMING EXISTING ATRIUM SMOKE CONTROL SYSTEM OPERATES AS INTENDED WITH ALL REQUIRED SMOKE EXHAUST FANS OPERATING. ALL REQUIRED WINDOWS AND DOORS OPEN, AND ALL REQUIRED HVAC SYSTEMS EITHER SHUT DOWN OR TURN DOWN TO A REDUCED FLOW CAPACITY.

HVAC & HYDRONIC PIPING DRAWING NOTES:

- CONNECT NEW 26"x26" WELDED STAINLESS STEEL LAB EXHAUST TO EXISTING DEDICATED RISER SERVING THE RENOVATED SPACE ON THE PLAZA LEVEL. EXISTING DUCT CAPED APPROXIMATELY 12" AFS.
- REPLACE EXISTING SUPPLY FANS IN THEIR ENTIRETY WITH SIMILAR FANS HAVING THE SAME CAPACITY. FANS SHALL BE MODEL 18TCEBEN 18" SW/SL CLASS III, TFC BELT DRIVEN, 12.35 BHP/15 MHP, 480V/3PH, AND CAPABLE OF 10,625 CFM @ 9.5" TSP AND CONTROLLED BY VFC'S. BALANCE TO COMBINED AIRFLOW INDICATED IN AIR HANDLING UNIT SCHEDULE. THIS UNIT SHALL BE CAPABLE OF SERVING FUTURE RENOVATION OF THE ADJACENT ATRIUM LAB.
- PROVIDE FAN GRAVITY BACKDRAFT DAMPER ASSEMBLY AS RECOMMENDED BY HAAKON INDUSTRIES.
- EXTEND GWS&R PIPING TO EXISTING LOOP IN LOCAL AREA. PROVIDE NEW COIL VALVE ASSEMBLY - SEE DETAIL.
- EXTEND CHWS&R PIPING TO EXISTING LOOP IN LOCAL AREA. PROVIDE NEW COIL VALVE ASSEMBLY - SEE DETAIL.
- EXTEND 1" GRAVITY DRAIN TO NEAREST FLOOR DRAIN.
- PROVIDE MOTORIZED ISOLATION DAMPER WITHIN OUTDOOR AIR PLENUM AT DUCT TAP. MECHANICAL CONTRACTOR TO VERIFY EXACT SIZE IN FIELD.
- THOROUGHLY CHEMICALLY CLEAN AND DISSINFECT EXISTING AHU-4 INTERIOR SURFACES, AND ALL INTERNAL COMPONENTS. REMOVE ALL EXISTING DEBRIS, INSTALL MISSING OR NON-FUNCTIONING LIGHT BULBS, INSTALL MISSING LIGHT FIXTURE LENSES, ETC. FOR A COMPLETE AND OPERATIONAL SYSTEM.
- PROVIDE NEW STEAM CONDENSATE TRAPS OF EQUAL TYPE AND QUANTITY. REINSTALL EXISTING INSULATING COVERS.
- PROVIDE NEW STEAM HUMIDIFIER PIPING AND VALVE ASSEMBLY - SEE DETAIL.
- INSTALL NEW MERV 8 PRE-FILTER IN EXISTING FILTER RACK ASSEMBLY
- INSTALL NEW 12" DEEP MERV 14 FINAL FILTER IN EXISTING FILTER RACK ASSEMBLY. MODIFY EXISTING HEPA A FILTER RACK TO ACCOMMODATE STANDARD MERV 14 FINAL FILTERS.
- PROVIDE NEW 3" CHWS ISOLATION VALVE. TAG "CHWS-010"
- PROVIDE NEW 3" CHWR ISOLATION VALVE. TAG "CHWS-012"
- BALANCE CHW COIL TO 62 GPM. TWO WAY MODULATING CONTROL VALVE SHALL BE OVERSIZED FOR ORIGINAL DESIGN CAPACITY.
- BALANCE RW HEATING COIL TO 18 GPM. THREE-WAY CONTROL VALVE SHALL BE SIZED FOR ORIGINAL DESIGN CAPACITY.
- INTERFACE AHU SHUTDOWN WITH FIRE ALARM SYSTEM. UNIT SHALL BE OFF DURING SMOKE CONTROL EVENT.
- OPERATING EXHAUST FAN SHALL TURN DOWN TO REDUCED FLOW OF 2,200 CFM VIA INPUT FROM BMS TO CONTROL VFC PRE-SET SPEED.

GLYCOL ENERGY RECOVERY LOOP SYSTEM MODIFICATIONS:

- THE EXISTING SYSTEM SHALL OPERATE UNDER ITS PRESENT SEQUENCE OF OPERATIONS. THIS PROJECT INCORPORATES ADDING AHU-4 TO THE ENERGY RECOVERY LOOP (WHICH WAS PLANNED FOR IN THE 2007 PROJECT DESIGN) AND ERU-3 SUPPLEMENTAL ENERGY RECOVERY UNIT WHICH IS AN ENHANCEMENT TO THE 2007 PROJECT DESIGN.
- ADJUST CIRCUIT SETTERS (IF PRESENT) AT CENTRAL CIRCULATING PUMPS P-3.1, P-3.2 AND P-3.3 TO ACCOMMODATE INCREASED FLOW TO NEW AHU-4 AND ERU-3 COILS (APPROXIMATELY 45 GPM ADDITIONAL). THESE PUMPS ARE CONTROLLED VIA VFC DRIVES AND DIFFERENTIAL PRESSURE SENSORS.
- NEW PIPING TO ERU-3 SHALL BE CONNECTED UPSTREAM OF THE EXISTING ERU-1 TWO-WAY BYPASS CONTROL VALVE. A NEW TWO-WAY BYPASS CONTROL VALVE SHALL BE PROVIDED TO CONTROL FLOW TO ERU-3. THESE VALVES SHALL BE CONFIGURED TO OPERATE IN UNISON.

GENERAL NOTES:

- ALL LAB EXHAUST DUCTWORK SHALL BE STAINLESS STEEL THROUGHOUT.
- THE 2007 RECORD DRAWINGS AND ASSOCIATED AS-BUILTS SHALL BE USED FOR REFERENCE ONLY AND UNDERSTANDING OF THE ASSOCIATED HVAC SYSTEMS DURING THE PROJECT CONSTRUCTION. BVH TAKES NO RESPONSIBILITY FOR THE ACCURACY OF THE DOCUMENTATION.
- ALL MATERIALS AND WORK ASSOCIATED WITH AHU-4 INTERNAL MODIFICATIONS SHALL BE INCLUDED IN THE MECHANICAL CONTRACTOR'S SCOPE OF WORK AND BID PRICE. COMPONENTS SHALL BE SUPPLIED BY HAAKON AND WORK PERFORMED BY HTS NEW ENGLAND SERVICE, PEABODY MA. (AUTHORIZED HAAKON SERVICE REPRESENTATIVE).

NOTE:
REFER TO MEP DRAWINGS FOR
ADDITIONAL INFORMATION.

RYAN INSTITUTE LABORATORY
PHASE 1 RENOVATIONS

URI - CBLS

120 FLAGG RD
KINGSTON, RI 02881

DATE: 03/19/2021
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BIDDING AND CONSTRUCTION
REVISIONS:
1 3/29/21 OWNER'S REVIEW
2 4/30/21 BIDDING & CONSTRUCTION
3 5/10/21 ADDENDUM NO. 1

H1.02

HVAC PENTHOUSE
PLAN

TLBA

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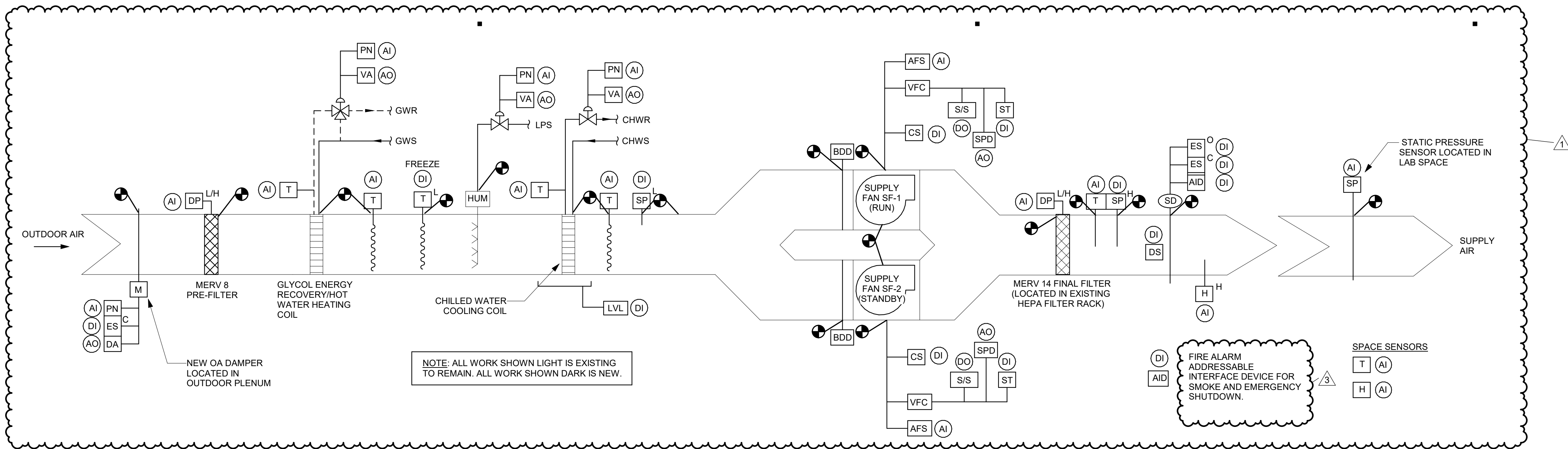
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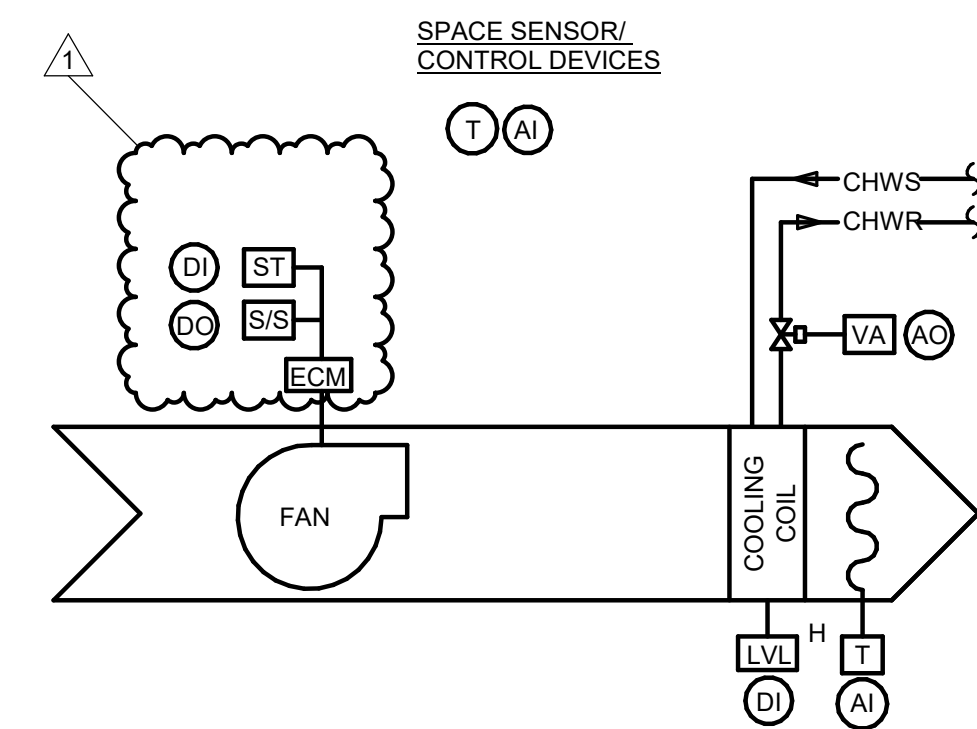
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EXISTING AIR HANDLING UNIT CONTROL SCHEMATIC (AHU-4)
NOT TO SCALE

