

ADDENDUM NO. 03

January 17, 2020

Murrieta Mesa High School New Classroom Building – DSA 04-118451 MURRIETA VALLEY UNIFIED SCHOOL DISTRICT

Project No. 02132020
DSA No. 04-118451
File No. 33-H18

The following changes, omissions, and/or additions to the Project Manual and/or Drawings shall apply to proposals made for and to the execution of the various parts of the work affected thereby, and all other conditions shall remain the same.

Careful note of the Addendum shall be taken by all parties of interest so that the proper allowances may be made in strict accordance with the Addenda, and that all trades shall be fully advised in the performance of the work which will be required of them.

Bidder shall acknowledge receipt of this Addenda in the space provided on the Bid Form. Failure to do so may subject Bidder to disqualification.

In case of conflict between Drawings, Project Manual, and this Addenda, this Addenda shall govern.

GENERAL NOTE

- 1) Bid date and time and submission location remain unchanged, as noted in the bid documents.

BID SCOPE CLARIFICATIONS

1) BNDS ADDENDUM NO. 03 – PROJECT MANUAL

a. CHANGES TO PROJECT MANUAL TABLE OF CONTENTS

Bid Package No. 13, Bid Package No. 14, Bid Package No. 15 –

Division 23 – HEATING VENTILATING AND AIR CONDITIONING

1. Add Section 237416.11 – Packages, Small-Capacity, Rooftop Air-Conditioning Units

b. SPECIFICATION SECTIONS ISSUED

Bid Package No. 13, Bid Package No. 14, Bid Package No. 15 –

Section 237416.11 – Packages, Small-Capacity, Rooftop Air-Conditioning Units

1. Section 237416.11 – Packages, Small-Capacity, Rooftop Air-Conditioning Units: Add entire section

c. CHANGES TO SPECIFICATIONS

Bid Package No. 08 –

Section 099113 Exterior Painting.

1. Addition / edit to subparagraph 2.1-A per attached.

Bid Package No. 08 –

Section 099123 Interior Painting.

1. Addition of subparagraph 2.2-D-6: Clear Wood Finish (ST-1).

Bid Package No. 13, Bid Package No. 14, Bid Package No. 15 –

Section 237416.11 Packaged, Small-Capacity, Rooftop Air Conditioning Units

1. Addition of subparagraph 2.1-A and B: Project Requirements

Bid Package No. 12 –

Section 271000 – Voice/ Data Infrastructure

1. Addition of Part 7 – Campus IP-Based Paging System Requirements.

Bid Package No. 12 –

Section 272000 – Integrated AV

1. Addition of section 2.10 under Part 2 - Products.
2. Partial omission in subparagraph 2.16.4 under Part 2-Products, section 2.16.
3. Addition of Campus IP-Based Paging Systems Requirements, section 2.28 through 2.35.6 under Part 2 – Products.

2) BNDS ADDENDUM NO. 03 - ARCHITECTURAL DRAWINGS

a. SHEET NO. A3.2, A8.2, A9.9 REVISED

Bid Package No. 06, Bid Package No. 10 –

The following Addendum (“AD”) Drawings are issued:

1. Drawing A3.2: Revise currently issued drawing per AD3-A08.
2. Drawing A8.2: Revise currently issued drawing per AD3-A09.
3. Drawing A9.9: Revise currently issued drawing per AD3-A10.

3) BNDS ADDENDUM NO. 03 – ELECTRICAL DRAWINGS

a. SHEET NO. E4.7 REVISED

Bid Package No. 12 –

The following Addendum (“AD”) Drawings are issued:

1. Drawing E4.7: Revise currently issued drawing per AD3-E01.

PRE-BID REQUESTS FOR INFORMATION

1. PB 006 Specification 062023-2.3A Interior Trim Transparency:

Bid Package No. 08 –

Question

Specification Section 062023 2.3.A-Interior Trim indicates transparent finish; however, there is no specification for transparent finish. Is this factory applied by Section 062023 or field applied by 099123? Please review and advise.

Response

This is to be field applied. An addendum (Addendum 3) will follow reflecting this in specification section 099123.

PRE-BID SUBSTITUION REQUESTS

1. 05 31 00 STEEL DECKING:

Bid Package No. 02 –

“No Exception Taken” by KNA Structural Engineers 2020.01.28, based upon the requirements per MMHS Substitution Request Form, pages 1 – 2, per Volume 1 of the Project Manual.

ADDENDUM 03 ATTACHMENTS:

SPECIFICATIONS:

1. Specification Table of Contents
2. Specification Sections 099113, 099123, 230923, 237416.11, 271000, 272000.

DRAWINGS:

42 X 30

1. AD3-A08
2. AD3-A09
3. AD3-A10
4. AD3-E01

OTHER:

1. Approved Substitution Request – 05 31 00 Steel Decking

END OF ADDENDUM NUMBER 03

102600 - WALL AND DOOR PROTECTION
 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES
 104413 - FIRE EXTINGUISHER CABINETS
 104416 - FIRE EXTINGUISHERS
 105113 - METAL LOCKERS

DIVISION 12 — FURNISHINGS

122116 - VERTICAL LOUVER BLINDS

DIVISION 21 — FIRE SUPPRESSION

211313 - WET-PIPE FIRE SPRINKLER SYSTEMS

DIVISION 22 — PLUMBING

220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING
 220518 - ESCUTCHEONS FOR PLUMBING PIPING
 220523.12 - BALL VALVES FOR PLUMBING PIPING
 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
 220719 - PLUMBING PIPING INSULATION
 221116 - DOMESTIC WATER PIPING
 221119 - DOMESTIC WATER PIPING SPECIALTIES
 221316 - SANITARY WASTE AND VENT PIPING
 221319 - SANITARY WASTE PIPING SPECIALTIES
 221319.13 - SANITARY DRAINS
 221413 - FACILITY STORM DRAINAGE PIPING
 221423 - STORM DRAINAGE PIPING SPECIALTIES
 223300 - ELECTRIC, DOMESTIC-WATER HEATERS
 224213.13 - COMMERCIAL WATER CLOSETS
 224213.16 - COMMERCIAL URINALS
 224216.13 - COMMERCIAL LAVATORIES
 224216.16 - COMMERCIAL SINKS
 224700 - DRINKING FOUNTAINS AND WATER COOLERS

DIVISION 23 — HEATING VENTILATING AND AIR CONDITIONING

230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC
 230713 - DUCT INSULATION
 230719 - HVAC PIPING INSULATION
 231123 - FACILITY NATURAL-GAS PIPING
 232300 - REFRIGERANT PIPING
 233113 - METAL DUCTS
 233300 - AIR DUCT ACCESSORIES
 233346 - FLEXIBLE DUCTS
 233416 - CENTRIFUGAL HVAC FANS
 233713.13 - AIR DIFFUSERS
 233723 - HVAC GRAVITY VENTILATORS
237416.11 - PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS
 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

DIVISION 26 — ELECTRICAL

260100 - General Provisions
 260519 - Power Conductors

3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, **from the same product run**, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical Surfaces: Provide samples of at least 25 sq. ft..

b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Manufacturers: For ease of specifying, unless otherwise noted, products of Sherwin-Williams have been used. Equivalent product of other manufacturers may be used subject to the substitution provisions listed under Section 01 25 00.**

Subject to compliance with requirements, provide products by the following or equal:

1. Dunn-Edwards Corporation.

2. Vista Paint

3. Or Equal

3

3

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dunn-Edwards Corporation.
 - 2. Sherwin-Williams Company (The).
 - 3. Vista Paint.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

- D. Products: For ease of specifying, unless otherwise noted, product numbers of Sherwin Williams have been used. **Equivalent products of other manufacturer's may be used subject to the substitution provisions listed under Section 01 25 00.**

- 1. Steel Doors and Frames/Miscellaneous metal- Galvanized - Semi-Gloss (PF-1)
 - a. Solvent clean, etch with PCI 02150 Metal Conditioner solution and rinse with clear water.
 - b. One coat primer SW ProCryl Acrylic Metal Primer.
 - c. Two Coats Finish SW ProIndustrial Acrylic Semigloss.
- 2. Ferrous metal piping, miscellaneous metal fabrications, and related components. (PF-2)
 - a. Solvent clean and rinse with clear water.
 - b. One coat primer SW ProCryl Acrylic Metal Primer.
 - c. Two Coats Finish SW ProIndustrial Acrylic Semigloss.
- 3. Gypsum Board - Low Sheen/Eggshell Paint Finish (PF-3)
 - a. One coat SW Quick Dry Interior/ Exterior Latex Primer.
 - b. Two coats SW ProMar 200 Zero VOC Eg-shel
- 4. Gypsum Board - Semi-Gloss Enamel finish (PF-4)
 - a. One coat SW Quick Dry Interior/ Exterior Latex Primer.
 - b. Two coats SW ProMar 200 Zero VOC Semigloss.
- 5. Gypsum Board Primer - Behind Vinyl Wall Covering & Walltalker

3

- a. One coat SW Quick Dry Interior/ Exterior Latex Primer and as recommended in writing by wall-covering manufacturer for intended substrate.

- 6. Clear Wood Finish (ST-1)**
 - a. Interior wood, clear finish, satin (polyurethane)**
 - b. Three coats: S-W Minwax Polycrylic Satin**



2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Wood: 15 percent.
 - 2. Gypsum Board: 12 percent.
 - 3. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM 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.**

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. Related Requirements:

- 1. Communications Cabling:**
 - a. Section 260523 "Control-Voltage Electrical Power Cables" for balanced twisted pair communications cable.**
- 2. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.**

1.3 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.**
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.**
- C. BACnet Specific Definitions:**
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.**

2. **BACnet Interoperability Building Blocks (BIBBs):** BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 3. **BACnet/IP:** Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
- D. 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.
- E. 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.
- F. Control System Integrator:** An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV:** Changes of value.
- H. DDC System Provider:** Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control:** Processing of system data is decentralized, and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS:** Data-Over Cable Service Interface Specifications.
- K. E/P:** Voltage to pneumatic.
- L. Gateway:** Bidirectional protocol translator that connects control systems that use different communication protocols.
- M. HLC:** Heavy load conditions.
- N. 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.

- O. I/P: Current to pneumatic.**
- P. LAN: Local area network.**
- Q. LNS: LonWorks Network Services.**
- R. 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.**
- S. 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.**
- T. Modbus TCP/IP: An open protocol for exchange of process data.**
- U. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.**
- V. MTBF: Mean time between failures.**
- W. 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.**
- X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.**
- Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.**
- Z. POT: Portable operator's terminal.**
- AA. PUE: Performance usage effectiveness.**
- BB. RAM: Random access memory.**
- CC. RF: Radio frequency.**
- DD. Router: Device connecting two or more networks at network layer.**
- 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. USB: Universal Serial Bus.**
- II. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.**

JJ. VAV: Variable air volume.

KK. WLED: White light emitting diode.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:

- 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.**
- 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.**
- 3. Product description with complete technical data, performance curves, and product specification sheets.**
- 4. Installation, operation and maintenance instructions including factors effecting performance.**
- 5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.**
 - a. Servers.**
 - b. Protocol analyzers.**
 - c. DDC controllers.**
 - d. Enclosures.**
 - e. Electrical power devices.**
 - f. Instruments.**
- 6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.**
- 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.**

B. Shop Drawings:

- 1. General Requirements:**
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.**
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.**
- 2. Include plans, elevations, sections, and mounting details where applicable.**
- 3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.**

4. **Detail means of vibration isolation and show attachments to rotating equipment.**
5. **Plan Drawings indicating the following:**
 - a. **Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.**
 - b. **Room names and numbers with coordinated placement to avoid interference with control products indicated.**
 - c. **Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.**
 - d. **Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.**
 - e. **Network communication cable and raceway routing.**
 - f. **Information, drawn to scale, of <Insert requirements>.**
 - g. **Proposed routing of wiring, cabling, conduit, and tubing coordinated with building services for review before installation.**
6. **Schematic drawings for each controlled HVAC system indicating the following:**
 - a. **I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.**
 - b. **I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.**
 - c. **A graphic showing location of control I/O in proper relationship to HVAC system.**
 - d. **Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.**
 - e. **Unique identification of each I/O that shall be consistently used between different drawings showing same point.**
 - f. **Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.**
 - g. **Narrative sequence of operation.**
 - h. **Graphic sequence of operation, showing all inputs and output logical blocks.**
7. **Control panel drawings indicating the following:**
 - a. **Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.**
 - b. **Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.**
 - c. **Front, rear, and side elevations and nameplate legend.**
 - d. **Unique drawing for each panel.**

- 8. **DDC system network riser diagram indicating the following:**
 - a. **Each device connected to network with unique identification for each.**
 - b. **Interconnection of each different network in DDC system.**
 - c. **For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.**
 - d. **Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.**

- 9. **DDC system electrical power riser diagram indicating the following:**
 - a. **Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.**
 - b. **Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.**
 - c. **Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.**
 - d. **Power wiring type and size, race type, and size for each.**

- 10. **Monitoring and control signal diagrams indicating the following:**
 - a. **Control signal cable and wiring between controllers and I/O.**
 - b. **Point-to-point schematic wiring diagrams for each product.**
 - c. **Control signal tubing to sensors, switches and transmitters.**
 - d. **Process signal tubing to sensors, switches and transmitters.**

- 11. **Color graphics indicating the following:**
 - a. **Itemized list of color graphic displays to be provided.**
 - b. **For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.**
 - c. **Intended operator access between related hierarchical display screens.**

C. System Description:

- 1. **Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.**
- 2. **Complete listing and description of each report, log and trend for format and timing and events which initiate generation.**
- 3. **System and product operation under each potential failure condition including, but not limited to, the following:**
 - a. **Loss of power.**
 - b. **Loss of network communication signal.**

- c. **Loss of controller signals to inputs and outputs.**
 - d. **Operator workstation failure.**
 - e. **Server failure.**
 - f. **Gateway failure.**
 - g. **Network failure**
 - h. **Controller failure.**
 - i. **Instrument failure.**
 - j. **Control damper and valve actuator failure.**
 - k. **Insert potential failure conditions.**
- 4. **Complete bibliography of documentation and media to be delivered to Owner.**
 - 5. **Description of testing plans and procedures.**
 - 6. **Description of Owner training.**

1.5 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 Section 017823 "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.**

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. **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.**

1.7 QUALITY ASSURANCE

A. DDC System Provider Qualifications:

- 1. **Authorized representative of, and trained by, DDC system manufacturer.**
- 2. **In-place facility located within 45 miles of Project.**
- 3. **Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.**
- 4. **Demonstrated past experience on [five] <Insert number> projects of similar complexity, scope and value.**
- 5. **Each person assigned to Project shall have demonstrated past experience.**
- 6. **Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.**
- 7. **Service and maintenance staff assigned to support Project during warranty period.**
- 8. **Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.**
- 9. **DDC system manufacturer's backing to take over execution of Work if necessary, to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.**

1.8 WARRANTY

- A. **Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.**

- 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
- 2. Include updates or upgrades to software and firmware if necessary, to resolve deficiencies.
 - a. Install updates only after receiving Owner's written authorization.
- 3. Warranty service shall occur during normal business hours and commence within 16 hours of Owner's warranty service request.
- 4. Warranty Period: Two year(s) from date of Substantial Completion.
 - a. For Gateway: Three -year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

- A. **Manufacturers: Subject to compliance with requirements, provide products by the following:**
 - 1. Carrier i-Vu.

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 WEB ACCESS

- A. **DDC system shall be Web based.**
 - 1. **Web-Based Access to DDC System:**

- a. **DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.**
- b. **Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.**
- c. **Web access shall be password protected.**

2.4 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 E 84; 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. DDC System Speed:

1. Response Time of Connected I/O:

- a. **AI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.**
- b. **BI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.**

- c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
- d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.

2. Display of Connected I/O:

- a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
- b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
- c. Alarms of analog and digital points connected to DDC system shall be displayed within 45 seconds of activation or change of state.
- d. Graphic display refresh shall update within eight seconds.
- e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

E. DDC System Data Storage:

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.

2. Local Storage:

a. Provide server with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:

a. Provide application-based and web browser interfaces to configure, upload, download, and manage data, and service plan with storage adequate to store all data for term indicated. Cloud storage shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

F. DDC Data Access:

1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.

- 2. **System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.**

G. Future Expandability:

- 1. **DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.**
- 2. **Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.**
- 3. **Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.**

H. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

- a. **Thermal: Within 3 percent of reading.**
- b. **Electric Power: Within 1 percent of reading.**
- c. **Requirements indicated on Drawings for meters not supplied by utility.**

2. Temperature, Dew Point:

- a. **Air: Within 1 deg F.**
- b. **Space: Within 1 deg F.**
- c. **Outdoor: Within 3 deg F.**

3. Temperature, Dry Bulb:

- a. **Air: Within 1 deg F.**
- b. **Space: Within 1 deg F.**
- c. **Outdoor: Within 2 deg F.**
- d. **Chilled Water: Within 1 deg F.**
- e. **Condenser Water: Within 1 deg F.**
- f. **Heating Hot Water: Within 1 deg F.**
- g. **Energy Recovery Runaround Liquid: Within 1 deg F.**
- h. **Steam: Within 2 deg F.**
- i. **Temperature Difference: Within 0.25 deg F.**
- j. **.**
- k. **Other Temperatures Not Indicated: Within 1 deg F.**

4. Temperature, Wet Bulb:

- a. **Air: Within 1 deg F.**
- b. **Space: Within 1 deg F.**

c. Outdoor: Within 2 deg F.

I. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

1. Current:

- a. Milliamperes: Nearest 1/100th of a milliampere.**
- b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.**

2. Energy:

a. Electric Power:

- 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.**
- 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.**
- 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.**

b. Thermal, Rate:

- 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.**
- 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.**

c. Thermal, Usage:

- 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.**
- 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.**

3. Temperature:

- a. Air, Ducts and Equipment: Nearest 1/10th of a degree.**
- b. Outdoor: Nearest degree.**
- c. Space: Nearest 1/10th of a degree.**
- d.**

J. Control Stability: Control variables indicated within the following limits:

- 1. **Flow:**
 - a. **Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.**
 - b.
- 2. **Temperature, Dry Bulb:**
 - a. **Air: Within 2 deg F.**
 - b. **Space: Within 2 deg F.**
 - c. **Chilled Water: Within 1 deg F.**
 - d. **Condenser Water: Within 1 deg F.**
 - e. **Heating Hot Water: Within 2 deg F.**
 - f. **Energy Recovery Runaround Liquid: Within 1 deg F.**
 - g. **Insert system.**
- 3. **Temperature, Wet Bulb:**
 - a. **Air: Within 1 deg F.**
 - b. **Space: Within 1 deg F.**

K. 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.**
- 2. **Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:**
 - a. **Outdoors, Protected: Type 3.**
 - b. **Outdoors, Unprotected: Type 4X.**
 - c. **Indoors, Heated with Filtered Ventilation: Type 1.**
 - d. **Indoors, Heated with Non-Filtered Ventilation: Type 2.**
 - e. **Indoors, Heated and Air Conditioned: Type 1.**
 - f. **Mechanical Equipment Rooms:**
 - 1) **Chiller and Boiler Rooms: Type 12.**

2) Air-Moving Equipment Rooms: Type 1.