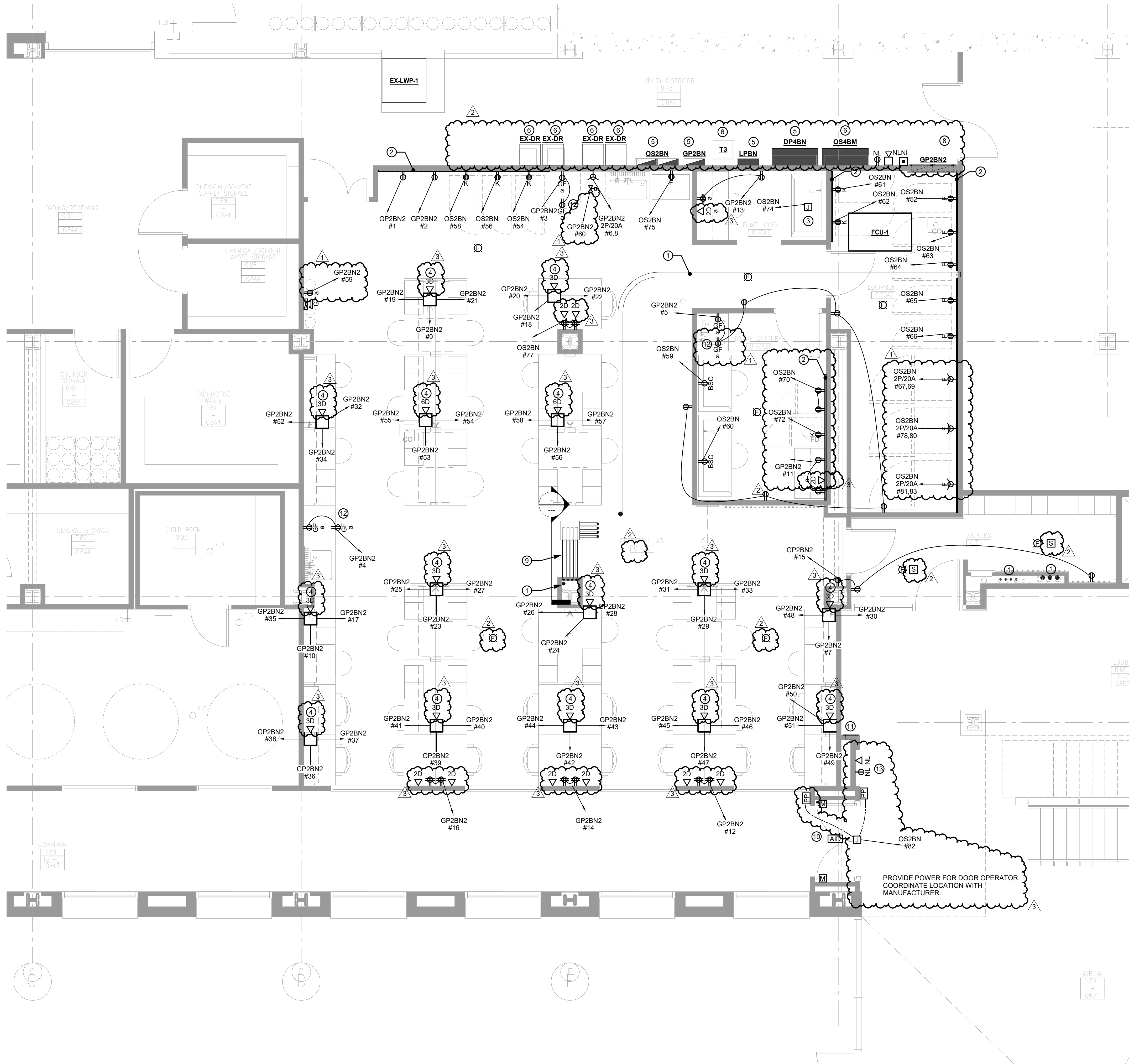
1. GENERAL:
 - A. 100% OUTDOOR AIR CONSTANT VOLUME AIR HANDLING UNIT WITH DUAL SUPPLY FANS, GLYCOL ENERGY RECOVERY/HOT WATER HEATING, CHILLED WATER COOLING, AND FILTRATION SERVING DUCT DISTRIBUTION. UNIT AND CONTROLS SHALL BE PROVIDED ON GENERATOR POWER SOURCE. FANS SHALL BE ROTATED ON A WEEKLY BASIS FOR EQUAL RUNTIME.
 2. ENABLE / DISABLE MODE:
 - A. UNIT SHALL BE ENABLED AND OPERATE CONTINUOUSLY 24/7/365, SUBJECT TO DISABLE AND SHUTDOWN COMMANDS.
 3. DISABLED CONDITION
 - A. WHENEVER THE UNIT IS DISABLED OR SHUTDOWN:
 - a. FANS SHALL BE OFF
 - b. THE SUPPLY SMOKE DAMPERS IN DUCT DISTRIBUTION SHALL BE CLOSED.
 - c. OUTSIDE AIR, RELIEF AIR, AND EXHAUST AIR DAMPERS SHALL BE CLOSED.
 - d. THE HEATING & COOLING VALVES SHALL BE FULLY CLOSED WHEN THE UNIT IS OFF.
 4. STANDBY POWER MODE:
 - A. DUAL FANS (SUPPLY) ARE POWERED FROM STANDBY BRANCH OF POWER. SYSTEM SHALL MONITOR STATUS OF STANDBY POWER AT ATS.
 5. RESTART/START COMMAND:
 - A. WHEN THE SYSTEM IS STARTED OR RESET:
 - a. COILS SHALL COME UNDER CONTROL FIRST.
 - b. SUPPLY SMOKE DAMPERS SHALL OPEN.
 - c. OUTDOOR AIR DAMPER SHALL OPEN.
 - d. SUBJECT TO END SWITCHES ON THE DAMPER CLOSED POSITIONS, THE RUN FAN SHALL BE SENT A START COMMAND.
 - e. SUPPLY FAN SHALL RAMP UP OVER 240 SECONDS (ADJ) AND HEATING/COOLING COIL COME UNDER NORMAL CONTROL.
 6. SINGLE FAN START/STOP:
 - A. IF A SINGLE SUPPLY FAN FAILS, IS DISABLED OR IS SHUT DOWN, IT SHALL BE COMPLETELY SHUT DOWN AND THE STANDBY FAN SHALL BE INITIATED TO RUN BASED ON ITS INTERNAL SAFETIES AND RAMP UP OVER 240 SECONDS (ADJ).
 7. STOP/SHUT-DOWN COMMAND:
 - A. UNIT SHUTDOWN SHALL OCCUR UNDER THE CONDITIONS INDICATED BELOW:
 - a. EMERGENCY SMOKE CONDITION IN AHU SUPPLY DUCT DISTRIBUTION AS SENSED BY AHU/DUCT DISTRIBUTION SMOKE DETECTORS.
 - b. EMERGENCY SHUTDOWN CONDITION AS COMMANDED FROM BUILDING FIRE ALARM SYSTEM FOR BOTH ALARM CONDITION IN ACCORDANCE WITH AHJ AND OWNER REQUIREMENTS AND FOR A MANUAL EMERGENCY SHUTDOWN COMMAND
 - c. EMERGENCY SUPPLY FAN STATIC ALARM CONDITION
 - d. EMERGENCY FREEZE CONDITION
 - e. MANUAL COMMAND FROM THE OPERATORS WORKSTATION
 - f. ACTIVATION OF SMOKE CONTROL SYSTEM.
 - B. ~~THE SHUTDOWN COMMAND FROM THE OPERATORS WORKSTATION SHALL BE BASED ON THE MINIMUM SPEED IN 120 SECONDS (ADJ) AND COMMAND OFF. ALL EMERGENCY COMMANDS SHALL BE A HARD WIRE INTERLOCK THAT IMMEDIATELY DISCONNECTS POWER TO THE SUPPLY FANS AND IS ARMED AT OPERATOR WORKSTATION. ONCE COMMANDED TO SHUTDOWN, THE UNIT SHALL GO TO DISABLED MODE. EACH EMERGENCY CONDITION SHUTDOWN REQUIRES A MANUAL RESET TO CLEAR ALARM AND ALLOW START OF UNIT.~~
 8. SUPPLY FAN CONTROL:
 - A. THE SUPPLY FANS SHALL RUN CONTINUOUSLY TO MAINTAIN STATIC PRESSURE, TEMPERATURE AND HUMIDITY.
 9. DISCHARGE AIR TEMPERATURE RESET:
 - A. AIR HANDLER DISCHARGE AIR TEMPERATURE SHALL BE SET TO 5°F (ADJ) AND RESET 2°F. AIR HANDLER DISCHARGE AIR TEMPERATURE SHALL BE RESET LOWER WHENEVER AN AIR TERMINAL IS AT MAXIMUM COOLING OR WHEN THE SPACE HUMIDITY RISES ABOVE 60% SUBJECT TO A LOW DISCHARGE LIMIT OF 50°F (ADJ).
 10. HUMIDITY CONTROL:
 - A. THE HUMIDIFIER SHALL BE ENABLED WHENEVER THE SPACE RH DROPS BELOW 35% (ADJ). SUBJECT TO POSITIVE VAV DUCT STATIC PRESSURE, THE HUMIDIFICATION CONTROL OUTPUT SHALL BE MODULATED TO MEET A MINIMUM OF 35% RH AS SENSED AT THE SPACE HUMIDITY SENSOR. CONTROL SHALL BE SUBJECT TO A HIGH LIMIT NOT TO EXCEED 85% RH (ADJ). WHEN AIR SYSTEM TEMPERATURE CONTROL IS LOST, CONTROL OUTPUT SHALL BE SET TO ZERO. UPON RE-ESTABLISHING SYSTEM TEMPERATURE CONTROL, DELAY START OF HUMIDIFICATION SYSTEM UNTIL ROOM TEMPERATURE HAS STABILIZED.
 11. COOLING COIL CONTROL:
 - A. THE COOLING COIL CONTROL VALVE SHALL MODULATE TO MAINTAIN DISCHARGE AIR TEMPERATURE SETPOINT IN SEQUENCE WITH THE HEATING COIL. HEATING AND COOLING COILS SHALL NOT BE PERMITTED TO OPERATE SIMULTANEOUSLY. MONITOR HIGH LEVEL IN CONDENSATE PAN AND ALARM AT BMS. DO NOT DISABLE AHU IN CONDENSATE HIGH LEVEL ALARM CONDITION.
 12. FILTER BANKS:
 - A. DIFFERENTIAL PRESSURE AT EACH FILTER BANK SHALL BE MONITORED AND ALARM WHEN DIFFERENTIAL STATIC PRESSURE IS REACHED.
 13. ENERGY RECOVERY CONTROL:
 - A. MONITOR BOTH ENTERING AND LEAVING TEMPERATURE AND HUMIDITY FOR BOTH OUTDOOR AND EXHAUST AIRSTREAMS.
 14. ALARMS:
 - A. UNIT STOPPED CONDITION
 - B. SINGLE SUPPLY FAN STOPPED CONDITION (EA)
 - C. SINGLE SUPPLY FAN FAULT/FAILURE CONDITION (EA)
 - D. SUPPLY SMOKE CONDITION
 - E. SUPPLY DISCHARGE HIGH STATIC CONDITION
 - F. SUPPLY INTAKE LOW STATIC CONDITION
 - G. FREEZE CONDITION
 - H. SPACE TEMPERATURE HIGH/LOW CONDITIONS
 - I. SPACE RH HIGH/LOW CONDITIONS
 - J. LOW/HIGH UNIT DISCHARGE AIR TEMPERATURES
 - K. HIGH FILTER BANK PRESSURES
 - L. OUTDOOR AIR DAMPER FAILURE CONDITION
 - M. CONDENSATE HIGH LEVEL ALARM
 - N. VFC FAULT (EA)
 15. GRAPHICS
 - A. ALARM CONDITIONS
 - B. OCCUPIED/UNOCCUPIED MODE
 - C. SUPPLY FAN STATUS (EA)
 - D. SUPPLY FAN SPEED (EA)
 - E. SUPPLY FAN AIR FLOW (EA)
 - F. HIGH HUMIDITY CONDITION
 - G. SUPPLY SYSTEM STATIC PRESSURE
 - H. DISCHARGE AIR TEMPERATURE
 - I. DISCHARGE AIR TEMPERATURE BASE SET POINT
 - J. DISCHARGE AIR TEMPERATURE RESET SET POINT
 - K. GW COIL VALVE COMMAND PERCENTAGE
 - L. GW COIL VALVE POSITION PERCENTAGE
 - M. GW COIL RETURN WATER TEMPERATURE
 - N. GW COIL DISCHARGE AIR TEMPERATURE
 - O. CHW COIL VALVE COMMAND PERCENTAGE
 - P. CHW COIL VALVE POSITION PERCENTAGE
 - Q. CHW COIL DISCHARGE AIR TEMPERATURE
 - R. OA DAMPER COMMAND
 - S. OA DAMPER POSITION
 - T. OUTSIDE AIR TEMPERATURE (GLOBAL)
 - U. OUTSIDE AIR HUMIDITY (GLOBAL)
 - V. FILTER DIFFERENTIAL PRESSURE (EA)
 - W. SUPPLY DUCT STATIC PRESSURE
 - X. SUPPLY STATIC PRESSURE SETPOINT
 - Y. HUMIDIFIER VALVE COMMAND PERCENTAGE
 - Z. HUMIDIFIER VALVE POSITION PERCENTAGE
 - AA. SPACE TEMPERATURE
 - AB. SPACE RH (%)
 - AC. VFC STATUS (EA)
 - AD. VFC SPEED (EA)
 - AE. VFC COMMAND (EA)



COOLING ONLY CHILLED WATER FAN COIL UNIT CONTROL
NOT TO SCALE

1. SEQUENCE OF OPERATION
 - a. FAN COIL UNIT SHALL RUN CONTINUOUSLY.
 - b. ON A CALL FOR COOLING FROM SPACE SENSOR, MODULATE COOLING VALVE OPEN TO MAINTAIN SETPOINT.
 - c. OCC SETPOINT: 75°F (ADJ)
 - d. ON COOLING COIL HIGH LEVEL CONDITION, CLOSE CHW VALVE, SYSTEM TO CONTINUE TO OPERATE
2. ALARMS
 - a. HIGH SPACE TEMPERATURE (85°F)
 - b. FAN FAILURE ALARM
 - c. HIGH LEVEL CONDENSATE
3. GRAPHICS
 - a. ALARM CONDITION
 - b. SPACE TEMPERATURE
 - c. VALVE COMMAND STATUS
 - d. FAN STATUS
 - e. FAN COMMAND

NOTE:
REFER TO MEP DRAWINGS FOR
ADDITIONAL INFORMATION.



- # ELECTRICAL POWER & SPECIAL SYSTEMS DRAWING NOTES:**
- EXISTING TO REMAIN CONDUIT.
 - PROVIDE WALL MOUNTED STEEL SINGLE CHANNEL RACEWAY SYSTEM. REFER TO FLOORPLANS FOR LENGTHS, CIRCUITRY AND RECEPTACLE SPACING. BASIS OF DESIGN LEGRAND 2000 SERIES.
 - PROVIDE POWER FOR FUME HOOD. COORDINATE EXACT LOCATION AND TERMINATION IN FIELD.
 - PROVIDE RECEPTACLES MOUNTED WITHIN THE OVERHEAD SERVICE PANEL. REFER TO DETAIL FOR ADDITIONAL INFORMATION.
 - EXISTING TO REMAIN ELECTRICAL PANELBOARD. UPDATE INDEX PANELBOARD SCHEDULE TO REFLECT NEW CIRCUITRY.
 - EXISTING TO REMAIN ELECTRICAL EQUIPMENT.
 - SUPPORT TRANSFORMER FROM STRUCTURE ABOVE. TRANSFORMER TO BE LOCATED ABOVE EXISTING TRANSFER SWITCH TO MAINTAIN ACCESS TO THE SIDE OF THE EXISTING TRANSFER SWITCH. LOCATE FUSED DISCONNECT IN ACCESSIBLE LOCATION UNDER THE TRANSFORMER. REFER TO ELECTRICAL RISER FOR ADDITIONAL INFORMATION.
 - PROVIDE NEW PANELBOARD FED FROM TX-GP2BN2. REFER TO ELECTRICAL RISER FOR ADDITIONAL INFORMATION.
 - PROVIDE NEW 2" CONDUIT TO EXTEND EXISTING 2" CONDUIT TO NEW LOCATION. INTERCEPT EXISTING CONDUCTORS AND SPLICE IN NEW CONDUCTORS IN CEILING MOUNTED HINGED JUNCTION BOX. COORDINATE WITH OTHER TRADES TO MAINTAIN ACCESSIBILITY TO JUNCTION BOX.
 - PROVIDE ADDRESSABLE INTERFACE DEVICE TO TIE NEW FIRE DOOR INTO THE EXISTING EDWARDS EST3 FIRE ALARM SYSTEM.
 - PROVIDE RECESSED WALLBOX TO HOUSE RELOCATED WINDOW ACTUATOR MANUAL SWITCHES. MATCH AND EXTENDED EXISTING WIRING TO NEW LOCATION. WALL BOX TO HAVE (8) GANGS, 14" WIDE X 13" TALL X 4" DEEP WITH LOCKABLE HINGED COVER. BASIS OF DESIGN LEGRAND EHWB8.
 - PROVIDE RECEPTACLE FOR FUTURE RO POLISHER. COORDINATE LOCATION IN FIELD WITH ARCHITECT/OWNER.
 - RELOCATED POWER AND DATA FOR TV. EXTEND EXISTING CONDUIT AND CIRCUITRY TO NEW LOCATION.
 - DISCONNECT AND MAKE SAFE EXISTING AUTOCLAVE. MATCH AND EXTEND EXISTING CONDUIT AND CONDUCTORS TO FACILITATE REINSTALLATION OF THE AUTOCLAVE.
 - PROVIDE AN ADDRESSABLE INTERFACE DEVICE TO TIE THE FIRE ALARM SYSTEM TO THE VARIABLE FREQUENCY DRIVER. REFER TO HVAC CONTROL SEQUENCE FOR ADDITIONAL INFORMATION.