- g. Localized Areas Exposed to Washdown: Type 4X.**
- h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.**
- i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.**
- j. Hazardous Locations: Explosion-proof rating for condition.**
- k. .**

L. 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.**
- 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:**
 - a. Outdoors, Protected: Type 3.**
 - b. Outdoors, Unprotected: Type 4X.**
 - c. Indoors, Heated with Filtered Ventilation: Type 2.**
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.**
 - e. Indoors, Heated and Air-conditioned: Type 1.**
 - f. Mechanical Equipment Rooms:**
 - 1) Chiller and Boiler Rooms: Type 12.**
 - 2) Air-Moving Equipment Rooms: Type 1.**
 - g. Localized Areas Exposed to Washdown: Type 4X.**
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.**
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.**
 - j. Hazardous Locations: Explosion-proof rating for condition.**
 - k. .**

M. Electric Power Quality:

1. Power-Line Surges:

- a. **Protect 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 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.

N. Backup Power Source:

- 1. **HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.**

O. UPS:

- 1. **DDC system products powered by UPS units shall include the following:**
 - a. **Desktop workstations.**
 - b. **Printers.**
 - c. **Servers.**
 - d. **Gateways.**
 - e. **DDC controllers, except application-specific controllers.**

P. 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.**

2.5 SYSTEM ARCHITECTURE

- A. **System architecture shall consist of no more than two levels of LANs.**
 1. **Level one LAN shall connect network controllers and operator workstations.**
 2. **Level one LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.**
 3. **Level two LAN shall connect application-specific controllers to programmable application controllers and network controllers.**
 4. **LAN shall connect application-specific controllers to application-specific controllers.**
- B. **Minimum Data Transfer and Communication Speed:**
 1. **LAN Connecting Programmable Application Controllers: 1000 Insert value kbps.**
 2. **LAN Connecting Application-Specific Controllers: 115,000 Insert value bps.**
- C. **DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and tenant data and communication networks.**
- D. **System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.**
- E. **System architecture shall perform modifications without having to remove and replace existing network equipment.**
- F. **Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.**
- G. **System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.**
- H. **Special Network Architecture Requirements:**

- 1. Air-Handling Systems:** For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Basically, create a DDC system LAN that aligns with air-handling system being controlled.

2.6 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:

- 1. Desktop and portable workstation with hardwired connection through LAN port.**
- 2. Portable operator terminal with hardwired connection through LAN port.**
- 3. Portable operator workstation with wireless connection through LAN router.**
- 4. Mobile device and application with secured wireless connection through LAN router or cellular data service.**
- 5. Remote connection through web access.**

B. Access to system, regardless of operator means used, shall be transparent to operator.

C. Portable Workstations:

- 1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.**
- 2. Able to communicate with any device located on any DDC system LAN.**
- 3. Connect to DDC system Level two LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.**
- 4. Connect to system through a wireless router connected to Level one LAN.**
- 5. Connect to system through a cellular data service.**
- 6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.**
- 7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.**
- 8. Have dynamic graphic displays that are identical to desktop workstations.**

D. Critical Alarm Reporting:

- 1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.**
- 2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.**

3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

E. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.7 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

- 1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
- 2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
- 3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
- 4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. Industry Standard Protocols:

- 1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
 - a. ASHRAE 135.
- 2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.
- 3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
- 4. Gateways shall be used to connect networks and network devices using different protocols.

2.8 SERVERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

- 1. **Dell Inc.**
- B. Mounting: Rack.**
- C. Performance Requirements:**
 - 1. **Performance requirements may dictate equipment exceeding minimum requirements indicated.**
 - 2. **Energy Star compliant.**
 - 3. **Minimum Processor Speed: 3.10GHz.RAM:**
 - a. **Capacity: 16 GB.**
 - b. **Expandable Capacity: 16.**
 - 4. **Hard-Drive Storage: One drives each with 2.0 TB storage and nominal rotational speed of 7200 rpm.**
 - 5. **Network Interface: Dual port Gigabit Ethernet.**
 - 6. **DVD +RW Drive.**
 - 7. **Next-day on-site warranty for two -year period following Substantial Completion.**
- D. Servers shall include the following:**
 - 1. **Full-feature backup server (server and backup minimum requirement).**
 - 2. **Software licenses.**
 - 3. **Cable installation between server(s) and network.**
- E. Web Server:**
 - 1. **If required to be separate, include Web server hardware and software to match, except backup server is not required.**
 - 2. **Firewalls between server Web and networks.**
 - 3. **Password protection for access to server from Web server.**
 - 4. **Cable installation between the server(s) and building Ethernet network.**
- F. Power each server through a dedicated UPS unit.**

2.9 SYSTEM SOFTWARE

- A. 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 and sent to printer.**
6. **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.**
7. **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.**

B. 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 similar to those indicated.**
 - 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.**
- C. **Project-Specific Graphics: Graphics documentation including, but not limited to, the following:**
1. **Site plan showing each building, and additional site element, 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, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation.**
 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 and other network devices.**
- D. **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.**

E. 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 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 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.**

F. 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.**

G. 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.

H. Tenant Override Reports: Prepare Project-specific reports.

- 1. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
- 2. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.
- 3. Annual summary report that shows after-hours HVAC usage on a monthly basis.

I. Utility Reports: Prepare Project-specific reports.

1. Electric Report:

- a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
- b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
- c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
- d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as lighting, receptacles and HVAC equipment showing daily electrical consumption and peak electrical demand.
- e. For each weekly, monthly and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.

2. <Insert requirements for each utility requiring a report>.

J. Energy Reports: Prepare Project-specific daily, weekly, monthly and annual, annual and since-installed energy reports.

1. Prepare report for each purchased energy utility, indicating the following:

- a. Time period being reported with beginning and end date, and time indicated.
- b. Consumption in units of measure commonly used to report specific utility consumption over time.
- c. Gross area served by utility.
- d. Consumption per unit area served using utility-specific unit of measure.
- e. Cost per utility unit.
- f. Utility cost per unit area.
- g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
- h. Consumption per unit area using common unit of measure.

- K. HVAC System Efficiency Reports: Prepare Project-specific monthly and annual HVAC system efficiency reports.**
1. Insert requirements for each HVAC system requiring a report.
- L. 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 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.
- M. 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 server hard drives.
 3. Data shall be retrievable for use in spreadsheets and standard database programs.
- N. 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.
 3. Programming software shall be as follows any of the following one of the following:
 - a. **Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.**
 - 1) **Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.**
 - 2) **Programming tools shall be viewable in real time to show present values and logical results of each function block.**

- b. **Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.**
 - c. **Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.**
4. **Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.**

2.10 ASHRAE 135 GATEWAYS

- A. **Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, Insert equipment, and variable-speed drives.**
- B. **Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.**
- C. **Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.**
- D. **Gateway Minimum Requirements:**
 - 1. **Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.**
 - 2. **Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.**
 - 3. **Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.**
 - 4. **Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.**
 - 5. **Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.**
 - 6. **Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.**

2.11 WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. **Dual-Band Wireless Routers:**

1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
 - a. Cisco Linksys.
 - b. D-Link Corporation/D-Link Systems, Inc.
 - c. NETGEAR Inc.
2. **Speed: Up to Insert number Mbps on 2.4-GHz band and up to 450 Mbps on 5-GHz band.**
3. **Compatibility: IEEE 802.11n/g/b/a wireless devices.**
4. **Ethernet Ports: Four, gigabit (1000 Mbps).**
5. **USB Port: One, USB 2.0 or 3.0.**

2.12 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. **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.**
- F. **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.**
- G. **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.**

2.13 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 that perform scheduling 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 Level one 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.**

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.**

2.14 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 that perform scheduling 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.**

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.**

2.15 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.

2.16 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. 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.**

C. 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.**

D. 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.**

E. 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.**

F. 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.**

G. Remote Communication:

1. **System shall have ability to dial out in the event of an alarm.**

H. 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.**
- I. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.**
- J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.**
- K. 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).**

L. 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.

- M. 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.

- N. 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.

- O. 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.

- P. 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.

2.17 ENCLOSURES

- A. General Enclosure Requirements:**

1. House each controller and associated control accessories in a single enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 48 inches high.
6. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
7. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
8. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
9. 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. For enclosures with windows, include pocket on bottom of enclosure.

B. 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.

2.18 RELAYS

A. General-Purpose Relays:

1. **Manufacturers: Subject to compliance with requirements, provide products by the following:**

Murrieta Mesa HS New Classroom Bldg
Murrieta Valley Unified School District
BakerNowicki Design Studio #17028-00

DIRECT DIGITAL CONTROL (DDC) SYSTEM
FOR HVAC
230923 – 36

a. **Siemens Building Technologies, Inc.**

- 2. **Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.**
- 3. **Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.**
- 4. **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.**
- 5. **Construct the contacts of either silver cadmium oxide or gold.**
- 6. **Enclose the relay in a clear transparent polycarbonate dust-tight cover.**
- 7. **Relays shall have LED indication and a manual reset and push-to-test button.**
- 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. Current Sensing Relay:

- 1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
 - a. **Square D; by Schneider Electric.**
- 2. **Monitors ac current.**
- 3. **Independent adjustable controls for pickup and dropout current.**
- 4. **Energized when supply voltage is present, and current is above pickup setting.**
- 5. **De-energizes when monitored current is below dropout current.**
- 6. **Dropout current is adjustable from 50 to 95 percent of pickup current.**
- 7. **Include a current transformer, if required for application.**
- 8. **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.**

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

- 1. **Manufacturers: Subject to compliance with requirements, provide products by the following:**
 - a. **Functional Devices Inc.**
- 2. **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.**

- 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.
- 4. **Relay:** Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
- 5. **Enclosure:** NEMA 250, Type 1 enclosure.

2.19 ELECTRICAL POWER DEVICES

A. Transformers:

- 1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
- 2. Transformer shall be at least 100 VA.
- 3. Transformer shall have both primary and secondary fuses.

B. Transient Voltage Suppression and High-Frequency Noise Filter Unit:

- 1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - a. **Current Technology Inc.**
- 2. The maximum continuous operating voltage shall be at least 125 percent.
- 3. The operating frequency range shall be 47 to 63 Hz.
- 4. Protection modes according to NEMA LS-1.
- 5. Unit shall have LED status indicator that extinguishes to indicate a failure.
- 6. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
- 7. Unit shall not generate any appreciable magnetic field.
- 8. Unit shall not generate an audible noise.

2.20 CONTROL WIRE AND CABLE

A. Single Twisted Shielded Instrumentation Cable above 24 V:

- 1. Wire size shall be a minimum No. 18 AWG.
- 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
- 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
- 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.

- 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
- 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
- 7. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable 24 V and Less:

- 1. Wire size shall be a minimum No. 18 AWG.
- 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
- 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
- 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
- 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
- 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
- 7. Furnish wire on spools.

C. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

- 1. Cable shall be balanced twisted pair.
- 2. Comply with the following requirements and for balanced twisted pair cable described in Section 260523 "Control-Voltage Electrical Power Cables." Section 271513 "Communications Copper Horizontal Cabling."
 - a. Cable shall be plenum rated.
 - b. Cable shall have a unique color that is different from other cables used on Project.

2.21 SOURCE QUALITY CONTROL

A. Testing Agency: 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. Server.

B. Product(s) and material(s) will be considered defective if it does 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. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.**
- E. 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.**
 - 2. Equipment to Be Connected:**
 - a. Roof-top units.**
 - b. Exhaust Fans.**

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.
- e. Insert requirements.

3. Integration of Existing Control System into DDC System:

- a. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
- b. Operator shall be able to upload, download, monitor, alarm, report, trend, control and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
- c. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists, or I/O is being installed.
- d. Insert requirements.

B. Integration with Existing Enterprise System:

- 1. DDC system shall interface with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
- 2. Owner's control system integrator will provide the following services:
 - a. Enterprise system expansion and development of graphics, logs, reports, trends and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
 - b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
 - c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.
- 3. Engage Owner's control system integrator to provide the following services:
 - a. Enterprise system expansion and development of graphics, logs, reports, trends and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
 - b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.

- c. **Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.**
- 4. **Control System Integrator Contact Information (Submit Proposed):**
 - a. **Company: Insert name.**
 - b. **Company Street Address: Insert address.**
 - c. **Company Contact: Insert name.**
 - d. **Phone Number: Insert phone number.**
 - e. **E-mail Address: Insert e-mail address.**
- 5. **Attend meetings with control system integrator to integrate DDC system.**

3.4 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. **Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.**
- B. **Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.**
 - 1. **DDC control dampers, which are specified in Section 230923.12 "DDC Control Dampers."**
 - 2. **Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."**
 - 3. **Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."**

3.5 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. **Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer and supervise installation for compliance with requirements.**
 - 1. **Application-specific controller.**

3.6 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. Brace products to prevent lateral movement and sway or a break in attachment.**
- 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 Section 078413 "Penetration Firestopping."**
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "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.**

3.7 SERVER INSTALLATION

- A. Install one server(s) at location(s) directed by Owner.**
- B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed location in Shop Drawings.**

- C. **Install software indicated on server(s) and verify that software functions properly.**
- D. **Develop Project-specific graphics, trends, reports, logs, and historical database.**
- E. **Power servers through dedicated UPS unit. Locate UPS adjacent to server.**

3.8 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.**
- 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.**

3.9 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. **Install wireless routers to achieve optimum performance and best possible coverage.**
- B. **Mount wireless routers in a protected location that is within 60 inches of floor and easily accessible by operators.**

- C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.**
- D. Install wireless router with latest version of applicable software and configure wireless router with WPA2 security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.**
- E. Test and adjust wireless routers for proper operation with portable workstation and other wireless devices intended for use by operators.**

3.10 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:**
 - 1. Controllers.**
 - 2. Electrical power devices.**
 - 3. UPS units.**
 - 4. Relays.**
 - 5. .**
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:**
 - 1. For NEMA 250, Type 1 Enclosures: Use corrosion-resistant-coated steel strut and hardware.**
 - 2. For NEMA 250, Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.**
 - 3. Install plastic caps on exposed cut edges of strut.**
- C. Align top or bottom of adjacent enclosures of like size.**
- D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using stainless-steel anchors.**
- E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.**

3.11 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.**
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.**

- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.**
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.**
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.**

3.12 NETWORK INSTALLATION

- A. Install balanced twisted pair or optical fiber cable when connecting between the following network devices located in same building:**
 - 1. Network controllers.**
 - 2. .**
- B. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:**
 - 1. Network controllers and programmable application controllers.**
 - 2. Programmable application controllers.**
 - 3. Programmable application controllers and application-specific controllers.**
 - 4. Application-specific controllers.**
 - 5. .**
- C. Install cable in continuous raceway.**
 - 1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.**

3.13 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.**
- B. ASHRAE 135 Networks:**
 - 1. MAC Address:**
 - a. Every network device shall have an assigned and documented MAC address unique to its network.**
 - b. Ethernet Networks: Document MAC address assigned at its creation.**
 - c. ARCNET or MS/TP networks: Assign from 00 to 64.**
 - 2. Network Numbering:**
 - a. Assign unique numbers to each new network.**

- b. **Provide ability for changing network number through device switches or operator interface.**
 - c. **DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.**
- 3. Device Object Identifier Property Number:**
- a. **Assign unique device object identifier property numbers or device instances for each device network.**
 - b. **Provide for future modification of device instance number by device switches or operator interface.**
 - c. **LAN shall support up to 4,194,302 unique devices.**
- 4. Device Object Name Property Text:**
- a. **Device object name property field shall support 32 minimum printable characters.**
 - b. **Assign unique device "Object Name" property names with plain-English descriptive names for each device.**
 - 1) **Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."**
 - 2) **Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".**
- 5. Object Name Property Text for Other Than Device Objects:**
- a. **Object name property field shall support 32 minimum printable characters.**
 - b. **Assign object name properties with plain-English names descriptive of application.**
 - 1) **Example 1: "Zone 1 Temperature."**
 - 2) **Example 2 "Fan Start and Stop."**
- 6. Object Identifier Property Number for Other Than Device Objects:**
- a. **Assign object identifier property numbers according to Drawings or tables indicated.**
 - b. **If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.**

3.14 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.**
- B. Wire and Cable Installation:**

1. **Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."**
2. **Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."**
3. **Comply with installation requirements in Section 271513 "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 Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.**
2. **Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.**

3.15 FIELD QUALITY CONTROL

- A. **Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.**
- B. **Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.**
- C. **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.**

D. 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. **Control Damper Checkout:**
 - 1. **Verify that proper blade alignment, either parallel or opposed, has been provided.**
 - 2. **Verify that actuator wiring is complete, enclosed and connected to correct power source.**

F. 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. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

N. Switches: Calibrate switches to make or break contact at set points indicated.

O. 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 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 desire 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 go to failed position on loss of power.
16. Meter, sensor and transmitter readings are accurate and calibrated.
17. Control loops are tuned for smooth and stable operation.
18. View trend data where applicable.
19. Each controller works properly in standalone mode.
20. Safety controls and devices function properly.
21. Interfaces with fire-alarm system function properly.
22. Electrical interlocks function properly.
23. Operator workstations and other interfaces are delivered, all system and database software are installed, and graphic are created.
24. 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 10 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. **Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.**
 - b. **All alarms, both binary and analog, are reported and printed; none are lost.**
 - c. **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 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 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 and begin procedures indicated in "Extended Operation Test" Article 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 Network 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 Server or 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. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. 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. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.**
 - 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.**

t. .