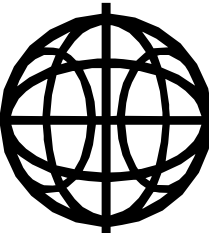
- POWER & SPECIAL SYSTEMS GENERAL NOTES:**
- TYPICAL HOMERUN FOR EACH BRANCH CIRCUIT SHALL BE FED WITH (2) #12 AND (1) #12 GROUND IN 3/4" CONDUIT TO A 20A-1P CIRCUIT BREAKER IN PANELBOARD DESIGNATED, UNLESS OTHERWISE NOTED.
 - PROVIDE BACKBOX AND CONDUIT FOR ALL TECHNOLOGY AND SECURITY DEVICES. CABLING AND ALL ASSOCIATED HARDWARE ARE TO BE PROVIDED BY OTHERS.

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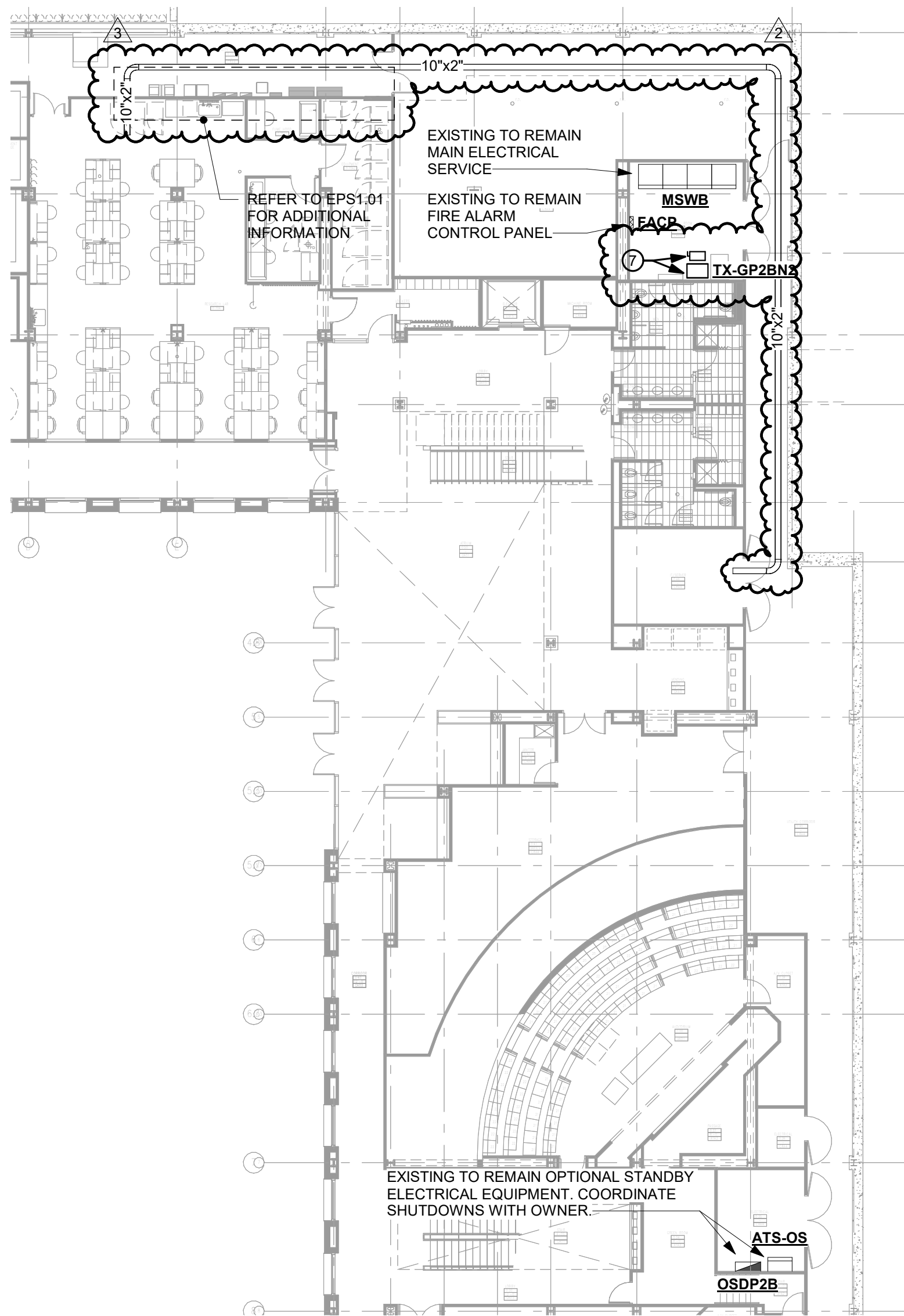
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EPS1.01

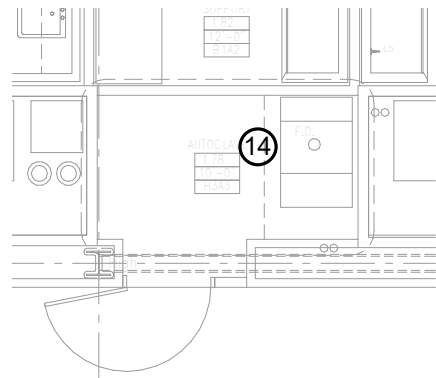
ELECTRICAL POWER & SPECIAL SYSTEMS
PLAZA LEVEL PLAN

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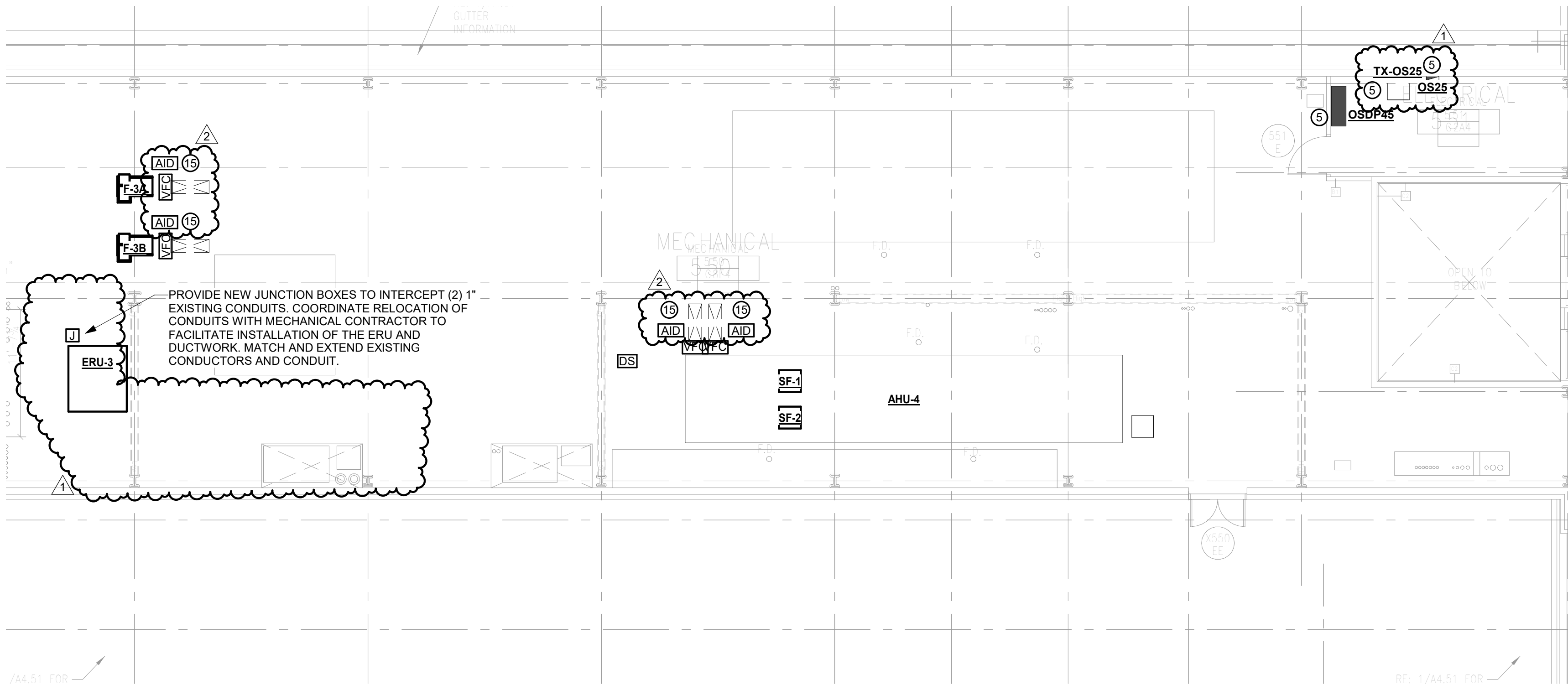
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PLAZA LEVEL EXTENDED PLAN
1/16" = 1'-0"



3 LEVEL 2 AUTOCLAVE PART PLAN
1/8" = 1'-0"



PENTHOUSE LEVEL PLAN
1/8" = 1'-0"

#	ELECTRICAL POWER & SPECIAL SYSTEMS DRAWING
NOTES:	
1	EXISTING TO REMAIN CONDUIT.
2	PROVIDE WALL MOUNTED STEEL SINGLE CHANNEL RACEWAY SYSTEM. REFER TO FLOORPLANS FOR LENGTHS, CIRCUITRY AND RECEPTACLE SPACING. BASIS OF DESIGN LEGRAND 2000 SERIES.
3	PROVIDE POWER FOR FUME HOOD. COORDINATE EXACT LOCATION AND TERMINATION IN FIELD.
4	PROVIDE RECEPTACLES MOUNTED WITHIN THE OVERHEAD SERVICE PANEL. REFER TO DETAIL FOR ADDITIONAL INFORMATION.
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15	PROVIDE AN ADDRESSABLE INTERFACE DEVICE TO TIE THE FIRE ALARM SYSTEM TO THE VARIABLE FREQUENCY DRIVER. REFER TO HVAC CONTROL SEQUENCE FOR ADDITIONAL INFORMATION.

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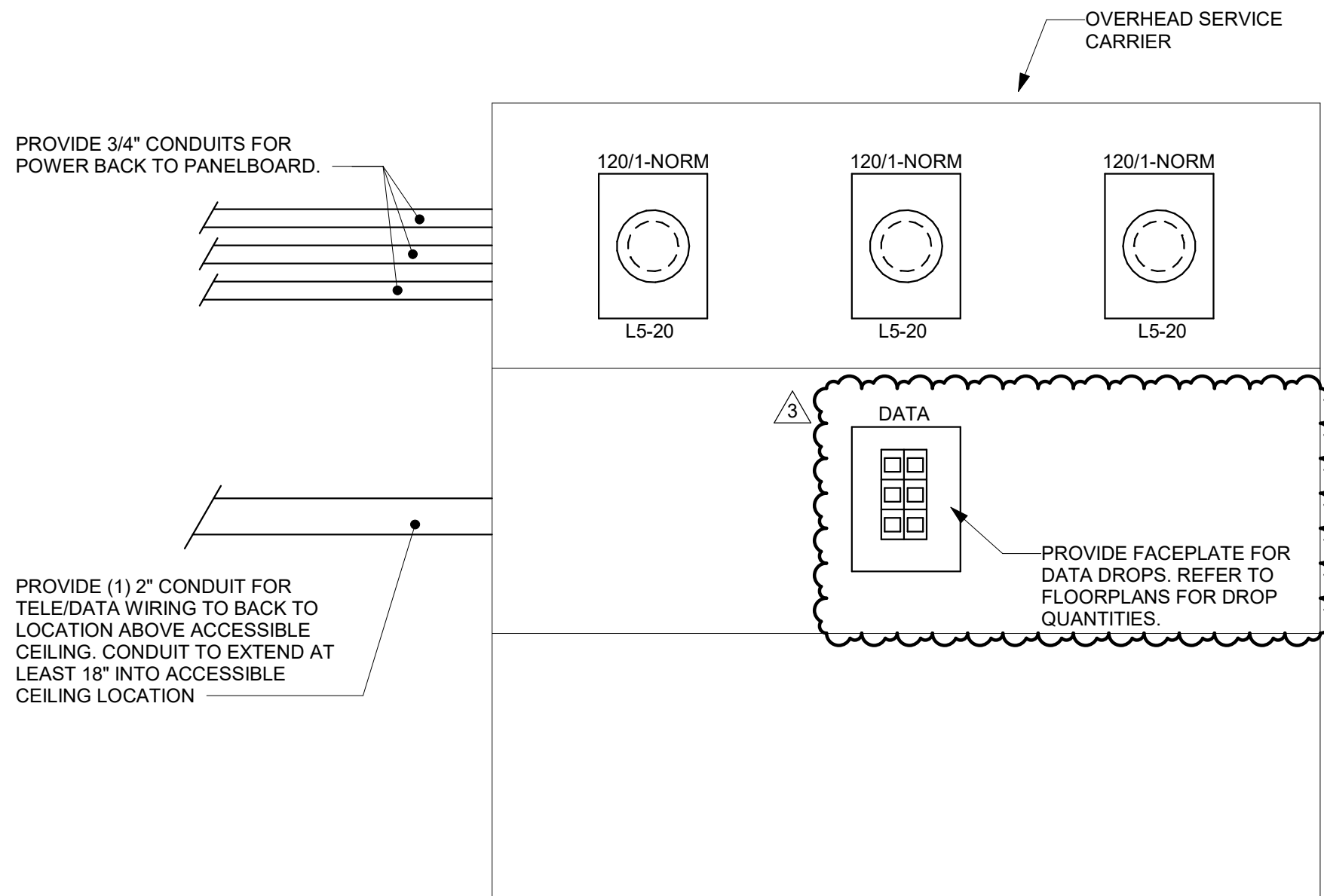
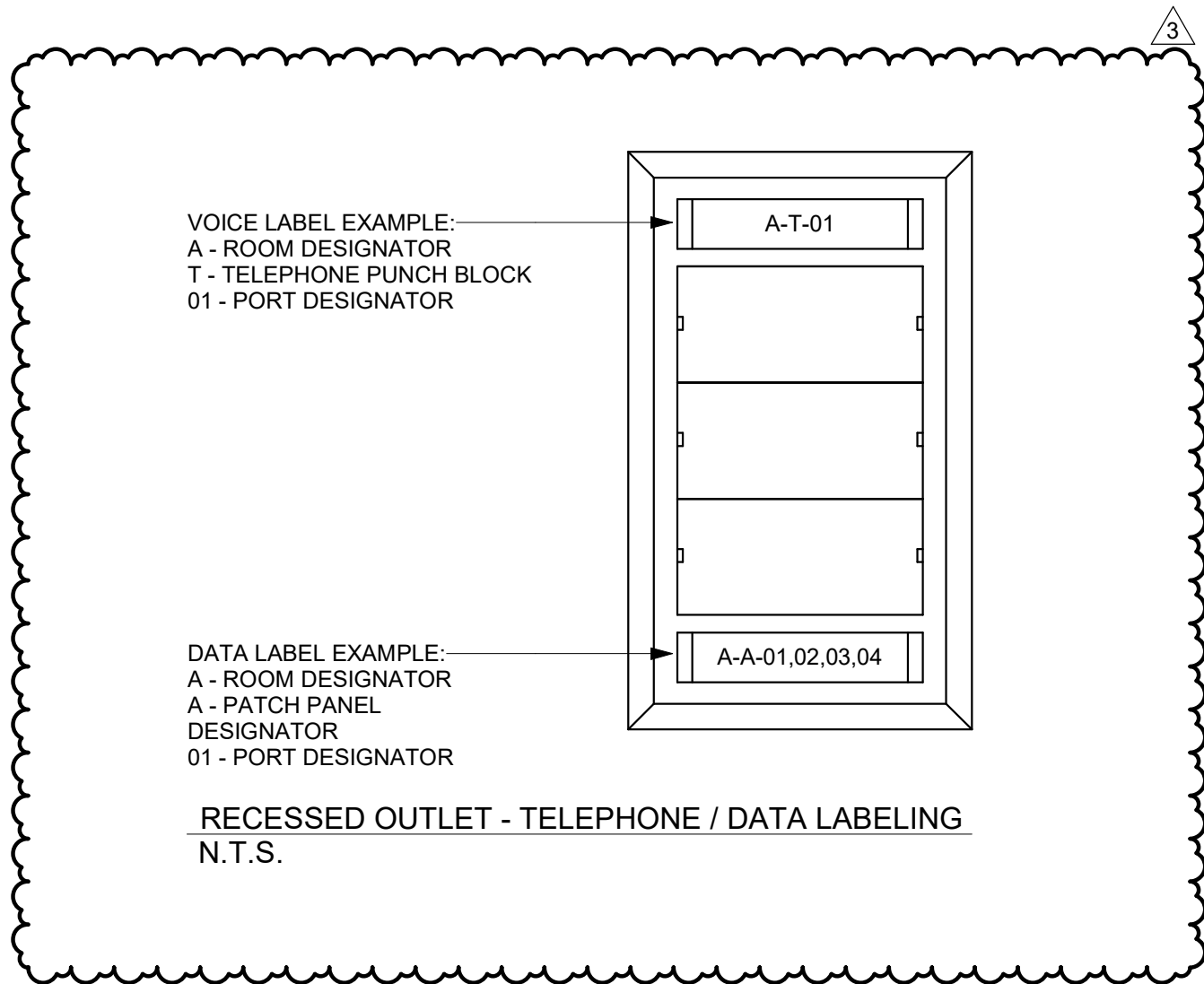
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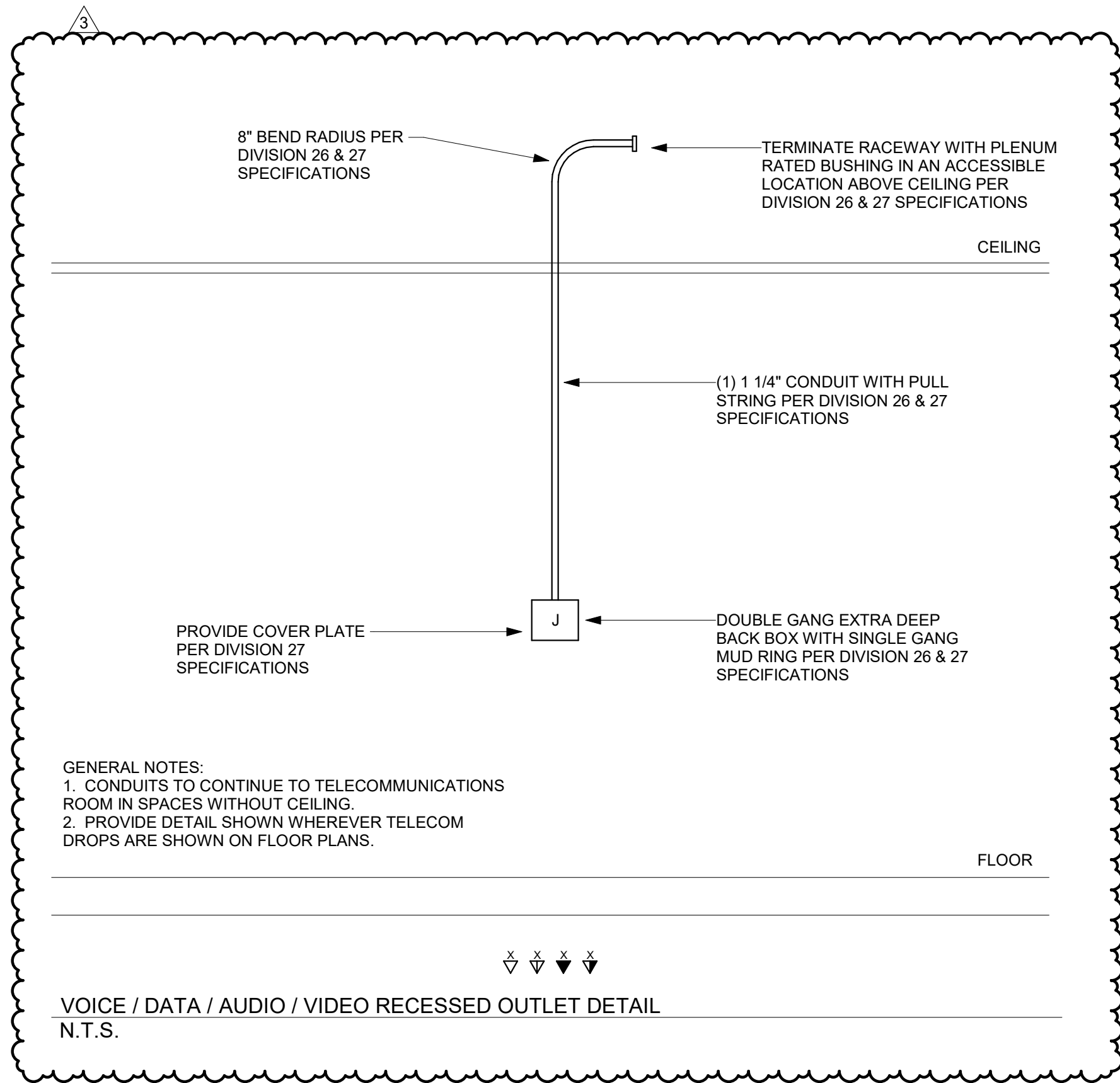
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**ELECTRICAL POWER &
SPECIAL SYSTEMS
PENTHOUSE PLAN**