3.22 EXTENDED OPERATION TEST

- A. **Extended operation test is intended to simulate normal operation of DDC system by Owner.**
- B. **Operate DDC system for an operating period of 28 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.**
- C. **Provide an operator familiar with DDC system installed to man an operator workstation while on-site during eight hours of each normal business day occurring during operating period.**
- D. **During operating period, DDC system shall demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.**
 - 1. **Correct defects of hardware and software when it occurs.**
- E. **Definition of Failures and Downtime during Operating Period:**

1. Failed I/O point constituting downtime is an I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
 2. Downtime is when any I/O point in DDC system is unable to fulfill its' required function.
 3. Downtime shall be calculated as elapsed time between a detected point failure as confirmed by an operator and time point is restored to service.
 4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation shall be 0.5 hours.
 5. Downtime shall be logged in hours to nearest 0.1 hour.
 6. Power outages shall not count as downtime but shall suspend test hours unless systems are provided with UPS and served through a backup power source.
 7. Hardware or software failures caused by power outages shall count as downtime.
- F. During operating period, log downtime and operational problems are encountered.**
1. Identify source of problem.
 2. Provide written description of corrective action taken.
 3. Record duration of downtime.
 4. Maintain log showing the following:
 - a. Time of occurrence.
 - b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
 - c. Downtime for each failed I/O point.
 - d. Running total of downtime and total time of I/O point after each problem has been restored.
 5. Log shall be available to Owner for review at any time.
- G. For DDC system to pass extended operation test, total downtime shall not exceed 1 percent of total point-hours during operating period.**
1. Failure to comply with minimum requirements of passing at end of operating period indicated shall require that operating period be extended one consecutive day at a time until DDC system passes requirement.
- H. Evaluation of DDC system passing test shall be based on the following calculation:**
1. Downtime shall be counted on a point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
 2. One point-hour of downtime is one I/O point down for one hour. Three points down for five hours is a total of 15 point-hours of downtime. Four points down for one-half hour is 2 point-hours of downtime.

3. Example Calculation: Maximum allowable downtime for 30-day test when DDC system has 1000 total I/O points (combined analog and binary) and has passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.

I. Prepare test and inspection reports.

3.23 ADJUSTING

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

3.24 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.25 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

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. **Total days of training shall be broken into not more than two separate training classes.**
 - d. **Each training class shall be not less than one consecutive day(s).**

C. Training Schedule:

1. **Schedule training with Owner 20 business days before expected Substantial Completion.**
2. **Schedule training to provide Owner with at least 20 business 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. Each morning session and afternoon session shall be split in half with 15 -minute break between sessions. Morning and afternoon sessions shall be separated by 60 -minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.**
4. **Provide staggered training schedule as requested by Owner.**

D. Training Attendee List and Sign-in Sheet:

1. **Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.**
2. **Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.**
3. **Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.**
4. **Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.**
5. **At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.**

E. Training Attendee Headcount:

1. **Plan in advance of training for five attendees.**
2. **Make allowance for Owner to add up to two attendee(s) at time of training.**
3. **Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.**

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. **High school and four-year college education and degree.**
2. **Advanced user knowledge of computers and office applications.**
3. **Intermediate knowledge of HVAC systems.**
4. **Advanced knowledge of DDC systems.**
5. **Advanced knowledge of DDC system and products installed.**

G. Attendee Training Manuals:

1. **Provide each attendee with a color hard copy of all training materials and visual presentations.**
2. **Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.**
3. **In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.**

H. 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.**

I. Organization of Training Sessions:

1. **Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:**
 - a. **Daily operators.**
 - b. **Advanced operators.**
 - c. **System managers and administrators.**
2. **Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.**

J. Training Outline:

1. **Submit training outline for Owner review at least 10 business day 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.**

K. 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.**

L. Off-Site Training:

1. **Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.**
2. **Provide capability to remotely access to Project DDC system for use in training.**
3. **Provide a workstation for use by each attendee.**

M. 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.
26. Insert requirement.

N. 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 controller's 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.**
16. **Insert requirement.**

O. 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.**
9. **Insert requirement.**

P. Video of Training Sessions:

1. **Provide a digital video and audio recording of each training session. Create a separate recording file for each session.**
2. **Stamp each recording file with training session number, session name and date.**
3. **Provide Owner with two copies of digital files on DVDs or 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 230923

SECTION 237416.11 - PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components:
 1. Casings.
 2. Fans, drives, and motors.
 3. Rotary heat exchangers.
 4. Coils.
 5. Refrigerant circuit components.
 6. Air filtration.
 7. Gas furnaces.
 8. Dampers.
 9. Electrical power connections.
 10. Controls.
 11. Roof curbs.
 12. Accessories.

1.3 DEFINITIONS

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.4 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
 3. Include unit dimensions and weight.

4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 5. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.
 - c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
 6. Include certified coil-performance ratings with system operating conditions indicated.
 7. Include filters with performance characteristics.
 8. Include gas furnaces with performance characteristics.
 9. Include dampers, including housings, linkages, and operators.
- B. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.
1. Include plans, elevations, sections, and attachment details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranty.
- B. Source quality-control reports.
- C. System startup reports.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set(s) of filters for each unit.
 2. Gaskets: One set(s) for each access door.

1.8 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PROJECT REQUIREMENTS

- A. **Contractor shall furnish and install Carrier i-Vu DDC interface module via BACnet interface. All programming shall meet the points and data requirements of the District. District shall have final approval of communicating data points and control points. Hardwired and override start/stop points shall be as directed by District.**
- B. **Carrier i-Vu controller shall be programmed and wired to a building wide DDC/BMC system. Contractor shall be responsible for Carrier i-Vu DDC and all infrastructure required for campus integration of new building.**

3

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.
- G. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
 - 1. Design RTU supports to comply with wind and seismic performance requirements.

- H. Seismic Performance: RTUs, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.0.
 - 3. .

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Trane.
 - 3. YORK; a Johnson Controls company.

2.4 UNIT CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Double-Wall Construction:
 - 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with , with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
 - 3. Floor Plate: G90 galvanized steel, treadplate, minimum 18 gauge thick.
 - 4. Casing Insulation:
 - a. Materials: Injected polyurethane foam insulation.
 - b. Insulation Thickness: 1 inch.
- C. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus 2-inch wg.
 - 2. For Unit Sections Downstream and Including Fans: 2-inch wg.
- D. Panels and Doors:
 - 1. Panels:

- a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
- b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
- c. Gasket: Neoprene, applied around entire perimeters of panel frames.
- d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

2. Access Doors:

- a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
- b. Gasket: Neoprene, applied around entire perimeters of panel frames.
- c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

E. Condensate Drain Pans:

- 1. Location: Each type of cooling coil.
- 2. Construction:
 - a. Single-wall, galvanized-steel or noncorrosive polymer sheet.
- 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - b. Minimum Connection Size: NPS 1.
- 4. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

2.5 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.

2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
 5. Mounting: For internal vibration isolation [and seismic control]. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
 6. Shaft Lubrication Lines: Extended to a location outside the casing.
 7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drives, Direct: Factory-mounted, direct drive.
- D. Condenser-Coil Fan: propeller, mounted on shaft of permanently lubricated multispeed motors.
- E. Motors:
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Enclosure Type: Open, drip proof.
 3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.6 COILS

- A. General Requirements for Coils:
1. Comply with AHRI 410.
 2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Outdoor-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

2.7 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

B. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.8 AIR FILTRATION

- A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
- B. Panel Filters:
 - 1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - 4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2.9 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 3. Gas Control Valve: Two stage.
 - 4. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
- D. Heat-Exchanger and Drain Pan: Stainless steel.
- E. Venting, Gravity: Gravity vented.
- F. Safety Controls:
 - 1. Gas Manifold: Safety switches and controls complying with ANSI standards.

2.10 DAMPERS

- A. Outdoor: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed -blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg .

2.11 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - i. Unoccupied-period-override push button.
 - j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature [and humidity], supply-air temperature, operating mode, and status.

B. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of two programmable periods per day.
4. Unoccupied Period:
 - a. Heating Setback: 10 deg F.
 - b. Cooling Setback: System off.
 - c. Override Operation: Two hours.
5. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
7. Gas Furnace Operation:
 - a. Occupied Periods: Stage burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
8. Fixed Minimum Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to 25 percent.
 - b. Unoccupied Periods: Close the outdoor-air damper.
9. Economizer Outdoor-Air Damper Operation:
 - a. Morning warm-up cycles.
 - b. Occupied Periods: Open to 25 percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use outdoor-air temperature. During economizer cycle operation, lock out cooling.
 - c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
10. Carbon Dioxide Sensor Operation:
 - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.13 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: 1-1/2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C916, Type I.
- C. Curb Dimensions: Height of 14 inches.

2.14 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- B. Low-ambient kit using [staged] [damper on] [variable-speed] condenser fans for operation down to [35 deg F] <Insert temperature>.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Remote potentiometer to adjust minimum economizer damper position.
- E. Return-air bypass damper.
- F. Factory- or field-installed, demand-controlled ventilation.
- G. Safeties:
 1. Condensate overflow switch.
 2. Phase-loss protection.
 3. High pressure control.
 4. Gas furnace airflow-proving switch.
- H. Coil guards of painted, galvanized-steel wire.
- I. Hail guards of galvanized steel painted to match casing.
- J. Door switches to disable heating or reset set point when open.
- K. Outdoor-air intake weather hood.

- L. Service Lights and Switch: Factory installed in fan and coil sections with weatherproof cover. Factory wire lights to a single-point field connection.

2.15 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Galvanized Steel: ASTM A653/A653M.
- C. Aluminum: ASTM B209.

2.16 SOURCE QUALITY CONTROL

- A. AHRI Compliance:
 - 1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. AMCA Compliance:
 - 1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
 - 2. Damper leakage tested according to AMCA 500-D.
 - 3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to AHRI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to RTU, allow space for service and maintenance.
- C. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- D. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

3.4 DUCT CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.5 ELECTRICAL CONNECTIONS

- A. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Locate nameplate where easily visible.

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect for visible damage to unit casing.
 - 3. Inspect for visible damage to furnace combustion chamber.
 - 4. Inspect for visible damage to compressor, coils, and fans.
 - 5. Inspect internal insulation.
 - 6. Verify that labels are clearly visible.
 - 7. Verify that clearances have been provided for servicing.
 - 8. Verify that controls are connected and operable.
 - 9. Verify that filters are installed.
 - 10. Clean condenser coil and inspect for construction debris.
 - 11. Clean furnace flue and inspect for construction debris.
 - 12. Connect and purge gas line.

13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency:
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:

- a. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
- a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Smoke and firestat alarms.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.9 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.10 CLEANING

- A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237416.11

SECTION 271000 - VOICE / DATA INFRASTRUCTURE

PART 1 – GENERAL

- 1.1 Include all labor, equipment and materials necessary for providing a complete networking infrastructure system as described herein and/or as indicated on the drawings.
- 1.2 Related specification sections:
 - 1.2.1 Section 26 01 00 - General Provisions.
 - 1.2.2 Section 26 05 33 - Conduit and Fittings.
 - 1.2.3 Section 26 05 19 - Conductors.
 - 1.2.4 Section 26 05 34 – Outlet and Junction Boxes.
- 1.3 Approved minimum Product and Contractor Extended Warranty Certifications;
 - 1.3.1 All components shall be manufactured by one of approved manufacturers, the installing Contractor must have the accompanying certification from the product manufacturer(s) for installation of a “Extended Warranted System” as required by each manufacturer and as indicated in these specifications.
 - 1.3.1.1 Specified system warranties are to be established between the component and cable manufacturers and the District, warranties between the cable manufacturer only or installing Contractor and the District are not considered equal.
 - 1.3.1.2 Warranty shall be a full “Performance Warranty” installed by a “Certified Contractor” as specified by one of the approved manufacturers. A “Component Warranty” will not be considered equal. All components, labor, and “Performance Criteria” shall be warranted by one of the approved manufacturers;
- 1.4 Acceptable manufacturers are:
 - 1.4.1 **Leviton / Berk-Tek**
 - 1.4.1.1 Installing Contractor must be LEVITON Network Solutions Premier certified to install this system.
 - 1.4.1.2 Warranty provision and training must be for the Leviton/Berk-Tek – Limited Lifetime Premium Performance Warranty program.
 - 1.4.2 **Commscope**
 - 1.4.2.1 Commscope’s Training and Warranty programs encompass the brand names known as Uniprise.

- 1.4.2.2 Installing Contractor must be PartnerPro certified to install any of the systems under the Commscope Family of brand names.
- 1.4.2.3 Warranty provision and training must be for the Commscope (Netconnect, Uniprise and Systimax) – 25-Year Premium Performance Warranty program.
- 1.4.3 **Ortronics (Legrand)/Superior Essex**
 - 1.4.3.1 Installing Contractor must be CIP-ESP or CIP certified to install this system.
 - 1.4.3.2 Warranty provision and training must be for the nCompass – Lifetime Premium Performance program.
- 1.4.4 **Panduit/General Cable**
 - 1.4.4.1 Installing Contractor must be PanGen certified to install this system.
 - 1.4.4.2 Warranty provision and training must be for the PanGen Certification Plus – 25-Year Siemon Premium Performance program.
- 1.4.5 Warranty shall be to the District, for the period as defined by the Network Infrastructure System selected for installation, after District acceptance and sign-off of the completed system. The Contractor must provide documentation from one of the approved manufacturers, as indicated in Section 1.3, indicating their qualifications for installation of this system in compliance with the manufacturer’s warranty period requirements as a warranted Contractor.
- 1.4.6 Equipment qualifications: It is the intent of these specifications that each bidder provides all hardware, components and installation services that are necessary to ensure a fully operational wiring system including warranties, as shown in the EIA/TIA Category-6 and the Augmented Category-6 (6A) guidelines.
- 1.4.7 All components, parts, infrastructure, patch cables, termination panels and cables must be classified by the manufacturer or manufacturers as a part of the “Extended Warranty” program. Contractor may not mix in components from other certified programs or materials that are not considered part of the “Lifetime” warranty.
- 1.4.8 Systems or components as manufactured by any other manufacturer which, are not specifically listed in 1.3, are **not** approved for use on this project.
- 1.5 **Installing Contractor qualifications:** Firms and their personnel must be regularly engaged in the installation of data networking cabling and equipment for systems of similar type and scope. The Contractor must have a full-service office able to respond to emergency callouts during the warranty period. The Contractor must also provide complete installation of all wiring and devices or equipment. **Subcontracts with Electrical Contractors or other warranted or non-warranted Contractors for supervised installation of any part of this system are not approved.**

- 1.5.1 Contractor shall have on staff a minimum of (1) BICSI RCDD on staff as full-time employees.
- 1.5.2 The successful Contractor shall be a California licensed C7 or C10 Premise Wiring Contractor as defined in this specification.
- 1.5.3 All work shall be performed under the supervision of a company accredited and trained by the Manufacturer of the components and cable and such accreditation must be presented with the bid submittal. Contractor must be accredited a minimum of 180 days prior to bid submittal date. All personnel performing work on this project must have successfully completed the manufacturer's training courses to completely comply with the extended warranty requirements prior to performance of any work on this project. Accreditation will consist of individual employee certifications issued by the manufacturer or manufacturers.
- 1.5.4 All personnel engaged in the testing of premises fiber optic and copper UTP cable systems must have successfully completed the test equipment manufacturer's training courses. Certification of such training must be presented with the bid submittal. Cut sheets of the test equipment to be utilized shall be provided with the Phase I project material submittals.
- 1.5.5 This project shall employ both Category-6 and Augmented Category-6 cabling. The Contractor shall install the related components in relation to the performance requirements for each type of cable installed.
- 1.5.6 If Contractor routes cables and/or associated pathways in another route than indicated on the drawings, they shall maintain all maximum cable installation distances as required by the manufacturer's distance limitations.
- 1.6 In order to ensure project cohesion, a single point of contact is required to provide a "TURNKEY" solution. The work covered under this section of the specification consists of furnishing all; labor; cabling; equipment; supplies; materials, and training. The Contractor will perform all operations necessary for the "TURNKEY" and fully completed installation in accordance with the specifications herein. As such, the successful Contractor must be factory trained on all aspects of Network Infrastructure Cabling System.
- 1.7 The drawings indicate a schematic routing of cables above ceilings. The Contractor shall field-verify the most appropriate routing of all above-ceiling cable prior to bid. Where cables penetrate through walls a conduit sleeve shall be provided. Where cables pass through fire rated walls, the conduit sleeve shall be sealed to maintain the rating of the wall assembly.
- 1.8 Unless otherwise noted in the project drawings or these specifications, the Division 26 Contractor shall provide the installation of all conduits, outlet and junction boxes, trenching and pull box installation.
- 1.9 The Contractor shall provide a licensed, qualified electrical Contractor for installation of all conduits, outlet and junction boxes, trenching and pull box installations.

1.10 General Submittal Requirements

1.10.1 **Phase I Submittal** shall be made in electronic format within (20) working days after the award of the contract by the District. This submittal shall include the following:

1.10.1.1 Complete Bill of Materials in Excel Spreadsheet format with bills of quantities, including all materials, components, devices, and equipment required for the work. The bills of quantities shall be tabulated respective of each and every system as specified, and shall contain the following information for each Section listed:

1.10.1.2 Description and quantity of each product.

1.10.1.3 Manufacturer's Name and Model Number.

1.10.1.4 Material Cut Sheets shall provide detailed product information and shall be original manufacturer product bulletins. Copies of material information from vendor websites shall not be considered equal and will not be accepted.

1.10.1.5 Material Cut Sheet part number provided shall be highlighted or provided with an arrow directed at the corresponding part number.

1.10.1.6 Specification Item Number referenced for each required product or if not shown in the specifications, Drawing Detail Number being referenced. (ie; Spec. 271000 Item 2.1 or DWG E4.15/#1)

1.10.1.7 Include with submittals all warranty information and a description of support and maintenance services to be provided. Also include all licenses and maintenance agreements required for continued operation of the equipment.

1.10.2 **Phase II Submittal** shall be provided within (20) working days after the approval of the Phase I submittals and prior to any fabrication or field conduit installations. All shop drawings shall be engineered in a CAD Software. Submission shall include electronic print copies to match the contract drawings, and Phase II submittals drawings shall include the following.

1.10.2.1 MDF and IDF equipment rack or cabinet elevations will be required to be provided including cable routing, grounding, support, UPS, network electronics, etc. and position of all components in the rack or cabinet.

1.10.2.2 Provide labeling plan which identifies the proposed scheme for identifying all components including Racks, patch panels (fiber and copper), site distribution feed cables, horizontal station cables and site conduit systems (handholes, pullboxes,etc.).

- 1.10.2.3 Provide shop drawings showing all end device locations, tap values, paging zones and amplifier sizing for each zone for analog speakers and horns, including devices connected to IP-Based zone controllers.
- 1.10.3 Common submittal mistakes which will result in submittals being rejected:
 - 1.10.3.1 Not including the qualifications of the installing Contractor Company and Contractor's Staff.
 - 1.10.3.2 Not including all items listed in the above itemized description.
 - 1.10.3.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed (provided for the project) or crossing out the items which are not applicable.
 - 1.10.3.4 Not including actual manufacturer's cut sheets or catalog information of proposed products.
 - 1.10.3.5 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" statements, or "to be determined later" statements. The products being submitted must be the products installed.
- 1.10.4 The Contractor shall make a written request directly to Johnson Consulting Engineers for electronic drawing files (CAD). As a part of the written request, please include the following information:
 - 1.10.4.1 Clearly indicate Project Name and Client, Johnson Consulting Job Number (located in bottom left corner of JCE Engineering Stamp) and each drawing Sheet Number required (i.e., E1.1, E2.1, E4.1 etc.).
 - 1.10.4.2 Identify the name, Company, Title, phone number, mailing address and e-mail address of the person to receive the files.
 - 1.10.4.3 Detail or Riser diagram sheets, System Schematic drawings or any other drawings other than floor plans or site plans, will not be made available to the Contractor.
 - 1.10.4.4 Files will only be provided in the AutoCAD format in which they were created (i.e., version 2015 or version 2016). Files will not be made available in REVIT format.
- 1.10.5 Requests for files will be processed as soon as possible; a minimum of 7 working days should be the normal processing time. The Contractor shall be completely responsible for requesting the files in time for their use and delays in requesting files will not alleviate the Contractor from submitting required documents within the required timeline.

PART 2 – RACKS AND CABINETS

- 2.1 Equipment racks have been detailed on the drawings and additional component information requirements have been described in the MDF or IDF products sections. The following is a list of approved manufacturers for each type of rack to be furnished.
 - 2.1.1 Alternate equipment manufacturers other than those indicated will not be reviewed or approved for use on this project.
 - 2.1.2 **(Open Frame – 4-Post)** shall be manufactured by Chatsworth CPI QuadraRack or Middle Atlantic R4 Series. Reference drawing details and specifications for complete requirements.

PART 3 – MDF ROOM REQUIREMENTS

Main Distribution Frame (MDF is existing in Building A – ‘MDF-A2’)

- 3.1 The Main Distribution Frame (MDF) Room is existing. The Contractor shall include the following items at this location;
 - 3.1.1 Provide all accessories required whether shown on the project drawings or within these specifications. The drawings and specifications shall be considered a single document.
 - 3.1.2 Fiber Optic Feed Cable Patch Panels - Fiber optic termination equipment (rack mounted), including all associated installation hardware. The equipment must have sufficient number of ports to connect all fibers in every cable terminated at this location. Provide 25% spare capacity for future wiring requirements, including bulkheads in the fiber patch panel. Provide blank fillers for all used portions of the panel. All fiber feed cables shall be terminated in a single fiber optic patch panel up to 144 strands. Additional strands shall be terminated in the largest size required to contain the remaining fibers.
 - 3.1.2.1 Contractor shall provide a minimum of 6-feet of slack on the fiber feed cable in the fiber optic patch panel. The first 48” of a tight buffered cable or the first 24” of a loose tube cable shall not be stripped back in the patch panel. Each type of cable shall have a minimum of 24” of stripped slack within the patch panel. Total slack within the patch panel shall not be less than 6-feet in length.
 - 3.1.2.2 All fiber cables shall be secured to the patch panel with the Kevlar strength members at the manufacturer provided anchor point at the rear of the panel.

Additional items required for each MDF are as follows:

- 3.1.3 Changes/Updates to the MDF Room – Contractor shall provide the following items in the existing MDF Room: Terminate new fiber optic feed cabling in the existing MDF racks. Provide new fiber optic patch panel and service loop manager in the MDF Room. Provide all other requirements associated with the provision of new fiber feed cabling. The remainder of the MDF Room shall remain as-is. See details and drawings for additional installation requirements.

- 3.1.4 Refer to the detail drawings and specifications for the termination requirements at the MDF and IDF locations
- 3.1.5 All fiber optic feed cables routed to the MDF Room shall be provided with 20-feet of slack for a service loop mounted on the backboard behind the racks. Contractor shall provide a 24” diameter wall mounted service loop manager for the fiber optic feed cables as manufactured by Leviton #48900-FR. Maximum of (3) fiber feed cables per manager. Provide quantity of managers as required to manage all service loops
- 3.1.6 Provide all other items as detailed on the drawings.

PART 4 – IDF REQUIREMENTS

Intermediate Distribution Frame (IDF) Typical Requirements

- 4.1 The Intermediate Distribution Frame (IDF) Room shall be a secondary wiring and equipment location for the data networking system. The Contractor shall include the following items at this location.
 - 4.1.1 Provide backboard 8'-0" high x 3/4" thick, with a minimum 48” width. Refer to the floorplans for the actual layout of the backboard coverage. Plywood mounting backboard shall be flame resistant, painted with fire resistant paint “white” or color to match the room finish. Contractor shall provide minimum one side finish grade plywood. Backboard shall be mounted with finish side out, regardless of location of fire rating stamp. Show proof of fire rating stamp to IOR or Inspector prior to installation.
 - 4.1.2 Fiber Optic Feed Cable Patch Panels - Fiber optic termination equipment (rack mounted), including all associated installation hardware. The equipment must have sufficient number of ports to connect all fibers in every cable terminated at this location. Provide 25% spare capacity for future wiring requirements. Provide blank fillers for all used portions of the panel. All fiber feed cables shall be terminated in a single fiber optic patch panel.
 - 4.1.2.1 Each IDF location shall be furnished with a minimum 24-Port patch panel, fully loaded with bulkheads. Type of connectors in the bulkheads shall be determined by the type of connectors used for termination of the fiber feed cables.
 - 4.1.2.2 Contractor shall provide a minimum of 6-feet of slack on the fiber feed cable in the fiber optic patch panel. The first 48” of a tight buffered cable or the first 24” of a loose tube cable shall not be stripped back in the patch panel. Each type of cable shall have a minimum of 24” of stripped slack within the patch panel. Total slack within the patch panel shall not be less than 6-feet in length.

- 4.1.2.3 All fiber cables shall be secured to the patch panel with the Kevlar strength members at the manufacturer provided anchor point at the rear of the panel.
- 4.1.3 Category-6 Modular Patch Panels (rack mounted) with RJ45 style connectors, for terminating all twisted pair cable from each Voice/Data, AV Equipment and IP Camera outlet, served from this location. Provide a minimum of 25% spare capacity for future wiring requirements. All patch panels shall be 48-Ports only, 24-Port patch panels shall not be accepted. Provide cable support bars at the rear of each patch panel all cables shall be secured to bars with velcro straps.
- 4.1.4 Augmented Category-6 Patch Panels (rack mounted) with RJ45 style connectors, for terminating all twisted pair cable from each WAP outlet served from this location. Provide a minimum of 25% spare capacity for future wiring requirements. All patch panels shall be 48-Ports only, 24-Port patch panels shall not be accepted. Provide cable support bars at the rear of each patch panel all cables shall be secured to bars with velcro straps.
- 4.1.5 If the project requires the installation of both Category-6 and Augmented Category-6 cabling and patch panel connections, the Augmented Category-6 patch panel shall be clearly labeled as “Augmented Category-6” and the RJ45 port connections shall be either a different color than the standard Category-6 patch panel ports, or the patch panel ports shall be provided with a colored icon to differentiate the Augmented Cat-6 connections from the Category-6 connections. **All patch panels shall be provided fully loaded with RJ45 style connectors.**
- 4.1.6 Uninterruptible Power Supplies (UPS) shall be furnished and installed by the District. Contractor shall furnish the required power outlet for the UPS at the IDF location. See the floor plans for the power requirements.
- 4.2 IDF Rooms provided with 4-Post Racks - Furnish and install equipment mounting racks as shown on project floor plans and details. Furnish the following additional components and installation practices for the racks;
 - 4.2.1 Provide all accessories required whether shown on the project drawings or within these specifications. The drawings and specifications shall be considered a single document.
 - 4.2.2 The racks shall be provided with structural seismic bracing using cable runway to the top of the rack, with the width of runway as shown on the MDF Room drawings and details.
 - 4.2.3 Universal 12” cable runway shall be as manufactured by CPI Model 10250-712. The cable runway shall be furnished with the additional adapters, connectors, support components, bends and offsets and extensions as required to fit the room and layout as shown in the drawings. Cable runway shall be bonded together as shown in the detail drawings.

- 4.2.4 Anchor the cable runway to the wall with the appropriate width angle bracket and bolts as manufactured by CPI Model #11421-712.
- 4.2.5 The cable runway shall also be attached to the top of the rack with the appropriate adapter panel. Cable runway shall be directly attached to the 4-Post racks with J-Hooks.
- 4.2.6 Cable runway routed along walls, shall be offset from the wall a minimum of 6” and shall be supported with cantilevered wall mount brackets as shown in the detail drawings.
- 4.2.7 The racks shall be structurally anchored to the floor with the anchors and bolts as shown in the detail drawings. Anchoring shall comply with all Local, State and National Codes.
- 4.2.8 Provide Standard 4-Post Racks, 19” mounting width by 84” High by 29” Deep with #12-24 mounting holes as shown in the IDF Room layout and details. See detail drawings for quantity of racks and additional requirements. Contractor shall be responsible for providing all racks and accessories as shown in the details. The 4-Post racks shall be as manufactured by CPI Model #50120-703 or approved equal by Middle Atlantic.
- 4.2.9 Provide (1) adjustable full depth vented shelf for each 4-Post equipment rack as manufactured by CPI #16350-719.
- 4.2.10 Provide full length vertical wire managers, CPI Double-Sided Narrow Vertical Manager, Part #12096-703, on each side of each rack. Vertical managers between racks may be substituted with the CPI #11729-703 6” wide double-sided manager. Single narrow vertical managers shall be provided on each end of the group of racks.
- 4.2.11 Provide horizontal wire managers between each patch panel or (1) manager per patch panel. Provide (1) spare manager per rack. Provide 2RMU height managers for each 48-Port patch panel and 1RMU height managers for 24-Port patch panels. CPI Part #30130-719 and #30139-719.
- 4.2.12 Provide (1) ground bus bar kit with lugs per IDF Room as detailed in the drawings. Ground Bus Bar kit as manufactured by CPI #40158-012 (or approved equal). Ground Bus Bar and all bonding conductors to the bus bar shall be labeled as shown in the drawing details. Grounding conductors shall be routed to the equipment racks, cable runway and electrical panel.
- 4.2.13 Furnish grounding to each rack as shown in the detail drawings. Each rack shall be provided with a grounding terminal block, #6 Ground wire from the rack to the busbar and a compression lug on the end of the ground wire at the busbar. Provide grounding components as manufactured by CPI #40167-001 terminal block and #40162-901 compression lug or approved equal.
- 4.2.14 All fiber optic feed cables routed to the IDF Room shall be provided with 20-feet of slack for a service loop mounted on the backboard behind the racks.

Contractor shall provide a 24” diameter wall mounted service loop manager for the fiber optic feed cables as manufactured by Leviton #48900-FR. Maximum of (3) fiber feed cables per manager. Provide quantity of managers as required to manage all service loops.

4.2.15 All cable runway, racks, accessories, supports and wire management shall be black in color. (Unless Otherwise Noted)

4.2.16 Provide all other items as detailed on the drawings.

PART 5 – MDF/IDF PATCH CORD REQUIREMENTS

5.1 Fiber Optic Patch Cords

5.1.1 Fiber optic patch cords shall be furnished and installed by the Contractor.

5.1.2 All fiber optic patch cords furnished by the Contractor shall match the grade and glass of the fiber optic feed cable installed for the network infrastructure cabling system. The Contractor shall confirm with the District IT Department the type of connector required at the network equipment prior to ordering or installing the patch cords.

5.1.3 Multimode Fiber Optic Patch Cords - Patch cords shall be duplex 50/125um, laser-optimized, OM4 grade multimode optical glass. Fiber optic patch cords shall be furnished with LC connectors at the network switch port end and LC connectors at the fiber optic patch panel end. Fiber patch cords shall be furnished with ceramic ferrules. All Multimode patch cords shall be Aqua (Lt. Blue) in color. Patch cords shall be 3-feet (1 meter) in length.

5.1.4 Single Mode Fiber Optic Patch Cords - Patch cords shall be duplex 8.3/125um, (OS2) grade single mode optical glass. Fiber optic patch cords shall be furnished with LC connectors at the network switch port end and LC connectors at the fiber optic patch panel end. All Single Mode patch cords shall be Blue in color. Patch cords shall be 3-feet (1 meter) in length. If the single mode fiber is directed to be stored for future use, the single mode patch cords will not be required. Refer to the new fiber optic feed cable section for instructions on termination of the new single mode fiber feed runs.

5.1.5 Each fiber optic feed cable from the MDF Room to the IDF location requires (2) duplex fiber optic patch cords for connection to the IDF switch. Contractor shall furnish (2) Multimode fiber patch cords for each fiber optic feed cable terminated in the MDF Room patch panels. Contractor shall be responsible for confirming the network switch connections with the District IT Director prior to ordering or installing the patch cords.

5.2 Copper Patch Cords

5.2.1 Copper patch cords shall be furnished and installed by the Contractor.

- 5.2.2 Provide Enhanced Category-6 rated (Patch Panel End) patch cords with pre-molded boot, provide quantity equal to:
 - 5.2.2.1 Provide 100% of the total Enhanced Category-6 rated cable ports provided on the patch panels.
 - 5.2.2.2 All patch cords to be installed by Contractor. Provide 100% of total copper patch cords required to be (2) feet in length.
- 5.2.3 Provide Enhanced Category-6 rated (Workstation End) patch cords with pre-molded boot, provide quantity equal to:
 - 5.2.3.1 Provide 100% of the total Enhanced Category-6 rated cable ports provided on the patch panels.
 - 5.2.3.2 All patch cords to be installed by Contractor. Provide 100% of total copper patch cords required for voice and data locations, to be (10) feet in length, unless otherwise noted.
 - 5.2.3.3 All patch cords to be installed by Contractor. Provide 100% of total copper patch cords required for IP Camera and AV Equipment locations, to be (2) feet in length, unless otherwise noted.
- 5.2.4 Provide Augmented Category-6 (Patch Panel End) patch cords with pre-molded boot, provide quantity equal to:
 - 5.2.4.1 Provide 100% of the total Category-6A cable ports provided on the patch panels.
 - 5.2.4.2 All patch cords to be installed by Contractor. Provide 100% of total copper patch cords required to be (2) feet in length.
 - 5.2.4.3 Augmented Category-6 patch cords shall be differentiated from the Category-6 patch cords with a different color jacket.
- 5.2.5 Provide Augmented Category-6 (Workstation End) patch cords with pre-molded boot, provide quantity equal to:
 - 5.2.5.1 Provide 100% of the total Category-6A cable drops provided on the patch panels.
 - 5.2.5.2 Patch cords installed at WAP (Wireless Access Point) locations shall be (2) feet in length.
 - 5.2.5.3 Augmented Category-6 patch cords shall be differentiated from the Category-6 patch cords with a different color jacket.
- 5.2.6 Requirements for all copper patch cords furnished:

- 5.2.6.1 Color of patch cords shall be determined by the color codes shown in the drawing details or as otherwise directed by the District IT Department.
- 5.2.6.2 Patch cords shall be as manufactured by Leviton, Commscope, Panduit or Ortronics based on the network infrastructure system furnished by the Contractor.
- 5.2.6.3 Definition of “Enhanced Category-6 Rated” patch cables – Since there is no official EIA/TIA rating level determined to be “Enhanced Category-6”, the provision of any cables shall be based on the manufacturer’s performance claims for the product.
- 5.2.6.4 Patch cords furnished must be in compliance with the manufacturer’s “Channel” warranty requirements. Patch cords not warranted through the selected manufacturer Channel warranty program will not be approved for use with the network infrastructure.