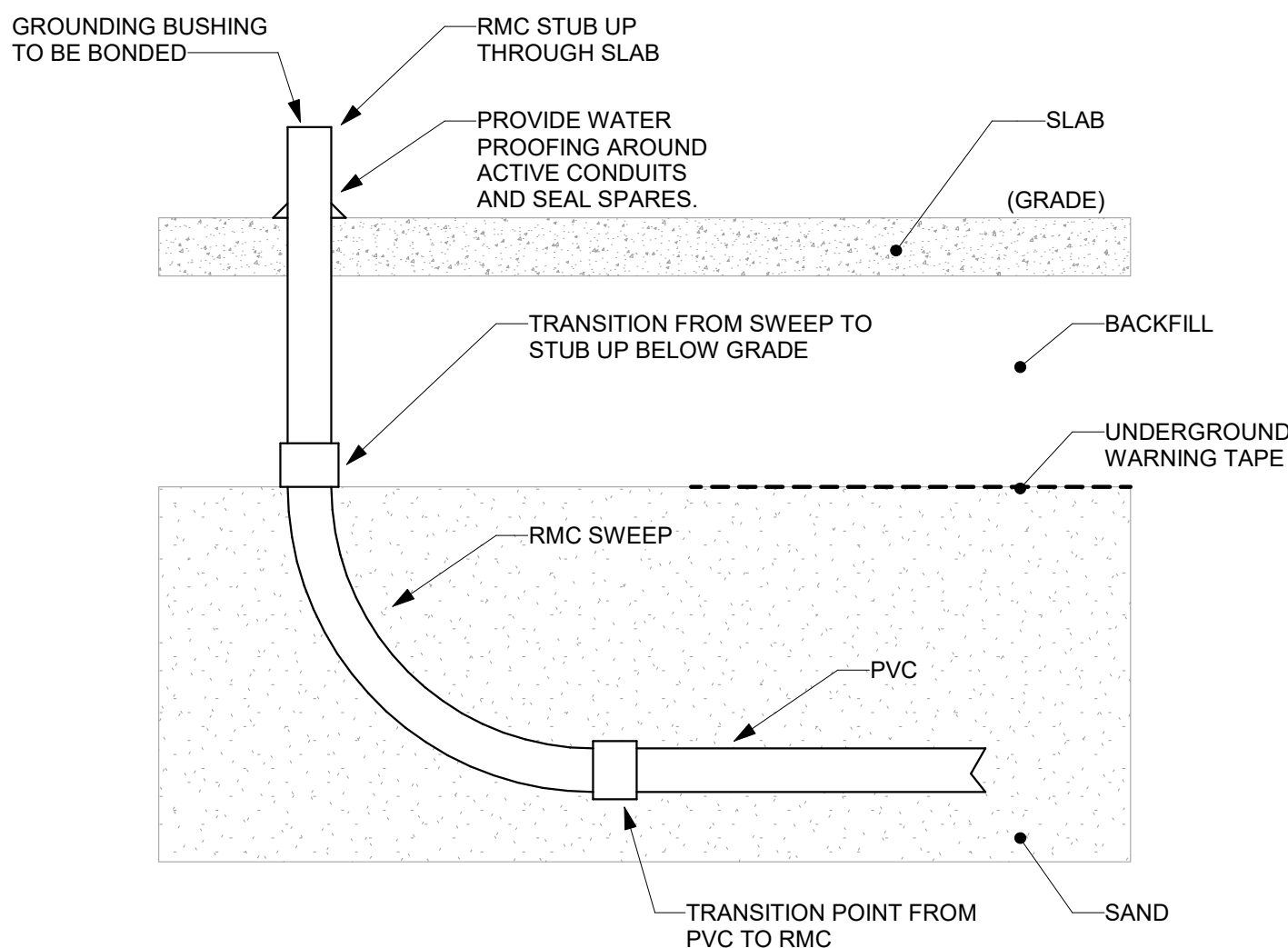
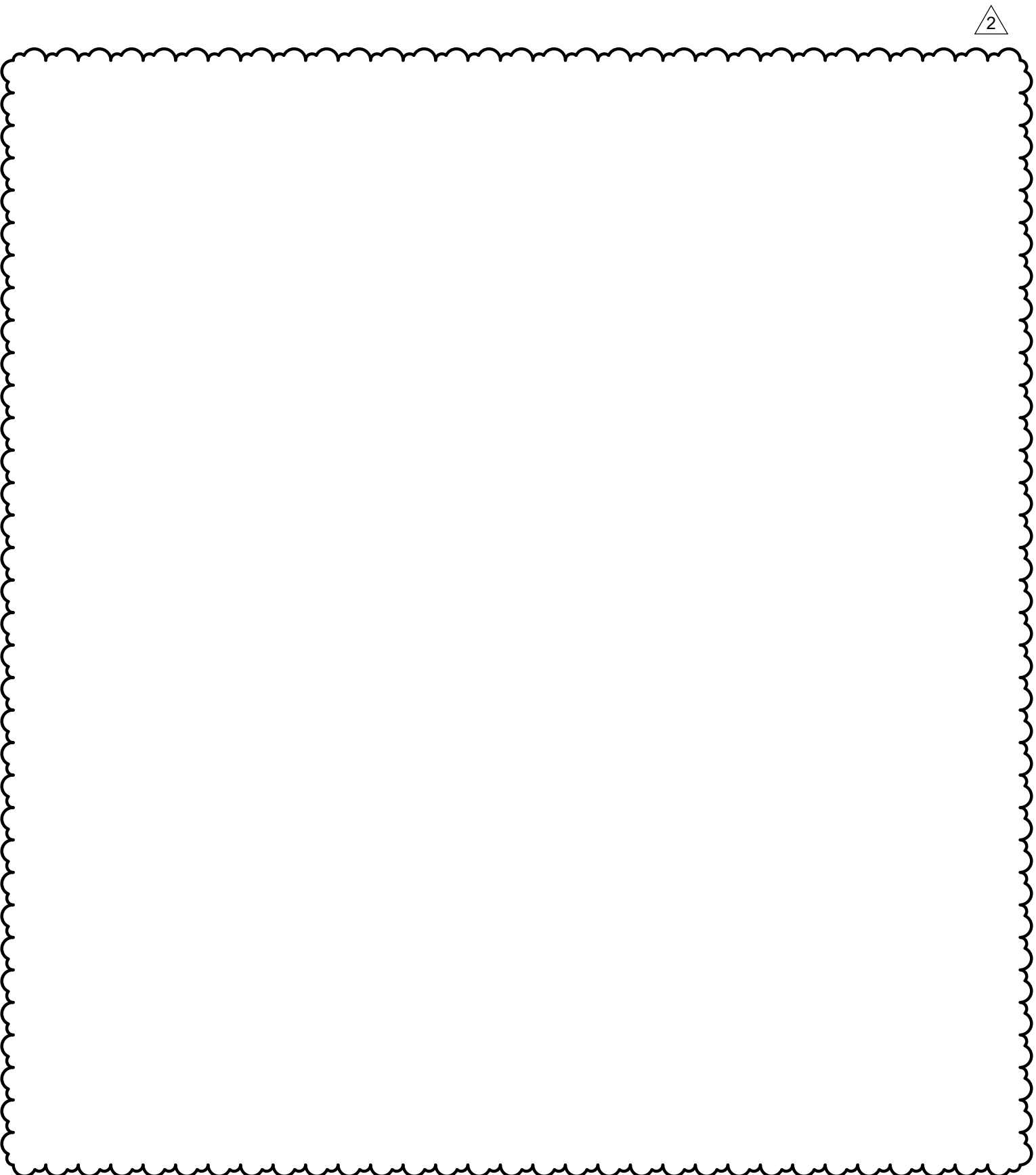
- GENERAL NOTES:
1. OVERHEAD SERVICE CARRIER PROVIDED BY OTHERS. REFER TO ARCHITECTURAL DRAWINGS/SPECIFICATIONS FOR ADDITIONAL INFORMATION.
 2. PROVIDE L5-20 TWIST LOCK RECEPTACLES TO BE MOUNTED WITHIN OVERHEAD SERVICE PANEL.