PART 6 – CABLING REQUIREMENTS

6.1 Campus Fiber Optic Feed Cable Requirements

- 6.1.1 Provide one continuous fiber optic cable routed from the Main Distribution Frame fiber patch panel to each Intermediate Distribution Frame fiber patch panel, and/or other locations as shown on the drawings.
- 6.1.2 For new Fiber Optic Feed Cables shown on the drawings and in the specifications; Fiber optic feed cables shall be installed in the existing pathways, unless otherwise shown on the drawings. Contractor shall not interrupt service to the users without a planned outage approved by the District. The Contractor may use the existing feed cable as a pull wire or other cables identified to be removed from the existing conduits, provided that the service is back on-line prior to the user’s normal working hours.
- 6.1.3 Provide (1) fiber optic feed cable to the New Classroom Building IDF location from the campus MDF location as designated in the drawings and specifications. The cable shall contain all of the quantities and types of fibers required in the drawings and specifications.
- 6.1.4 Outdoor Fiber Feed Cable Applications - Fiber optic cable shall be rated for indoor/outdoor riser rated applications. Construction shall consist of; all dielectric, indoor/outdoor Riser Rated Tight Buffer Style, flame retardant PVC or PE jacket, rated OFNR, Outer and Inner Layer of Dielectric Strength Yarns with central member constructed of Dielectric Strength Yarns, dry water-blocking compound, and blank fillers as required. Fiber shall be small form factor type fiber for use in existing conduit and pathways and **shall not exceed an Overall Outside Diameter (OD) of .370”**. Central tube or loose tube type fiber will not be considered equal.
- 6.1.5 Fiber optic feed cables for the data infrastructure must be installed as follows:

- 6.1.5.1 Composite Fiber Optic feed cable run – Fiber optic feed cable containing both Multimode and Single Mode strands shall be installed as a single composite feed cable. Provide a total of 24-strands of fiber, with 12-strands of OM4-Rated Multimode and 12-strands of OS2-Rated Single Mode glass to the IDF location, unless otherwise directed in the drawings or specifications. Do not provide separate fiber optic cables for each type of fiber to the IDF location. Feed cables shall be clearly defined and labeled at each junction box or handhole.
- 6.1.6 Feed cables shall be clearly defined and labeled for each system. Provide color coding designations with a different color marker for the multimode and/or single mode fiber feed terminations in the fiber patch panels.
- 6.1.7 Additional labeling on the fiber optic patch panel is required to identify which type of fiber is terminated on the bulkheads in the panel. All connectors and bulkheads shall be color coded with Aqua for 50/125um Multimode and Blue for Single Mode fiber types.
- 6.1.8 Each fiber optic feed cable shall contain one or all types of the fiber optic glass listed below:
 - 6.1.8.1 Provide Multimode 50/125-micron fiber optic glass, (minimum OM4 laser-optimized grade) for dual mode operation at 850 nm and 1300 nm wave lengths.
 - 6.1.8.1.1 Maximum attenuation at 3.5dB/km @ 850nm and 1.5dB/km @ 1300nm. Minimum 1-gigabit Ethernet distance guarantee of 1040 meters @ 850nm and 600 meters @ 1300nm. Minimum 10-gigabit Ethernet distance guarantee of 550 meters @ 850nm and 300 meters @ 1300nm. Fiber shall be ISO-TIA OM4 rated.
 - 6.1.8.2 Single mode 8.3/125-micron fiber optic glass, (minimum OS2) High Performance grade for dual mode operation at 1310 nm and 1550 nm wave lengths.
 - 6.1.8.2.1 Maximum attenuation at 0.7dB/km @ 1310nm and 0.7dB/km @ 1550nm. Quantity of fibers as per detail drawings.
- 6.1.9 All fibers in the fiber optic feed cable shall be fully operational within the required performance characteristics as published by the manufacturer. If any individual fiber does not meet the minimum standards, the entire cable must be replaced, end to end, including connectors, without any additional expense to the customer.
- 6.1.10 All fiber optic strands shall be fully terminated and tested, unless otherwise noted in the drawings or in these specifications.

6.1.11 Refer to drawings for cable types required. Refer to acceptable cables section for additional information and approved manufacturers.

6.1.12 Acceptable cables shall be:

- Berk-Tek Multimode — GIGALITE 10-FB-OM4
- Berk-Tek Single Mode — Enhanced OS2 Single Mode -AB
- Commscope Multimode — (All Brand Names) Systemax LazrSpeed 550 OM4
- Commscope Single Mode — (All Brand Names) Systemax TeraSpeed OS2
- Superior Essex Multimode — TeraGain 10G-550-OM4 (Type F)
- Superior Essex Single Mode — TeraFlex G.657 Enhanced OS2 (Type K)
- General Cable Multimode — Clear Curve OM4 (Type BL)
- General Cable Single Mode — SMF-28 Ultra Enhanced OS2 (Type Ax)
(Note; General Cable use Corning glass and Corning descriptions)

Above glass types are an example of product names per manufacturer. Confirm requirements for indoor/outdoor and riser rated fiber cable with riser drawings and site plans. Part numbers for composite style cable will vary greatly. Confirm part numbers with manufacturer.

6.2 Category-6 Station Cable

6.2.1 Contractor shall provide a Category-6 UTP cable to each Data, Voice, Audio-Visual Data and IP Camera indicated on the drawings and specifications. Provide quantity of cables as indicated on the drawings at each location.

6.2.2 Provide one Category-6, 4-pair, unshielded twisted pair (UTP) cable from the nearest MDF or IDF location to each RJ45 data outlet port indicated on the drawings. Dual port outlets will require two such cables. Four port outlets will require four cables. Refer to the drawing details for jacket color requirements for each type of connection. Color of cable jacket for each type of connection shall be determined by the drawing details. Confirm color of cable jackets prior to ordering with the District IT Director. Contractor shall be responsible for providing the correct jacket color per the drawings per District Standards.

6.2.3 Unless otherwise shown in drawing details, the color of the Category 6 UTP cables shall be blue, shall be copper wire, individually insulated and color coded.

6.2.4 The cables shall be UL or ETL rated and UL verified in compliance Category-6 EIA/TIA standards. Approved cables for Network Infrastructure System;

- Commscope (Uniprise) — CS37R
- Superior Essex — NextGain Cat 6eX - #54-246-xA
- Berk-Tek — LANMARK 2000 – 10167477

General Cable — GigaSpeed 6500 71339XX

- 6.2.5 Manufacturer names and part numbers are shown as a point of reference and do not specifically designate required packaging or color for the cable. Contractor shall verify colors and packaging options shall be determined by Contractor preferences.
- 6.2.6 Definition of “Enhanced Category-6 Rated” cable – Since there is no official EIA/TIA rating level determined to be “Enhanced Category-6”, the provision of any cable shall be based on the manufacturer’s performance claims for the product.

6.3 Augmented Category-6 Station Cable

- 6.3.1 Contractor shall provide an Augmented Category-6 UTP cable to each Wireless Access Point location indicated on the drawings and specifications. Provide quantity of cables as indicated on the drawings at each location.
- 6.3.2 The new Augmented Category-6 UTP cables will replace the existing Category-6 UTP cabling to each of the existing Wireless Access Point locations. Terminate the new cables at the existing WAP location and reconnect the WAP to the new cable infrastructure.
- 6.3.3 Provide one Augmented Category-6, 4-pair, unshielded twisted pair (UTP) cable from the nearest MDF or IDF location to each RJ45 data outlet port indicated on the drawings. Dual port outlets will require two such cables. Four port outlets will require four cables. Refer to the drawing details for jacket color requirements for each type of connection. Color of cable jacket for each type of connection shall be determined by the drawing details. Confirm color of cable jackets prior to ordering with the District IT Director. Contractor shall be responsible for providing the correct jacket color per the drawings per District Standards.
- 6.3.4 Unless otherwise shown in drawing details, the color of the Augmented Category 6 UTP cables shall be blue, shall be copper wire, individually insulated and color coded.
- 6.3.5 The cables shall be UL or ETL rated and UL verified in compliance with Augmented Category-6 EIA/TIA standards. Approved cables for Network Infrastructure System;

Commscope (Uniprise)	—	CS44R
Superior Essex	—	10 Gain XP - #6H-246-xA
Berk-Tek)	—	LANMARK 10G2 – 10137700 (Part Number for different color jackets for Berk-Tek cable varies)
General Cable	—	GenSpeed 10,000 71338XX

- 6.3.6 Manufacturer names and part numbers are shown as a point of reference and do not specifically designate required packaging or color for the cable. Contractor shall verify colors and packaging options shall be determined by Contractor preferences.

6.4 **Category-6 Outlets**

- 6.4.1 Unshielded twisted pair Category-6 outlets shall be an RJ45 Enhanced performance type 8-position / 8 conductor modular jacks, and shall comply with Category-6 performance requirements. Provide single port, dual port, four port or quantity as indicated on the floor plans at each outlet location. All outlets shall be wired in an EIA/TIA 568B configuration.
- 6.4.2 Provide Category-6 inserts, wired for EIA 568B. Provide installation kits for all locations furnished with Category-6 UTP cabling.
- 6.4.3 Refer to the detail drawings for color of the Category-6 outlets required. Contractor shall be responsible for confirming all color requirements prior to ordering.
- 6.4.4 Provide the following Category-6 UTP data connector per Network Infrastructure warranty requirements;
 - 6.4.4.1 Leviton eXtreme Cat6+ Quick Port Series 61110-R
 - 6.4.4.2 Uniprise (Commscope) SL 110 Series 1-1375055
 - 6.4.4.3 Ortronics Clarity 6 Tracjack Series OR-TJ600
 - 6.4.4.4 Panduit MiniCom TX6 Plus Series CJ688TG

6.5 **Augmented Category-6 Outlets**

- 6.5.1 Unshielded twisted pair Augmented Category-6 outlets shall be an RJ45 Enhanced performance type 8-position / 8 conductor modular jacks, and shall comply with Augmented Category-6 performance requirements. Provide single port, dual port, four port or quantity as indicated on the floor plans at each outlet location. All outlets shall be wired in an EIA/TIA 568B configuration.
- 6.5.2 Provide unshielded Augmented Category-6 inserts, wired for EIA 568B. Provide unshielded installation kits for all locations furnished with Augmented Category-6 UTP cabling.
- 6.5.3 Refer to the detail drawings for color of the Augmented Category-6 outlets required. Contractor shall be responsible for confirming all color requirements prior to ordering.
- 6.5.4 Provide the following unshielded Augmented Category-6 UTP data connector per Network Infrastructure warranty requirements;

- 6.5.4.1 Leviton Atlas-X1 Cat-6A Series 6AUJK-R
- 6.5.4.2 Uniprise (Commscope) AMP Twist SL Series 1-1933476
- 6.5.4.3 Ortronics Clarity 6 Tracjack Series OR-TJ600
- 6.5.4.4 Panduit MiniCom TX6 Plus Series CJ688TG

6.6 Outlet Faceplates

- 6.6.1 Provide a two-port faceplate for all one and two port outlet locations. Provide blanks for all unused openings.
- 6.6.2 Provide a four-port faceplate for all three and four port outlet locations. Provide blanks for all unused openings.
- 6.6.3 All fax/modem locations shall be provided as single port outlets. Requirements shall be the same as a single port data outlet as shown on the Technology Legend.
- 6.6.4 For single port voice outlet locations intended for wall telephone connections, a wall telephone type faceplate with attachment studs shall be provided. The wall telephone jack shall be 8-pin, RJ45 type and use IDC wire terminations only. Provide Category-6 insert, within stainless steel wall plate faceplate. Provide faceplate from the approved manufacturers listed in the specifications.
- 6.6.5 Provide single port or dual port Surface mount small surface mounted outlet box for IP Camera data outlets in the J-Box for the camera locations. Provide surface mount box by Leviton QuickPort Series 41089-xxx or equal by one of the approved manufacturers. The location shall also be furnished with a blank weather-tight faceplate to protect the data termination until the cameras are installed.
- 6.6.6 Wireless Access Point data connections for ceiling mounted WAPs shall be terminated above the accessible ceiling at the wireless access point (WAP) location. Refer to the drawing details for additional requirements.
- 6.6.7 Wireless Access Point data connections for WAPs shall be terminated at the WAP location as shown in the drawing details. Provide surface mount box by Leviton QuickPort Series 41089-xxx or equal by one of the approved manufacturers. The data connections at the WAP locations shall be Augmented Category-6 and shall be provided in the color as shown in the drawing details. The location shall also be furnished with a blank inserts for the unused ports. Label the cables and faceplate the same as standard data outlets.
- 6.6.8 All faceplates and surface mount outlet boxes shall be furnished with label windows. All labeling shall be installed within the label window.
- 6.6.9 Confirm color of all faceplates prior to ordering. All data outlet faceplates shall have a unique sequential identification number applied to faceplate. Hand

written labels are not permitted. All color schemes shall be approved by the customer prior to installation.

6.6.10 Colored inserts are required for this project. Refer to the detail drawings for the exact color scheme to be provided. Inserts submitted that do not follow the color and identification requirements will be rejected. Inserts installed that do not follow the color coding as shown in the detail drawings will be replaced at the Contractor's expense.

6.6.11 All labels will be installed under label windows. Labels adhered to the surface of the faceplate will not be accepted. Contractor must provide clear laminating type of cover material over the surface mounted labels where used.

6.6.12 Reference the drawings for special outlet configurations or plate requirements

6.6.13 All data outlet faceplates shall have a unique sequential identification number applied to faceplate. Refer to the detail drawings for labeling requirements. Hand written labels are not permitted. Faceplates, with the exception of wall telephone outlets, shall include color coded port inserts. All color schemes shall be approved by the District prior to installation.

6.6.14 Reference the drawings for special outlet configurations or plate requirements.

3

PART 7 – CAMPUS IP-BASED PAGING SYSTEM REQUIREMENTS

- 7.1 **The Contractor shall furnish and install the analog paging speakers and horns in the new classroom building for the IP-Based Paging System Control Software and interface devices provided by the 27 20 00 Contractor. The 27 10 00 Contractor shall install the cabling, speakers and amplifiers in the IDF Room for the system. The network connections to the paging interface devices in the IDF Room, installation and programming of the paging system software and network interface connections shall be provided by the 27 20 00 Contractor.**
- 7.2 **The common areas of the building interior shall be connected to one zone and the exterior page horns shall be connected to another zone. The analog paging speakers and horns shall be installed as a (2) Two zone system from the Control Software provided by the 27 20 00 Contractor.**
- 7.3 **The 27 20 00 Contractor shall coordinate all paging system zoning, paging system input levels to the amplifiers from the interface devices and paging system pre-recorded messages with the District. The paging requirements within the actual classroom shall be provided by the Classroom AV System speakers.**
- 7.4 **The 27 10 00 Contractor shall be responsible for testing all paging speakers and horns and ensuring the proper volume levels are set from the amplifiers. Provide (4) man hours for re-adjustment of the paging speakers and horns volume per the District's requirements 4 weeks after the school has been occupied by the students. Check with School Administrative Staff for areas that are either too loud or too soft. The final adjustments to the individual speakers, horns and amplifiers shall be documented and furnished as part of the As-Built documents for the project.**

- 7.5 The 27 10 00 Contractor shall furnish and install all cabling for the analog speakers and horns, Analog Paging Speakers, Paging Horns and Amplifiers associated with the IP-Based Paging System. Analog paging speakers and horns shall be as manufactured by Atlas Sound. These speakers must be procured from Atlas Sound Authorized distributors. Contact Atlas/IED for a list of authorized distributors.
- 7.6 The 27 10 00 Contractor shall be responsible for providing enclosures for all analog speakers and horns. Contractor shall provide vandal resistant screws with all enclosures for attachment of the speaker/horn grilles and baffles. Exterior locations shall be provided with stainless-steel enclosures and stainless-steel vandal resistant screws.
- 7.7 All surface mounted enclosures shall be furnished and installed by the 27 10 00 Contractor in all areas shown in the floor plans including exterior surface mounted enclosures.
- 7.8 Recessed flush mount enclosures shall be furnished by the 27 10 00 Contractor and installed by the Division 26 Contractor, unless otherwise noted on the Legend or Floor Plans. Recessed enclosures shall be furnished with manufacturer provided “wing” bracket panels that attach to the side of the enclosure and shall be used for attachment to the structural members.
- 7.9 Provide amplifiers for the analog paging speakers and horns connected to the IP-Based Paging System Interface devices in the IDF Room. Amplifiers shall be rack mounted in the IDF equipment rack. Provide rack mount adapter bracket as required to mount one or two amplifiers on the rack side-by-side. Provide size of amplifiers to service the quantity of horns and speakers as shown on the drawings. A separate amplifier must be provided for each Paging Zone. Size of amplifier shall be determined by the load, plus 25% expansion capacity. Larger amplifier may be required for a single zone depending on quantity of horns and speakers requiring amplification. Contractor is responsible for providing sufficient power amplification to service all speakers and horns. Contractor is responsible for connecting the amplifiers to the IP-Based paging interface devices and insuring proper operation between the interface devices and amplifiers. All speakers/horns shall be connected to the amplifiers at 70 volts.
- 7.9.1 Provide amplifier choice based on load; Approved Model; Atlas/IED Model #PA601 (or approved equals). Connect the “line out” terminal on the IP-Based paging interface devices provided by the 27 20 00 Contractor to the amplifier input terminals. Confirm with 27 20 00 Contractor whether a balanced or unbalanced line level audio signal will be provided.
- 7.9.2 Route the output from the amplifiers to the terminal strips on the Communications backboard for connection to the cabling terminal strips for the speakers and horns.
- 7.9.3 Provide rack mount adapter bracket Model #AARMK2-5, one bracket for each pair of amplifiers provided. If there is a single amplifier to be installed

at the rack, the amplifier would still require the rack mount bracket. Provide optional Level Control Security Covers for all models.

7.9.4 **Multi-zone amplifier Approved Models: Atlas/IED #CP400 (2-zone), QSC #CX108V (8 zone). Amplifiers rated at 100 watts/channel or 70 volts.**

7.10 **Analog Paging Speakers and Horns**

7.10.1 **Recessed accessible ceiling mounted speaker – Atlas/IED Part #DT12 1’x2’ drop in type speaker with external tap selector, recessed ceiling enclosure and tile bridge. Speaker baffle shall be white power coat epoxy finish. Speaker shall be tapped at a minimum of 2 watts. Louder areas (such as common hallways) shall be tapped at 5 watts.**

7.10.2 **Recessed non-accessible ceiling mounted speaker – Atlas/IED Part #SD72WV speaker with volume control, with recessed round ceiling enclosure Part #95-8 mounted in the hard lid ceiling. Speaker baffle shall be white powder coat epoxy finish. Speaker shall be tapped at a minimum of 2 watts. Louder areas (such as common hallways) shall be tapped at 5 watts.**

7.10.3 **All ceiling mounted speakers shall be provided with a minimum of (1) 12-AWG ceiling support wire securely attached to the structure above with either a power actuated nail into the concrete deck above or with a screw type hanger into the wood structural members. The speaker shall not depend on the ceiling tile grid for support.**

7.10.4 **Surface mounted speaker – Atlas/IED Part #VP14ENC with square surface mount slanted enclosure. Provide 8” speaker plus baffle – Atlas/IED Part #VP14MB with white power coat epoxy finish and shall be attached to the enclosure with vandal-resistant screws. Speaker shall be tapped at a minimum of 2 watts. The speaker shall be surface mounted on the wall, over J-Box furnished by the Division 26 Contractor. Louder areas (such as common hallways) shall be tapped at 5 watts.**

7.10.5 **Recessed Exterior Paging Horn – Provide Atlas/IED Part #VP161-APF Vandal Proof Baffle, #APF-15T series Horn/Loudspeaker, and #161RES stainless steel series enclosure. Unit must be weather and vandal resistant. All horns shall be tapped at 15 watts.**

7.10.6 **Surface Mounted Exterior Paging Horn – Provide Atlas/IED Part #VP161-APF Vandal Proof Baffle, #APF-15T series Horn/Loudspeaker, and #161SES stainless steel series enclosure. Unit must be vandal and weather resistant. All horns shall be tapped at 15 watts.**

7.10.7 **All analog speakers and horn grilles and baffles must be provided with vandal resistant screws. Contractor shall furnish (2) tools for removal of the screws to the District IT department.**

7.10.8 **Contractor is responsible for proper paging coverage and tap settings of the speakers and horns. Contractor shall confirm tap settings are adequate after**

the school has been occupied, testing the paging after the students have occupied the campus to properly judge the ambient noise levels and make adjustments before the project completion.

- 7.11 All wiring shall test free of grounds and shorts.
- 7.12 Each speaker location cable shall be home run to the IDF Room Communications backboard. Provide 1-pair, 18-AWG unshielded CMR rated speaker cable by West Penn #224 (or approved equal) to each speaker location. Terminate speaker cable on terminal strips at the backboard. All speakers shall be home run to the IDF location. Speakers/Horns may not be run in a series, unless otherwise shown on the drawings. All speaker runs shall be numbered and labeled.
- 7.13 Cross connect the speaker or horn wiring from the amplifiers output on the terminal strips. All connections shall be labeled at the terminal strip with the Zone and Building Name or Number.
- 7.14 All paging speaker cables installed shall contain all necessary conductors and/or cables to all devices shown on the Drawings and the Contractor shall make all necessary conductor terminations to all devices for a complete system.
- 7.15 All cables routed underground shall be suitable for wet location provided with UL listed wet location insulation or flooded type cable construction as manufactured by West Penn Aquaseal #AQ224 (or approved equal).
- 7.16 Wrap around labels are required on all cable connections at the rear of the amplifier, at the zone controller and at the terminal strip for all cabling to the speakers or connections between equipment. Label shall clearly define paging zones, room numbers or type of port. Label shall be Brady self-Laminating 1.2" x 1/5" wrap around type #29689 – (No approved equal).

PART 8 - INSTALLATION

- 8.1 Upon completion of 10% of the cabling installation, the Contractor shall notify the Project Engineer for an inspection of the methods and types of materials used on the project. The Contractor shall give a minimum of 72 hours notification to the Project Engineer for the scheduling of the inspection. The Contractor will be given a written review of the findings, so if adjustments are required, they can be done before the project proceeds. The Contractor shall be responsible for adhering to the findings and a follow-up inspection will not be provided.
- 8.2 Pull strings shall be provided with all cable runs including but not limited to; conduit stub ups, conduit sleeves, cable trays, open wiring routes, innerduct, and point-to-point conduits. Pull strings shall be free from cable bundles in open wiring routes. Pull strings shall not be substituted for pull ropes for the exterior site conduits.
- 8.3 Velcro cable management straps are required on all Category-6 cable bundles, the last 20 feet or upon entry into equipment closet, a maximum of 12" apart. Cable bundles shall also be routed through cable management or "D" rings in the equipment closet.

- 8.4 Data Contractor shall supply protective bushings or slide on rings at the ends of all exposed conduits used for the data system cabling. This is to include all conduits installed for any future data cabling requirements. Contractor shall submit planned protection bushings prior to installation of cabling for approval.
- 8.5 Velcro cable management straps are required on the cabling in the rear section of the vertical managers on the equipment racks. Straps shall be a maximum of 12" apart. At a minimum, Velcro straps shall be provided at each point the cables are routed to the patch panels from the main bundle.
- 8.6 Every fiber in every fiber optic cable must be terminated at both ends on a fiber patch panel in the MDF/IDF closet or cabinet location. Termination shall be accomplished using the correct style of connectors as directed by the District with a strain relief boot. All connectors shall be of the same manufacture to ensure compatibility. Polarity of fiber strands must be observed at all times.
- 8.7 Labeling
- 8.7.1 Each cable run shall be permanently labeled at each end with a unique sequential number which corresponds to a similar number provided for each data outlet and patch panel point. A printed label shall be placed at each of the following locations;
- 8.7.1.1 On the cable at the rear of the patch panel or termination block. Requires the use of a self-laminating wrap around label. Brady Label self-laminating 1.2" by 1.5" wrap around label Part #29689 (NO ACCEPTABLE EQUAL).
- 8.7.1.2 On each cable in the j-box behind the faceplate location. Requires the use of a self-laminating wrap around label. Brady Label self-laminating 1.2" by 1.5" wrap around label Part #29689 (NO ACCEPTABLE EQUAL).
- 8.7.1.3 On the cable at the terminal strip prior to termination point. Requires the use of a self-laminating wrap around label. Brady Label self-laminating 1.2" by 1.5" wrap around label Part #29689 (NO ACCEPTABLE EQUAL).
- 8.7.1.4 On the face of the patch panel, provide a 3/4" by 3/4" label with a letter or number identifying the patch panel designation. For special purpose data connections such as WAP, Audio-Visual, IP Page and IP Camera ports, the label shall be designated with colored label icon or marker.
- 8.7.1.5 On the face of the faceplate in the label holder window. The label shall be clearly defined with a minimum #10 font size.
- 8.7.2 Hand written labels are not permitted. Where cable ID includes room number identification, the Contractor shall obtain written verification of final room numbers prior to beginning labeling (numbers on plans do not always match final

room numbers). Cable pulling cross reference lists will not be accepted with final documentation.

- 8.7.3 Each patch panel port shall be identified with a unique sequential labeling scheme. Port identification labeling pattern shall be consistent throughout the project.
- 8.7.4 All faceplates shall be identified with permanent printed labels. Labels must not be subject to removal by incidental contact. Contractor shall be responsible for replacing defective labeling for a period of one year from date of final sign-off of project.
- 8.7.5 All fiber optic and UTP feed cables shall be identified with a permanent, water resistant, printed labels. Labeling information shall include closet identifications, quantity of conductors (UTP) or strands (fiber) and house pair designations (UTP). Cables shall be labeled in the IDF/MDF closets at the site conduit entrance point, Riser conduit entrance point and prior to entering either punch blocks or patch panels. Labels for fiber and copper feeds shall include both the name of the origination point and the destination point, house pair or house fiber strand count, cable composition (ie:12-Strand MM 50/125 LO; 6-Strand SM). See details for additional requirements.
- 8.7.6 Labeling will follow recommended EIA/TIA standards or as requested by the customer. Contractor will confirm labeling pattern prior to final identification or testing. All test results will be identified by the final labeling scheme. Contractor shall be required to have the labeling scheme approved in writing by the District IT Director prior to manufacture or installation of the labeling.
- 8.7.7 All fiber optic cables and/or innerduct shall be tagged with fiber optic warning tags in every manhole or pullbox. Fiber warning tags shall also be placed at each end of the cable in the termination closets in clear view. A minimum of (3) tags are required at each end, with a label tag on each cable in the service loop. Fiber warning tags shall be placed on fiber optic cable and/or innerduct routed through open ceiling environments at increments no less than 15 feet apart.
- 8.7.8 Refer to detail drawings for additional labeling requirements.
- 8.8 Where open wiring cables are run through the ceiling space (only permitted where specifically noted on the drawings), the wire shall be bundled together and supported above the ceiling.
- 8.9 All cables must be fastened to the building structure via “j-hooks” or an approved Category 6 suspension system, and not directly in contact with ceiling system. For “j-hooks” maximum fill capacity is as follows: 1-5/16" hooks – 35 cables; 2" hooks - 60 cables; 4" hooks - 120 cables. For quantities beyond 120 cables use a sling support system such as “Erico Cable Cat” or equal. Maximum fill capacity 200 cables. D-rings, “Caddy #WMX cable hangar”, “Caddy Bridle Rings”, drive rings or any other type of wire ring support is not allowed.

- 8.10 All new cabling shall include the support systems (J-hooks, saddles, Velcro ties, etc.) regardless if the outlets are shown as new locations or existing locations where the cables are to be replaced.
- 8.11 Where cables pass through a fire-resistant portion of the structure, conduit sleeves shall be provided to maintain the rating of the wall penetrated. Sealing of all penetrations with an approved fire barrier is required. Conduits and sleeves must remain accessible for future use. Permanent sealants may not be used to seal sleeves and conduits.
 - 8.11.1 The 27 10 00 Contractor shall be responsible for fire-stopping all unused conduit sleeves in the ceiling or through rated walls. The Electrical Contractor shall be responsible for fire-stopping around the conduit or sleeve, unless the sleeve is installed by the 27 10 00 Contractor, in which case, the 27 10 00 Contractor shall be responsible for all fire-stopping requirements.
 - 8.11.2 Expanding foam is not an acceptable sealant for any conduit opening. Contractor shall be responsible for complete replacement of the conduit and cabling in any conduit filled with expanding foam used as a sealant.
- 8.12 Fiber optic feed cables connecting to equipment racks from the MDF Room or from an adjacent IDF location, shall be installed with not less than a 20-foot service loop between the rack and mounted on the backboard. See drawings for fiber optic service loop requirements.
- 8.13 Provide 6 inches of cable slack at computer data system outlets inside conduit box.
- 8.14 In an accessible ceiling area, provide a 10-foot (stored in a Figure-8 configuration) service loop above the all data/voice outlet locations. Service loop must be securely tied up off of ceiling tiles or ceiling surface and supported at two opposite points. Neatly coil cable without exceeding minimum bend radius limitations. Do not provide length in excess of 15 feet, as it may cause improper test results and errors.
- 8.15 Do not provide a service loop in the MDF/IDF Room on the UTP cables, unless otherwise noted. Cables shall be neatly routed around the perimeter of the room to the cable runway from the point of entrance into the room.
- 8.16 The minimum bending radius for all cables and the maximum pulling tension shall not exceed manufacturer's recommendations.
- 8.17 Cables installed in manholes and pullboxes shall be supported with Velcro ties or loosely fitted UV rated tie wraps, on wall mounted cable support racks. The cables shall be clearly labeled in the manhole or pullbox.
- 8.18 Provide a full 360-degree loop of slack cable around manhole and pullbox interiors. Cables entering handholes from the bottom, shall not be allowed to touch the bottom of the cover when closed and shall not be pinched or crushed in any way.
- 8.19 Cable pulling shall use a split mesh grip over the cable jacket. Connection directly to optical fibers and copper wire conductors shall not occur.

- 8.20 When pulled through conduits, cable pulling lubricants shall be continuously applied to all cables and be specifically approved by the manufacturer.
- 8.21 Where cables are pulled through or pulled from a center of run, pull without splices or terminations, lead out the cables at all manholes, pullboxes, and conduits, taking care to feed them in again by hand for the next run.
- 8.22 For each cable pull where a cable direction change is required, flexible feed-in tubes, pullout devices, multi-segmented sheaves, etc., shall be used to ensure proper cable pulling tensions and side wall pressures. Cables shall not be pulled directly around a short right-angle bend. Any device or surface the cable comes in contact with when under pull-in tension shall have a minimum radius 50% greater than the final specified minimum installed cable bending radius. The maximum possible size radius sheaves and feed-in tubes, usable in the available working space, shall be provided in all situations, to ensure the minimum possible cable sidewall pulling pressure. Do not use devices with multi-segment "roller" type sheaves.
- 8.23 Cable lengths over 250 feet shall be machine pulled, not hand pulled. Cables shall be pulled in a continuous, smooth operation without jerking or stop-start motion after initiation of pull. Maximum cable pulling speed shall be less than 50 feet per minute. Minimum pulling speed shall be greater than 15 feet per minute.
- 8.24 A pull string shall be placed with all UTP and paging station cables at the time of installation. Conduit runs and surface raceway for station cabling shall be furnished with a minimum 2-Ply spiral wrap style, pull string rated for 240 ft/lbs. pulling strength, such as manufactured by Greenlee #431 or approved equal. Includes all conduit stubs and cables routed through open ceilings and cable trays. Pull strings shall be tied off in the junction box and in the ceiling. Provision for the installation of the pull string shall apply to all empty and spare conduits as well. Single ply type pull string will not be accepted as a substitute for the 2-ply pull string.
- 8.25 A measuring pull tape shall be placed with all feed cables at the time of installation. Indoor riser and Outdoor conduit runs between buildings designated for feed cabling, in excess of 150 feet shall be provided with a minimum ½" polyaramid style, measuring true tape pull string annotated with footage increments rated for 2500 ft/lbs. pulling strength, such as manufactured by Greenlee #39245 or approved equal. Conduit runs less than 150 feet shall be furnished with a ¼" polyaramid style, measuring true tape pull string annotated with footage increments rated for 1250 ft/lbs. pulling strength, such as manufactured by Greenlee #39243 or approved equal. Provision for the installation of the measuring pull tape shall apply to all empty and spare conduits as well. Standard twine style pull strings and standard nylon or polypropylene style pull ropes will not be accepted as a substitute for the polyaramid measuring tape type pull string.
- 8.26 When pulling cable through conduit, cables shall be pulled straight into or out of the raceway without bends at the raceway entrance or exit. Pull in cable from the end having the sharpest bend (i.e., bend shall be closest to the reel.) Keep pulling tension to minimum by liberal use of lubricant, hand turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one at manhole or pullbox during this operation. Cables shall be pulled directly from cable reels.

- 8.27 All cables shall be new and extend continuous from each MDF or IDF backboard or rack to all outlet locations.
- 8.28 Where cables are not installed in a conduit or other raceway system, they shall not be routed parallel with other line voltage equipment or wiring (120 volt and above) within 36" or within 12" of line voltage equipment or wiring where crossing.
- 8.29 Where OSP-Rated UTP cables or OSP-Rated fiber optic cables are routed exposed through ceilings for more than 50'-0", Contractor shall install the cable in innerduct or EMT conduit in the ceiling. Innerduct installed in the accessible ceiling space shall be a minimum of riser rated and a minimum of 1" in diameter. Innerduct shall be supported a minimum of every 3-feet to the structural members.

PART 9 - TESTING

- 9.1 All Category-6 cables shall be point to point (link) tested after installation/termination, and verified to operate at minimum 1000Mbps. Performance of installed cables shall satisfy all current addendums to the EIA/TIA 568A standard for Category-6 wiring. In addition, testing shall satisfy all proposed amendments to the existing ISO/IEC requirements. The wiring shall support all specified communication protocols. Testing shall support the Category-6 requirements by the EIA/TIA.
- 9.2 All Augmented Category-6 cables shall be point to point (link) tested after installation/termination and verified to operate at minimum 10000Mbps. Performance of installed cables shall satisfy all current addendums to the EIA/TIA 568A standard for Augmented Category-6 wiring. In addition, testing shall satisfy all proposed amendments to the existing ISO/IEC requirements. The wiring shall support all specified communication protocols. Testing shall support the Augmented Category-6 requirements by the EIA/TIA.
- 9.3 Upon completion of testing cable links for both copper and fiber optic cabling, the Contractor shall supply a copy of the original database files downloaded from the tester in original format on a USB Flash Drive. Contractor shall provide with the testing database files, an original copy of the tester's manufacturer software program (included in original cost) for record management and archiving, in a Windows format (i.e.; Fluke Linkware software program)
 - 9.3.1 The manufacturer's software program will be used by the Project Engineer to review all test results, and then turned over to the District to keep as their record copy with the final approved test results. Provide (3) copies of tests on USB Flash drive. Do not submit test results for review in Excel or PDF file formats, as the submittal will be rejected and not reviewed.
- 9.4 Contractor will repair or replace cable runs or connecting hardware that do not meet specified criteria.
- 9.5 Multimode fiber optic cables shall be tested bi-directionally at 850nm and 1300nm. Single mode fiber optic cable shall be tested bi-directionally at 1310nm and 1550nm. All fiber strands shall be tested with an OTDR (Optical Time Domain Reflectometer). All

fiber test results shall contain final source and destination information that matches IDF or MDF labeling shown on the fiber optic patch panels and final documentation. OTDR test results shall be included with the copper test results and submitted with the tester's software for review. Do not submit test results for review in Excel or PDF file formats, as the submittal will be rejected and not reviewed.

- 9.6 Test procedures shall comply with EIA/TIA 526-14 Method B. Test results shall meet the minimum following criteria:
 - 9.6.1 Fiber optic test results shall not exceed 2db total attenuation loss in addition to inherent loss published by manufacturer tested at minimum 2000 Mhz for 850nm and 500 Mhz for 1300nm for the fiber optic cable.
 - 9.6.2 Test all data cables minimum Category-6 UTP cable to test results for "Channel Testing" requirements @ 250 Mhz per current EIA/TIA requirements. Any cables which do not meet these minimum requirements shall be replaced or repaired at no cost to the District.
 - 9.6.3 Test all data cables minimum Augmented Category-6 UTP cable to test results for "Channel Testing" requirements @ 500 Mhz per current EIA/TIA draft requirements. Any cables which do not meet these minimum requirements shall be replaced or repaired at no cost to the District.
- 9.7 End to end attenuation testing shall be performed with a temporary test jumper cable at each end of the installed fiber cable. The test jumper utilized shall be the same fiber core size and grade of glass as the installed cable. The measured attenuation of the test jumpers, test connectors, and test interconnection sleeve between the two test jumpers shall be less than 1dB as calibrated at the time of the test at indicated wave lengths and frequencies. Test jumpers shall be "zeroed out" before testing of fiber strands begins.

PART 10 – CLOSE-OUT DOCUMENTATION

- 10.1 Final As-Built Drawing Submittals - Provide (1) hard bound copy of "E-size" As-Built drawings and (3) copies on USB Flash Drive in AutoCAD (2014 or newer version) format. A Hand marked-up copy of the original construction drawings will not be accepted as the final As-Built drawing submittal. Final As-Built drawings shall include copies of the floor plan drawings of each building, detailed elevations of each MDF or IDF locating all equipment, quantities outlets and speaker locations, locations of all sleeves and identification of all final cable routes. In addition, the drawings shall include all outlet locations with cable identification numbers.