OVERHEAD SERVICE CARRIER
N.T.S.



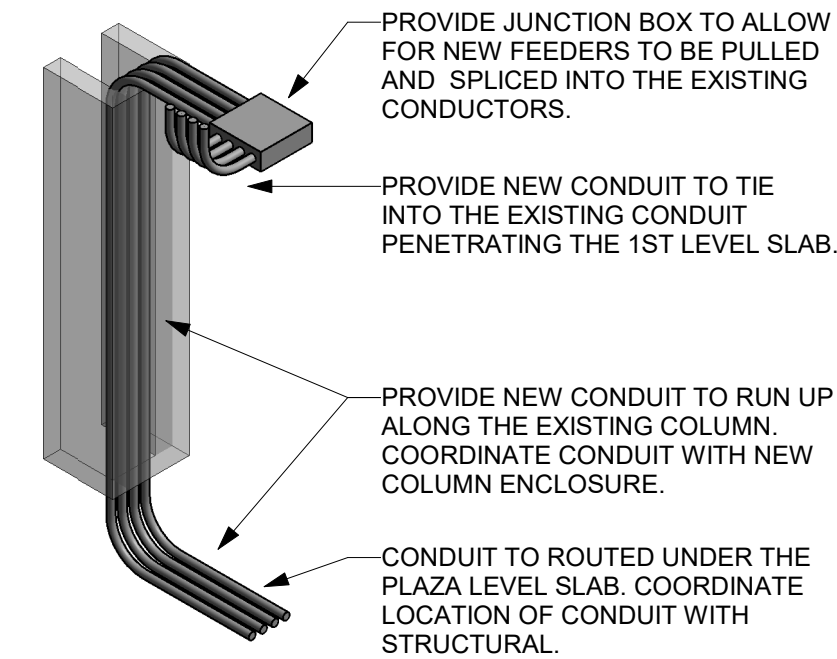
- GENERAL NOTES:
1. CONDUITS TO CONTINUE TO TELECOMMUNICATIONS ROOM IN SPACES WITHOUT CEILING.
 2. PROVIDE DETAIL SHOWN WHEREVER TELECOM DROPS ARE SHOWN ON FLOOR PLANS.

VOICE / DATA / AUDIO / VIDEO RECESSED OUTLET DETAIL
N.T.S.



- GENERAL NOTES:
1. THIS DETAIL APPLIES TO ALL CONDUITS PENETRATING A SLAB.
 2. PROVIDE UNDERGROUND WARNING TAPE WHEN OUTSIDE OF THE BUILDING FOOTPRINT.
 3. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.

TYPICAL CONDUIT SWEEP THRU SLAB
N.T.S.