END OF SECTION 272000

SECTION 272000 - INTEGRATED AUDIO/VISUAL SYSTEM

PART 1 – GENERAL

SUMMARY

- 1.1 The Contractor shall furnish all labor, project management, materials, tools, equipment, and resources necessary for the installation, startup, and testing of the system shown on the plans and described in the specifications.
- 1.2 Related Specification Sections:
 - 1.2.1 Section 26 01 00 -General Provisions
 - 1.2.2 Section 26 05 33 -Conduit and Fitting
 - 1.2.3 Section 26 05 19 -Conductors
 - 1.2.4 Section 26 05 34 -Outlet and Junction Boxes
- 1.3 The Contractor shall furnish and install the system as defined by the plans and specifications. The Contractor must demonstrate to the Owner that the system is complete and complies with all operational requirements set forth in the plans and specifications.
- 1.4 The work covered under this section of the specifications consists of furnishing all labor, equipment, supplies and materials, and in performing all operations necessary for the turnkey and fully completed installation of an audio/ video system in accordance with the specifications and accompanying drawings, except as specifically noted otherwise.
- 1.5 Cables for the system shall be pulled through the conduit systems furnished by the building Contractor. The 27 20 00 Contractor shall be responsible for providing all cables required and for coordinating and supervising the cable installation. The 27 20 00 Contractor shall be responsible for ensuring the integrity of the cables before and after installation.
- 1.6 Work Excluded:
 - 1.6.1 Excluded from this work shall be any and all general construction services regarding masonry and general carpentry services. Those services are to be provided and installed by the general Contractor.
 - 1.6.2 Conduit/raceways, sleeves, cable trays, electrical boxes, hand holes, pullboxes, etc. required for the system shall be furnished and installed by the Electrical Contractor. The conduit/raceways and electrical boxes furnished and installed under Electrical Contractor shall conform with the requirements of the drawings and specifications for the system.
- 1.7 In order to ensure project cohesion a single point of contact is required to provide a "TURNKEY" solution. The work covered under this section of the specification consists of furnishing all labor; cabling; equipment; software; supplies; materials and training. The Contractor will perform all operations necessary for the "TURNKEY" and fully completed installation in accordance with the specifications herein. As such, the successful Contractor must be factory trained on all aspects of system hardware. The successful

Contractor shall be a California licensed C7 or 10 premise wiring Contractor as defined in this specification. SubContractors may not be utilized in the implementation of the plant wiring installation.

- 1.8 Approval to bid shall not release the Contractor from full specification compliance requirements. Final system acceptance testing shall govern final system acceptance and compliance with the specifications.
- 1.9 Failure to provide a functional equivalent shall result in the removal of the alternate system at the Contractor's expense.
- 1.10 These specifications contain statements which may be more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions.
- 1.11 Where the words 'provide' or 'provision' is used, it shall be definitely interpreted as 'furnishing and installing complete in operating condition'. Where the words 'as indicated' or 'as shown' are used, it shall mean as shown on contract drawings.
- 1.12 Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras mentioned on drawings or specifications. All specified and supplied equipment shall be new.

DEFINITIONS

- 1.13 Concealed: Hidden from sight, as in trenches, chases, hollow construction, or above furred spaces, hung ceilings - acoustical or plastic type, or exposed to view only in tunnels, attics, shafts, crawl spaces, unfinished spaces, or other areas solely for maintenance and repair.
- 1.14 Exposed, Non-Concealed, Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the 'finish schedule' with exposed and unpainted construction for walls, floors, or ceilings or specifically mentioned as 'unfinished'.
- 1.15 Finish Space: Any space ordinarily visible, including exterior areas.

Contractor Qualifications

- 1.16 The successful bidder shall be a California licensed C7 or C10 premise wiring Contractor as defined in this specification. Subcontractors may not be utilized in the implementation of the installation or programming.
- 1.17 The successful bidder shall have design staff with a minimum of the following certifications and shall include all certifications with their bid.
 - 1.17.1 (1) BICSI certified (RCDD) Registered Communications Distribution Designer.
 - 1.17.2 CTS Certification
 - 1.17.3 Extron XTP Systems Engineer

- 1.17.4 Extron TLP programming certifications
- 1.17.5 Extron Global Configuration Certification
- 1.18 The successful bidder shall have installation staff with a minimum of the following and shall include all certifications with their bid.
 - 1.18.1 CTS-I certification
 - 1.18.2 Extron Advanced A/V Certifications.
 - 1.18.3 Contractor must have a minimum of (8) full time certified installation technicians with Extron Certifications (include certifications with submittals)
- 1.19 All bidders must provide a listing of two similar size projects having the same scope of work using the proposed information delivery equipment. This listing shall be complete with facility names, completion dates, names of contacts, and their telephone numbers. Referenced projects must have been completed in the past 18 months.
- 1.20 The bidder shall have a factory trained service department. The service department shall be on call 24 hours a day, 365 days a year, to arrive and initiate onsite service the specified equipment upon (24) hours notice.
- 1.21 The Contractor shall employ factory-trained technical/service personnel for service and maintenance of the system. Their résumés will be required. The factory-trained technical/service personnel shall have a minimum of two years experience installing the proposed system. The Bidder shall submit the names and copies of the certificates issued by the factory. The bidder shall instruct the Owner's technical personnel in the operation, care, and maintenance of the system.

CODE COMPLIANCE

- 1.22 All material and equipment shall be clearly listed, labeled, or certified by Underwriters Laboratories, Inc. All power supplies and computers shall be clearly UL Listed. Any system which is not UL Listed at time of bid will be rejected.
- 1.23 All acceptable systems shall be approved under Part 15, Subpart B, Section 15.107b of the FCC Rules and Regulations. Bidders must provide the FCC Registration Number of the proposed system. Systems that are not in compliance with the FCC will not be considered. Any system that is not FCC compliant at time of bid will be rejected. All equipment must be clearly labeled with FCC compliance stickers.
- 1.24 The system shall be installed in accordance with local and national electrical codes.
- 1.25 The manufacturer and Contractor shall provide the Owner with a release for use of all copyright materials, corporate logos, and corporate trademarks at time of bid.

SUBMITTALS

- 1.26 General Submittal Requirements

- 1.26.1 Phase I Submittal shall be made in electronic format within (20) working days after the award of the contract by the District. This submittal shall include the following:
 - 1.26.2 Complete Bill of Materials in Excel Spreadsheet format with bills of quantities, including all materials, components, devices, and equipment required for the work. The bills of quantities shall be tabulated respective of each and every system as specified, and shall contain the following information for each Section listed:
 - 1.26.3 Description and quantity of each product.
 - 1.26.4 Manufacturer's Name and Model Number.
 - 1.26.5 Manufacturer's Specification Sheet or Cut Sheet. Material Cut Sheets shall provide detailed product information and shall be original manufacturer product bulletins. **Copies of material information from vendor websites shall not be considered equal and will not be excepted.**
 - 1.26.6 Material Cut Sheet part number provided shall be highlighted or provided with an arrow directed at the corresponding part number.
 - 1.26.7 Specification Item Number referenced for each required product or if not shown in the specifications, Drawing Detail Number being referenced. (ie; Spec. 271000 Item 2.1 or DWG E4.15/#1)
 - 1.26.8 Include with submittals all warranty information and a description of support and maintenance services to be provided. Also include all licenses and maintenance agreements required for continued operation of the equipment.
- 1.27 Phase II Submittal shall be provided within (20) working days after the approval of the Phase I submittals and prior to any fabrication or field conduit installations. All shop drawings shall be engineered in a CAD Software. Submission shall include electronic print copies to match the contract drawings, and Phase II submittals drawings shall include the following.
 - 1.27.1 MDF and IDF equipment rack or cabinet elevations will be required to be provided including cable routing, grounding, support, UPS, network electronics, etc. and position of all components in the rack or cabinet.
 - 1.27.2 Provide labeling plan which identifies the proposed scheme for identifying all components including Racks, patch panels (fiber and copper), site distribution feed cables, horizontal station cables and site conduit systems (handholes, pullboxes, etc.).
- 1.28 Common submittal mistakes which will result in submittals being rejected:
 - 1.28.1 Not including the qualifications of the installing Contractor Company and Contractor's Staff.

- 1.28.2 Not including all items listed in the above itemized description.
 - 1.28.3 Including catalog cut sheets which have several items on a page, and not clearly identifying by highlighting, underlining or clouding the items to be reviewed (provided for the project) or crossing out the items which are not applicable.
 - 1.28.4 Not including actual manufacturer's cut sheets or catalog information of proposed products.
 - 1.28.5 Do not provide website sales pages instead of Material Cut Sheets. Printing the entire web page with advertising and non-applicable items or information will not be acceptable.
 - 1.28.6 Do not include multiple manufacturers for similar products and do not indicate "or approved equal" or "to be determined later" statements. The products being submitted must be the products installed.
- 1.29 Component Samples and Mock-ups
- 1.29.1 Provide one full size installation sample mock-up of a normal wall faceplate for approval. All samples are to be fully labeled per these specifications. Samples are to be delivered to the Construction Manager's office on site prior to installation.
 - 1.29.2 All sample mock-ups are intended to represent the components that are to be installed as part of this project. They are to be provided with all associated components and labeling necessary to make up a complete mock-up. Installation shall not proceed until the Owner's Representative has approved the samples. Once samples and other documents have been submitted and inspected by the Owners Representative approved, they shall be retained. Any installation that does not meet this standard shall be replaced or re-worked as approved by the Owners' Representative at no cost to the project.
- 1.30 The Contractor shall make a written request directly to Johnson Consulting Engineers for electronic drawing files (CAD). As a part of the written request, please include the following information:
- 1.30.1 Clearly indicate Project Name and Client, Johnson Consulting Job Number (located in bottom left corner of JCE Engineering Stamp) and each drawing Sheet Number required (i.e., E1.1, E2.1, E4.1 etc.).
 - 1.30.2 Identify the name, Company, Title, phone number, mailing address and e-mail address of the person to receive the files.
 - 1.30.3 Detail or Riser diagram sheets, System Schematic drawings or any other drawings other than floor plans or site plans, will not be made available to the Contractor.

- 1.30.4 Files will only be provided in the AutoCAD format in which they were created (i.e., version 2015 or version 2016). Files will not be made available in REVIT format.
- 1.31 Requests for files will be processed as soon as possible; a minimum of (7) working days should be the normal processing time. The Contractor shall be completely responsible for requesting the files in time for their use and delays in requesting files will not alleviate the Contractor from submitting required documents within the required timeline.
- 1.32 Contractor shall be responsible for the complete provision and installation of all components as specified herein. The Contractor shall provide all tools, equipment, fixtures, appliances, ancillary piece parts and hardware as necessary to complete the assembly and installation as requested. The Owner's Representative may conduct scheduled or unscheduled inspections of the Contractor's work at any time during construction. All work included in the scope assigned to the Contractor that is associated with this project shall be accomplished in a workmanlike manner, installed and assembled plumb, level and square. The product shall be delivered to the Owner finished complete, and ready to operate according to the manufacturer's specifications.
- 1.33 All installation work shall be completed to the standard of the samples approved by the Owner's Representative during the submittal process. Any products not installed to the quality detailed in these specifications and approved in the submittal process shall be reworked by the Installer to the satisfaction of the Owners Representative at no additional cost to the Owner.
- 1.34 Products as manufactured by "Extron" have been specified to coordinate with an existing facility and other contracts to be issued for this project. Alternate products will not be approved.

SEISMIC ANCHORING

- 1.35 All sound systems, A/V equipment or enclosures shall be anchored to the structure. Where details have not been provided on the drawings, anchorage shall comply with CBC Section 1632A and Table 16-A0. The Contractor shall submit drawings signed by the Contractor's registered structural engineer indicating method of compliance prior installation.

CLEANUP

- 1.36 In addition to cleanup specified under other sections, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any spattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- 1.37 Use steel brushes on exposed metal work to carefully remove rust, etc., and leave smooth and clean.
- 1.38 During the progress of the work, keep the premises clean and free of debris.

GENERAL COORDINATION

- 1.39 The A/V drawings may reference components by manufacturer which conflict with the written specification requirements, where this occurs the written specifications shall be followed.
- 1.40 The 27 20 00 Contractor shall actively coordinate all power requirements for the Audio-Visual Systems with the Division 26 Electrical Contractor. The 27 20 00 Contractor shall coordinate the placement of the electrical outlets and hard-wired power connections at projectors, AV Systems cabinets and other equipment, with the Division 26 Contractor to determine the exact placement of the power. Outlet placement in many of the applications is critical to the space requirements and power cord length of the equipment or devices being installed.
- 1.41 Warranty: All components and installation, shall be warranted by the Contractor to the School District for a period of **2-years** after District acceptance and sign-off of the completed system. With the exception of the following equipment that shall be provided with longer warranties as noted;
- 1.41.1 **Provide a (3) three year warranty for all projectors provided for the project.** Provide additional warranty coverage if the projector is not already warranted for at least three years by the manufacturer. Contractor warranty is not considered equivalent to a manufacturer warranty.
- 1.42 Contractor shall provide a spreadsheet for the District provided asset tags for all newly installed AV equipment. Contractor shall provide the populated tag list at the end of the projector as part of their turn-over documents.
- 1.43 Contractor shall coordinate assignment of ALL installed IP addressable equipment. The District will provide a list of available IP addresses based of Contractors device count. Contractor shall provide a spreadsheet containing the IP and MAC addresses as well as each particular device location. This list shall also contain the Switch Port Number, and Label Description.
- 1.44 See the example below:

Room #	Device	IP (Static)	MAC	WallJack Label	Switch #	Switch Port		IDF#
								Switch # - (From top to bottom - 1,2,3, ...- use A,B,C.. in label) Switch Port - (1 - 48)
2014	Extron	10.63.155.159	0000.0322.a32b	A1-A04	1	4	Example	IDF A1 -- Top Switch (A) -- Port 4
123	Extron	10.63.155.152	0000.0322.aabb	C1-B24	2	24	Example	IDF C1 -- 2nd Switch down in stack (B) -- Port 24
2201	Cisco AP	dhcp	0012.aaaa.12ab	A2-C35	3	35	Example	IDF A2 -- 3rd Switch down in stack (C) -- Port 35
2202	<device>	dhcp	0012.aa4a.12ab	A2-C36	3	36	Example	IDF A2 -- 3rd Switch down in stack (C) -- Port 36

PART 2 — PRODUCTS

General Classroom Audio-Video Requirements:

- 2.1 The Contractor shall refer to the Audio/Video Patch Cable section of this specification for the descriptions of the type and style of patch cable to be furnished for the different Audio-Visual and data patch cable connections. Patch Cable Section includes the different requirements for cable runs based on length and style of connector. HDMI cables shall be

furnished as outlined in this section and based on the length of the cable, the model of HDMI cable required will vary. Individual patch cord specifications are not shown in the room system descriptions, only the type of cable required will be shown.

- 2.2 Contractor shall furnish and install all Audio-Visual system components as shown in the A/V system details and these specifications. Refer to the Audio-Visual System Diagram for additional information. The drawing details and specifications shall be considered as one overall document. Contractor shall provide all systems as complete turn-key operational Audio-Visual systems.
- 2.3 Provide installation of projectors with audio/video components and all local wiring. Projectors shall be located per the drawings and specifications.
 - 2.3.1 Projectors shall be furnished and installed by the Contractor. Coordinate exact model or manufacturer to be used to insure compatibility with A/V system drawings.
- 2.4 Each Classroom AV System shall be furnished with a Projector at the front of the classroom in the location shown on the floor plans. The Projectors shall serve at the presentation location within the classroom for all video. The Projector will be connected to the Classroom AV Switch in the AV Enclosure. All audio will be routed to the system speakers.
- 2.5 Provide installation of projectors with audio/video components and all local wiring. Projectors shall be located per the drawings and specifications.
 - 2.5.1 Projectors shall be furnished and installed by the Contractor. Coordinate exact model or manufacturer to be used to insure compatibility with A/V system drawings. Digital projectors must be able to fill, per the manufacturer's recommended image size at 100% of all projector performance capabilities, a 119" diagonal screen (16:9 aspect ratio). Throw distance shall not exceed 54" from the surface of the projection screen. Projectors shall be the non-interactive type.
 - 2.5.2 **Provide lump sum of \$55,000 for the purchase of (11) short throw, non-interactive laser digital projectors.** Lump sum amount shall cover projector and lens invoice cost only plus tax. Shipping, contractor mark-up, profit and overhead, installation & programming set-up, and all mounting hardware, labor costs and demonstration shoot out shall be included as part of the contractor bid and not part of the lump sum. Actual make and model of projectors will be determined prior to installation and shall be approved by the Project Engineer prior to purchase.
 - 2.5.3 Prior to purchase of the projectors, Contractor shall submit an itemized spreadsheet to the Project Engineer, Architect, Construction Manager and District Project Manager for the projectors being proposed for purchase including the following information; Make, Model, Lumen Output Rating, Native Resolution, Lens Model and Throw Ratio, Invoice Cost and Tax. The proposed projector submittal shall include manufacturer cut sheets for each type and size of

each model submitted, with proper part numbers highlighted. Each type of proposed projector shall be submitted with a copy of the projector calculator showing the foot lambert rating for the image on the 119" screen. The spreadsheet shall be provided to the Construction Team a minimum of 12 weeks prior to the first proposed purchase date to allow enough time for approval, purchase and delivery of the projectors. The Contractor shall not proceed with purchase or warehousing of the equipment without written approval.

- 2.6 Provide installation of projection screens for the Classroom Audio-Visual Systems. The projection screens will all be electric type screens and shall be furnished with the optional Wireless RF Remote Control. Installation shall include all low voltage connectivity and power requirements. Projection screens shall be located per the drawings.
 - 2.6.1 Contractor shall provide all hardware and structural support including, but not limited to, channel strut, brackets and hardware. Power shall be furnished by the Division 26 Contractor. All screens must be installed to comply with local codes and Zone 4 Seismic requirements.
 - 2.6.2 All new projection screens will require a structural support mechanism to the building structure. The basic requirements will be shown in the detail drawings, but the exact requirements must be field verified by the Contractor. Contractor shall refer to the drawing details for the type of structural support system to be provided based on the type of screen used and the building conditions. The Contractor shall furnish and install all support.
 - 2.6.3 All screens shall be electric tab-tensioned. Coordinate the screen's location with the installation of the projectors. The location of both the projector and screen must be properly coordinated to insure the proper image size and orientation. Projector and screen locations shown on the floor plans are diagrammatical. Exact locations must be field verified by the Contractor prior to the installation of either component
- 2.7 **Provide each Classroom AV System with an RF-based Extron Voicelift Pro Voice Amplification System.** Provide each system with (2) pendant hung microphones, Model #VLM 3002. Each system shall be connected to the PoleVault switch in the AV Enclosure location. Provide RF sensor with system installed in the Audio-Visual system enclosure. See A/V diagrams for additional requirements.
- 2.8 Provide each Classroom AV System with an ADA Assistive Listening System Transmitter. Receivers shall be provided as detailed in the specification's ADA Assistive Listening System Receivers and Spare Parts Section. Provide system components as manufactured by Listen Technologies or approved equal.
 - 2.8.1 Each classroom shall be furnished with an ADA transmitter at the front of the classroom, unless otherwise shown. The transmitter shall be connected to the line level output from the AV switcher. Provide the audio cable connection from the AV Switch to the ADA Transmitter. The ADA transmitter shall be provided for each Classroom AV System.