PROPOSED CONDUIT RELOCATION ROUTING

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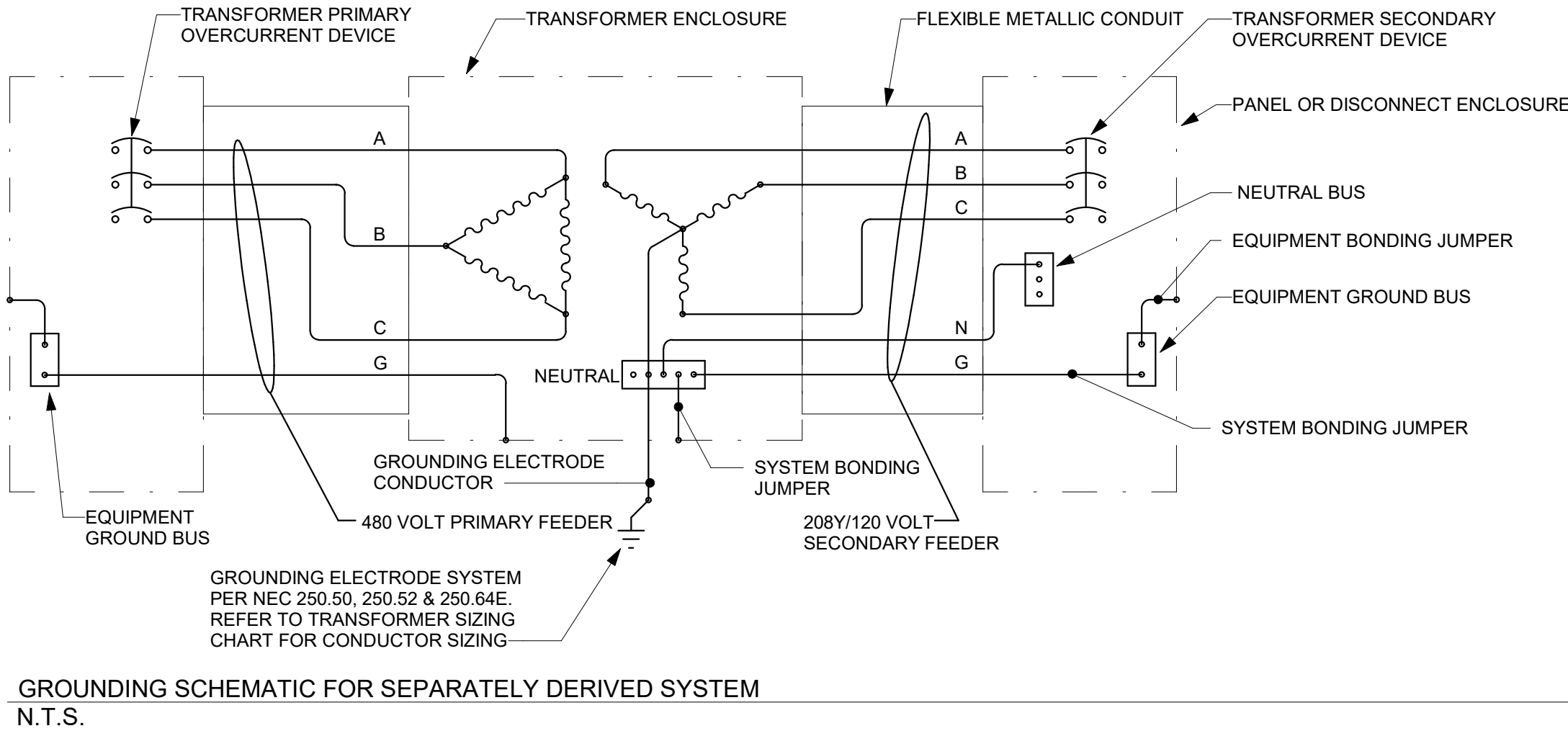
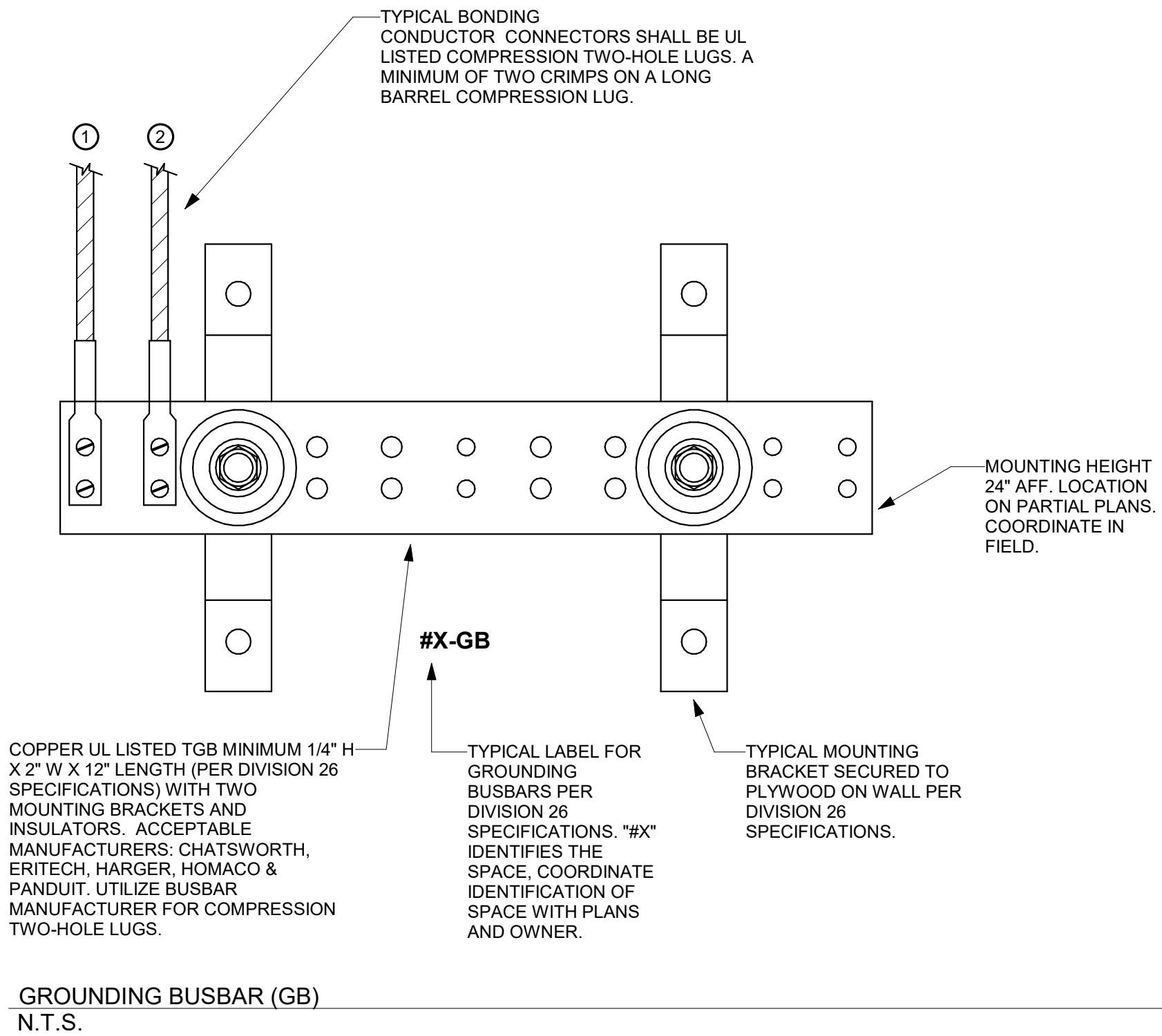
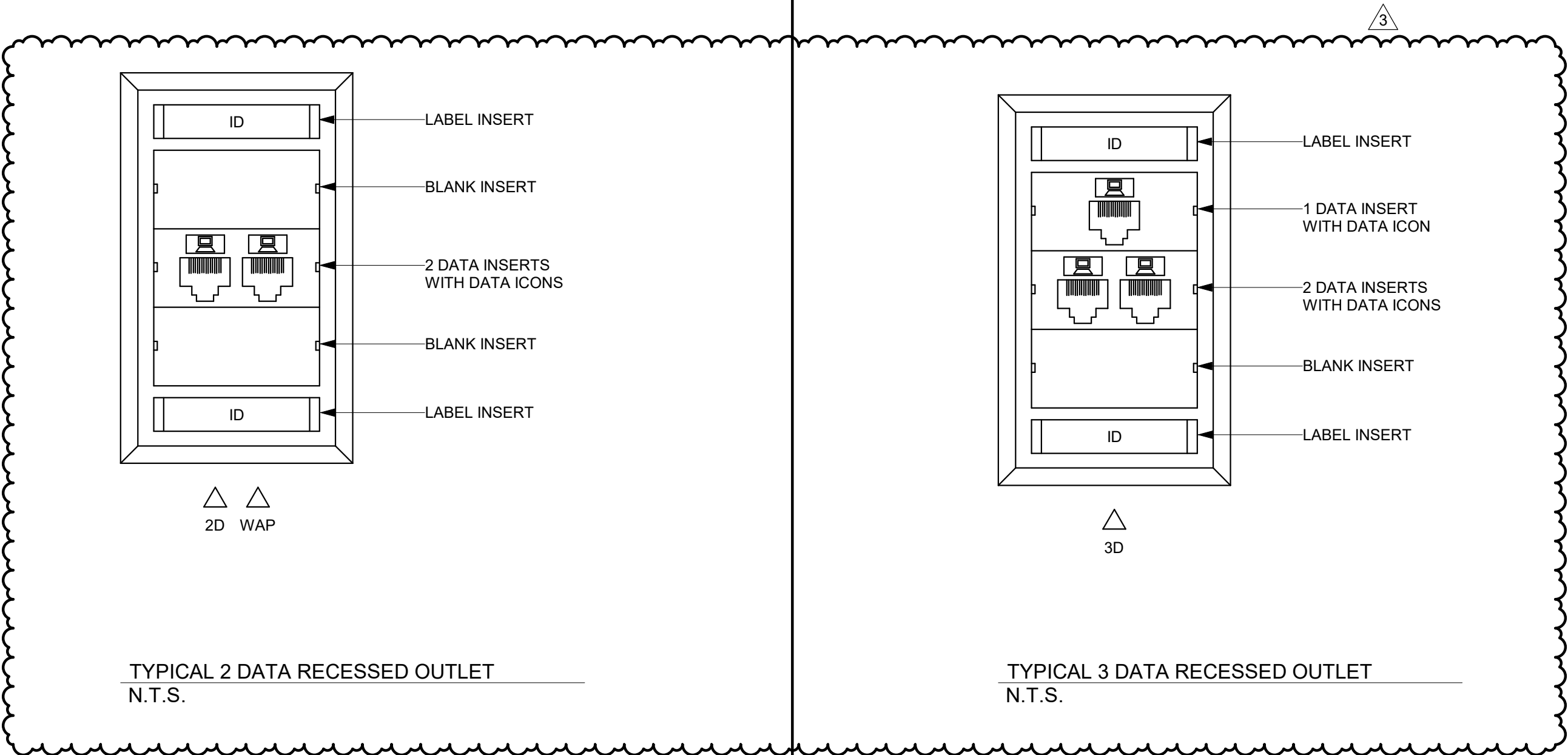
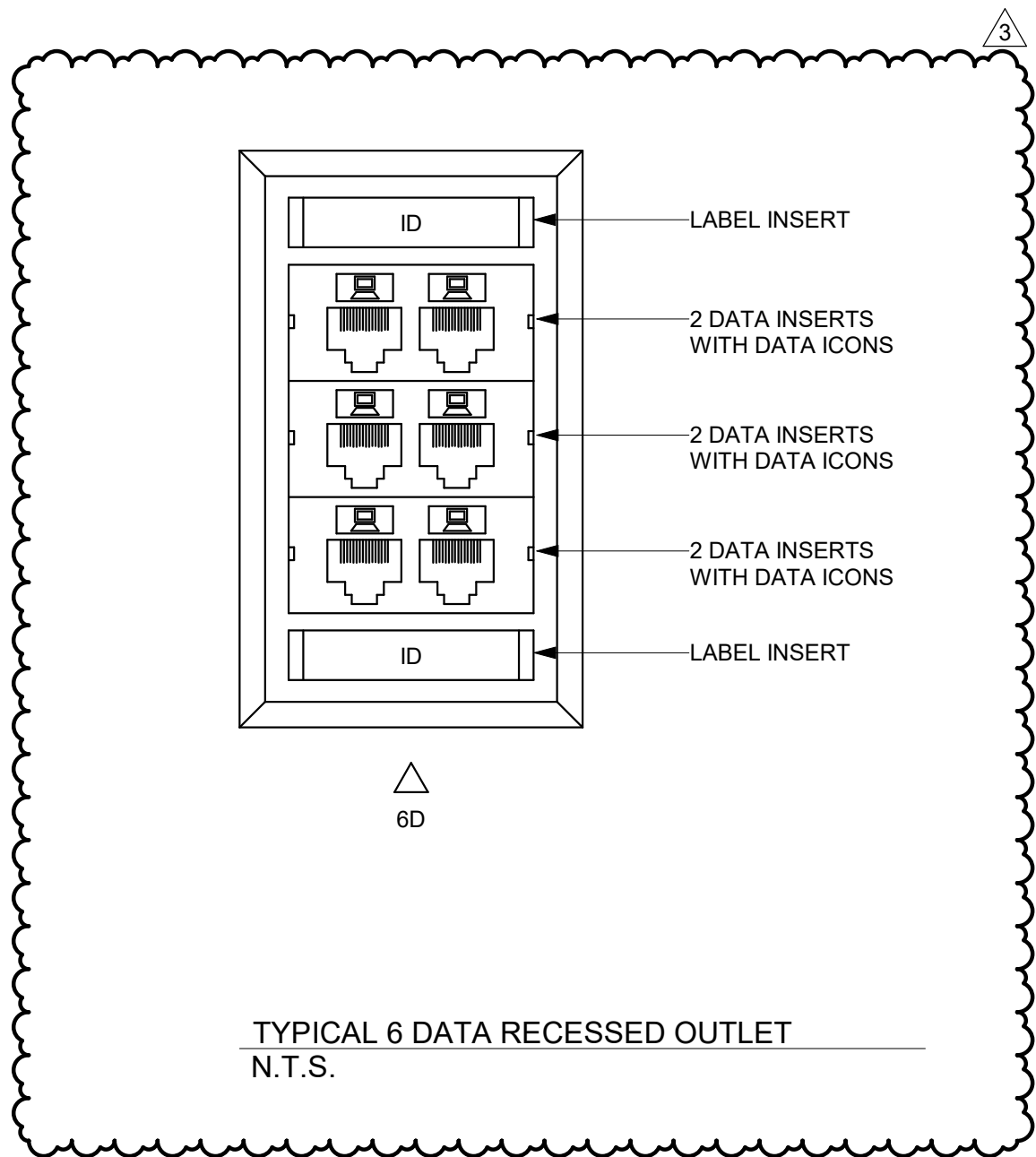
TLBA

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DATE: 03/19/2021
PROJECT NO: 2020.021
DRAWN: MCS
CHECKED: JRD
ISSUED FOR:
BIDDING and CONSTRUCTION
REVISIONS:
1 3/29/21 OWNER'S REVIEW
2 4/30/21 BIDDING & CONSTRUCTION
3 5/10/21 ADDENDUM NO. 1

E4.02

ELECTRICAL DETAILS



BUSBAR DETAIL GENERAL NOTES

- FASTENING BONDING CONNECTOR TWO-HOLE LUGS TO ALL BUSBARS SHALL BE CLEANED AND APPLY A COPPER ANTI-OXIDANT TO THE CONTACT AREA OF BOTH THE CONNECTOR LUG AND THE BUSBAR.
- BONDING CONDUCTORS AND BUSBARS SHALL BE LABELED WITH IDENTIFICATION IN ACCORDANCE WITH THE REQUIREMENTS OF ANSI/TIA/EIA-606-A.
- SEE PLANS FOR QUANTITY OF BUS BARS.

BUSBAR DETAIL DRAWING NOTES

- BCT TO NEAREST BUILDING STEEL STRUCTURE, IF APPLICABLE. UTILIZE EXOTHERMIC WELDING CONNECTION TO BUILDING STEEL.
- BCT TO NEAREST BUILDING ELECTRICAL PANELBOARD GROUND BAR. UTILIZE LISTED CONNECTOR TO PANELBOARD GROUND BUS.

GROUNDING & BONDING DETAIL NOTES
N.T.S.

NOTE:
REFER TO MEP DRAWINGS FOR
ADDITIONAL INFORMATION.

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RYAN INSTITUTE LABORATORY
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URI - CBLs
120 FLAGG RD
KINGSTON, RI 02881

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E4.03

ELECTRICAL DETAILS



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