2.8.2 Install the ADA system IR Radiator at the front of the classroom just below the accessible ceiling. Mount radiator securely to the wall and aim for proper coverage of the room. Refer to the manufacturer's installation instructions for additional information. Set the transmitter for the proper frequency and set the level output as shown in the manufacturer's instructions. Provide (1) Stationary IR Transmitter/Radiator Combo – Model LT-84-01 for each Classroom AV System.

3

2.9 Document Camera, Computer and Monitors units shall be furnished by the District and installed by the District.

2.10 The Classroom AV System's speakers shall serve as the campus paging devices as well as being used for local input amplification. The Contractor shall provide the Extron IP-Based Paging Module for each of the systems and shall furnish and install the Extron GlobalViewer Campus Communication Suite Control software. The IP-Paging software suite shall be provided with a dedicated server installed in the existing Campus MDF Room. Refer to the specifications below for requirements.

2.11 Provide Extron Global Configurator Plus and Global Configurator Professional software to be used to program all system components and all of the different types of systems installations. The Contractor shall include programming of all assets in each room system and the entire school site controls into the software from the central server location. The programming shall include assigning IP addresses, coordinate all IP addresses with the District IT Department.

Standard Classroom Audio-Video Requirements:

2.12 Classroom Audio-Visual Systems shall be provided for the Standard Classroom spaces in the new Classroom Addition Building. Contractor shall furnish and install all system components as shown in the A/V system details and specifications. Provide Extron Digital PoleVault Audio-Visual System. Refer to detail drawings and diagrams for exact installation configuration and required parts.

2.13 Short Throw Projector shall be placed in the following manner to ensure the proper distance from the screen surface; 1) Projector must be positioned in the center of the surface area and 2) the image shall fit the screen size exactly at the proper aspect ratio. Coordinate with other trades and the Project Engineer to insure proper placement of the projector.

2.13.1 Projectors shall be furnished and installed by the Contractor. Short throw projectors must be able to fill a 119" diagonal screen or surface (16:9 aspect ratio) from a distance not greater than 80" from the surface. Projectors shall be a non-interactive type. Contractor shall be responsible for furnishing and installing the all software, tools and control systems as required by the manufacturer for proper operation. Each of the projection systems must be properly calibrated during the installation process to allow for the images and inputs to be presented properly.

3

- 2.13.2 **Special Set-Up and Testing Requirements** - Contractor shall provide installation of the specified projectors, so that the image shall fit the screen's designated image area and aspect ratio, without the use of the keystone (0% keystone requirement), image shift (Vertical and Horizontal) and zoom functions, or modification of the calibration settings. The image shall not be artificially manipulated to allow the image to fit the screen due to the placement of the projector mount or projector.
- 2.13.3 **Projector must be installed level.** The projector may not be tilted to achieve the proper image area throw coverage on the screen or use manual shift/keystone functions on the projector to compensate for the distortion caused by the projector being tilted. The Contractor must use the correct length pole on the mount to achieve the proper image throw, regardless of the pole provided with the ceiling mount kit. Contractor shall be responsible for determining the correct length 1-1/2" NPT pole prior to installation of the projector.
- 2.14 Teacher's interface wall plates; Each classroom shall be furnished with (1) input wallplate location. The Teacher's PC will serve as the main interconnection device to the system. Provide all patch cables for the system. See Classroom A/V diagrams for wall plate and other system component requirements. Provide the following interfaces at the Teacher's wallplate;
- 2.14.1 Provide (1) dual HDMI input digital wallplate at the Teacher's Interface (LO) location (See AV Diagram); The Teacher's wallplate shall be provide a total of (2) separate HDMI inputs to the Digital Polevault switch. See the A/V diagram for wallplate requirements. Provide (1) Extron PVT HDMI Decora Style wallplate.
- 2.14.2 Wallplate shall be white in color, unless otherwise noted, Extron Decora style, with color matched screws. The wallplate requires a dual gang box and trim ring. The input wallplate shall be furnished with a 3-Port data outlet furnished by the 27 10 00 Contractor. Coordinate with the 27 10 00 Contractor for data requirements.
- 2.14.3 Contractor shall provide a single Extron Cat-X cable from the wallplate to the PoleVault switch in the Ceiling AV Enclosure. No other cable will be considered equal.
- 2.14.4 Contractor shall furnish and install (2) 12-foot HDMI patch cables at the Main Teacher's Interface wallplate. All HDMI patch cables shall be factory manufactured. Contractor shall provide patch cable connections to the Teacher's PC/Laptop and Document Camera from the wallplate. Refer to patch cable section for requirements.
- 2.15 Provide Extron Model MLC Plus 200 Control Panel, designated with an (LC) Local Control symbol on the drawings.
- 2.15.1 MLC Control Panel shall be connected to the 12VDC power supply at the AV Enclosure location, a relay connection for the electric screen Up/Down functions

and an RS-232 connection from MLC Control Panel to the ceiling mounted projector.

- 2.15.2 Provide (1) Category-6 patch cable from the AV Switch in the ceiling enclosure to the MLC Plus Control Panel location in the classroom where shown on the floor plans. Provide length of patch cable as required. Patch cable lengths over 25 feet must be constructed of solid conductor cable. Stranded conductor cable will not be accepted. All cables must be factory manufactured. Field constructed or modified cables will not be accepted. Refer to patch cable section for requirements.
 - 2.15.3 Program Teacher's PC or Laptop Computer to show a quick link on screen for emulation of the MLC Control Panel buttons and functions. Teacher shall be able to control input access and screen functions from either the Control Panel or the PC/Laptop. Teacher shall be able to access the control panel function with a single APP quicklink.
 - 2.15.4 Designate buttons on MLC Control Panel for both HDMI inputs. Inputs shall be labeled as follows; HDMI Input #1 – Computer 1, HDMI Input #2 – Document Camera. All inputs on the wallplates shall be labeled with the same designations as shown on the MLC Control Panel. Confirm all labeling requirements with the District IT Department prior to installing the MLC Control Panels.
- 2.16 Contractor shall provide a ceiling mounted audio-visual enclosure for the rooms with an accessible ceiling. Provide Extron Digital PVS 407D IP 4-Input switcher/amplifier in the ceiling mounted enclosure. The components do not have to be plenum rated or the enclosure sealed, as the ceiling is not a plenum environment. The Ceiling enclosure, Model #PVM 220, shall be installed in the accessible ceiling at the location shown on the floor plans. Confirm typical placement of the enclosure with the Project Engineer prior to installation of any AV cabling.
- 2.16.1 Each ceiling enclosure will be provided with a 3-port data outlet on a 4-Port surface jack inside the enclosure by the 27 10 00 Contractor. Coordinate location of the data outlet with the 27 10 00 Contractor.
 - 2.16.2 Provide 6-outlet surge suppressor at each AV enclosure for power connections inside the enclosure. Provide Cyber Power Model #CSB600WS or approved equal.
 - 2.16.3 Each enclosure shall be hard-wired with power connection by the Division 26 Contractor. Coordinate the location and electrical connection with the Division 26 Contractor.
 - 2.16.4 All of the enclosures will house the AV switcher as well as the power supply for the ADA Assistive Listening System Transmitter, WePresent Interactive Device, MLC Control Panel and IP Page Controller device. The Contractor may elect to provide a 12DVC Power Supply Brick in lieu of separate power supplies inside the enclosure.



- 2.17 Provide (1) 2-foot long, Category-6 patch cable from the data outlet in the enclosure to the input Ethernet Port #1 on the AV switch. The incoming network connection must be connected to Ethernet Port #1 on the AV Switch. Color of patch cable TBD by the District IT Department. Refer to patch cable section for patch cable requirements.
- 2.18 Contractor shall furnish and install (1) HDMI cable from the PoleVault switch to ceiling mounted projector. All HDMI patch cables shall be factory manufactured. Contractor shall provide length of cable as required. Refer to patch cable section for patch cable requirements.
- 2.19 Extron Model #FF120 Flat Field ceiling speakers shall be furnished in rooms with accessible ceilings. Standard classrooms are to be provided with (4) speakers. Confirm quantity of speakers as shown on the floor plans for each room. Color of speakers shall be white.
- 2.19.1 Speakers shall be provided with a minimum 18AWG speaker wire to the AV switch or Amplifier.
- 2.20 Provide Interactive Collaboration Device above ceiling mounted AV Enclosure. Provide Velcro ties and sticky back holders for the attachment of the interactive device to the top of the enclosure. Classroom Audio-Visual System design based on the use of a WePresent Interactive Collaboration device. Final device choice will be made by the District IT Director.
- 2.21 **Provide lump sum of \$7,200 for the purchase of (11) Interactive Collaboration Devices.** Lump sum amount shall cover Interactive Collaboration Device invoice cost only plus tax. Shipping, contractor mark-up, profit and overhead, installation & programming set-up, all mounting hardware and labor costs shall be included as part of the contractor bid and not part of the lump sum. Actual make and model of Interactive Collaboration Devices will be determined prior to installation and shall be approved by the District IT Director and the Project Engineer prior to purchase.
- 2.21.1 Interactive Collaboration Device HDMI video output shall be routed to one of the direct HDMI inputs on the 4-Port HDMI Switch. The audio output shall follow the video through the HDMI port to the AV Switch. Program system to allow audio to follow the video from the Interactive Collaboration Device. Provide a high-speed HDMI patch cable for the video output from the Interactive Collaboration Device to the AV Switch. All HDMI patch cables shall be factory manufactured. Contractor shall provide length of cable as required. Refer to patch cable section for patch cable requirements
- 2.21.2 Provide (1) 4-foot long, Category-6 patch cable from the data outlet in the enclosure to the Interactive Collaboration Device. Color of patch cable TBD by the District IT Department. Refer to patch cable section for patch cable requirements.
- 2.21.3 The Interactive Collaboration Device shall be set-up to allow for users to access the system remotely. Each system shall be set-up with a different access code each time the system is initiated. Contractor shall be responsible for

programming the access of the Interactive Collaboration Device from the Control Panel.

- 2.21.4 Separate Training for use of the Interactive Collaboration Device shall be provided to the High School Teaching Staff set to occupy the classrooms. The Contractor shall allow for a separate training service from the overall training requirement, for the operation of the Interactive Collaboration Device capabilities. Coordinate with the High School's Administration and Staff to schedule the training. Provide a minimum of 4-hours training for a minimum of (10) Staff Teaching Personnel. Contractor may be required to provide training in multiple sessions to accommodate all of the Teachers. Provide the number of training sessions as required to train all of the Teachers scheduled to occupy the classrooms in the new building.
- 2.22 Provide each Classroom AV System with an Extron Voicelift Pro Voice Amplification System.
 - 2.22.1 Provide Microphone RF Receiver Model #VLR302 with system installed in the Audio-Visual System ceiling enclosure adjacent to the Projector at the front of the classroom. Provide each system with (2) pendant hung microphones, Model #VLP 302 with charging base Model #VLC302. Charging Base shall be provided at the Teacher's Desk location in each classroom.
- 2.23 Provide electric front projection, tab-tensioned screen at the front of the classroom where shown on the drawings. Contractor shall provide all hardware including, but not limited to, beam clamps, hardware, support systems and mounting brackets. The projection screen shall be mounted recessed above the accessible ceiling.
 - 2.23.1 **Wall mounting the screen case below the ceiling shall not be accepted as an alternate mounting method.** The screen case must be mounted above the ceiling using the ceiling trim kit.
 - 2.23.2 Coordinate the screen location with the installation of the projector. Screen shall be mounted to allow for the projector to be mounted with the proper image drop of the screen's usable image area or with a drop as recommended by the manufacturer's throw calculator. Screen must be aligned with projector to create the proper image size and orientation.
 - 2.23.3 Mount screen to the structural members of the ceiling area above the screen. The structural support members are above the screen in the accessible ceiling. Additional structural support shall be furnished and installed by the Contractor. The support of the screens may require a unistrut support system to be constructed or additional bracing members to be installed between the building support members. Contractor to field verify the exact conditions prior to installation of the screen.
 - 2.23.4 The electric projection screen shall be furnished with the Draper Optional Ceiling Opening Trim Kit. Refer to the Ceiling Opening Trim Kit installation instructions

from the manufacturer and the detail drawings for complete installation requirements.

- 2.23.5 Draper Model “Premier” electric tab-tensioned projection screen, 58” High by 104” Wide by 119” Diagonal at 16:9 aspect ratio loaded with front projection screen surface by Draper Model “TecVision XT1000X” with a 1.0 Gain and 180-Degree Viewing Cone.
- 2.23.6 Provide black out drop at the top of the screen as required to allow for the proper image size and location. The amount of black out drop used at the top of the screen may not exceed 12”. Field verify dimensions and black-out requirements prior to ordering the screen. Image area shall begin at the top of the screen, based on the throw coverage of the projector. The actual quantity of screen drop required for viewing shall be adjusted and pre-set to drop the exact same distance each time the screen is activated. All screens must have the preset distance for the blackout area set for both the RF Remote Control and MLC Control Panel operation.
- 2.23.7 Provide RS-232 Low Voltage Control module option for remote control of the screen from the PoleVault switch. Provide cabling from the screen control module to the MLC Control Panel location in the classroom. See the floor plans for further information. The screen shall be controlled from the MLC Control Panel or from the Extron APP. Provide programming and wiring connections to allow for screen up/down, on/off controls from the MLC Control Panel. Provide Draper Model LVC-IV Control Module (In Screen Case). Module shall extend the length of the screen case per manufacturer’s specifications.
- 2.23.8 Provide any additional items as shown on the A/V wiring details and diagrams

Classroom VoiceLift Pro Amplification System Spare Parts

- 2.24 Provide the following spare parts for the Voicelift systems for the classrooms;
 - 2.24.1 Provide (1) spare RF Microphone Receivers, Model #VLR 302
 - 2.24.2 Provide (2) spare pendant hung microphones, Model #VLP 302
 - 2.24.3 Provide (8) spare ‘AA” NiMH 2400 mAh rechargeable batteries
 - 2.24.4 Provide (2) spare Dual Charging stations, Model #VLC 302.
 - 2.24.5 Deliver all microphones and components to the School District Facilities Department. Contractor shall be required to produce a signed copy of the materials receipt by the District Facilities Director or the District Project Manager.

ADA Assistive Listening System Receivers and Spare Parts

- 2.25 The new Classroom Building shall be provided with a set quantity of ADA receivers to be shared among all classrooms. Provide the following quantities of receivers and accessories for new Building Classroom Section;
- 2.25.1 Provide a total of (8) IR Lanyard 4-Channel Receivers, Listen Technologies Model LR-5200-IR-P1 Receivers with integrated neck loop/lanyard and universal ear speakers for each section. Receivers shall be furnished with Lithium Ion battery.
 - 2.25.2 Provide (3) Signage Kits – Model LA-304 Assistive Listening Notification Signage for each section. The signage shall be installed at each of the common entrance areas to the classroom building. Coordinate the exact placement of the signs with the District IT Director and the Architect.
 - 2.25.3 Provide (1) Intelligent 12-Unit hard sided charging/storage case – Model LA-380, for charging and storage of the receivers, ear speakers and neck loops.
 - 2.25.4 Deliver Charging Case and all components as a complete set to the School Administrative Department. Contractor shall be required to produce a signed copy of the materials receipt by the High School Principal or the District Project Manager.
- 2.26 Provide the following quantities of spare ALS receivers and accessories for the Classroom Audio-Visual Systems included in the Section 27 20 00 specification. Spares will be delivered with the rest of the system components;
- 2.26.1 Provide (5) Lithium Ion spare rechargeable batteries, Model LA-365.
 - 2.26.2 Provide (2) Signage Kits – Model LA-304 Assistive Listening Notification Signage.
 - 2.26.3 Contractor shall be required to produce a signed copy of the materials receipt by the District Facilities Director or the District Project Manager.

Audio/Video Patch Cables

- 2.27 All patch cables must be factory manufactured. Cables may not be field modified or altered. Length of cable shall be as required by the specification section. If length is not specified, the cables shall be the nearest factory manufactured length above the minimum distance required.
- 2.27.1 Audio Cable Assemblies 25-feet in length or less; All 3.5mm stereo audio cable assemblies shall be a male to male cable fully shielded cable with 3.5mm bayonet style connectors. Extron Mini Audio Cables Series or equal. Provide minimum length of 6 feet.
 - 2.27.2 HDMI Patch Cables 3-feet in length or less; All HDMI patch cables must be 4K verified and must conform to the HDMI High-Speed cable standards. Patch cable shall be Extron HDMI Micro Series High-Speed, ultra-flexible patch cables.

Length of patch cable shall be either 3 feet or 1.5 feet as required for proper operation.

2.27.3 HDMI Patch Cables 6-feet to 15-feet in length; All HDMI patch cables must be 4K/30 verified and must conform to the Extron HDMI 4K Premium (6-12 feet) and Extron HDMI 4K High-Speed (15 feet) ultra-flexible cable standards. Patch cables shall be Extron HDMI Ultra Series patch cables. Length of patch cable shall be as required for proper operation.

2.27.4 HDMI Cable Assemblies for the Teacher's wallplate location - 12 feet in length; All HDMI patch cables must be 4K/30 verified and must conform to the HDMI Premium and High-Speed cable standards. Cables shall be furnished with 180o swivel head design, Vanco Pro Digital High-Speed HDMI Swivel cable, UL and CL3 rated.

2.27.5 Category-6 Patch Cables 25-feet or Less; Category-6 UTP patch cables shall be as manufactured by Leviton or Commscope or approved equal. Patch cables shall be provided with standard patch cable material.

2.27.6 All patch cables shall be provided for each type of connection required to provide a complete and operational system. All patch cables shall be factory manufactured.

3

Campus IP-Based Paging System Requirements

- 2.28 **Contractor shall furnish and install the Extron GlobalViewer Campus Communication Suite IP-Based Paging System software (No Approved Equal), server and interface devices to connect to the Classroom AV Systems and analog paging speakers provided by the 27 10 00 Contractor. The system shall be connected to the existing High School LAN via the network switches provided by the District IT Department. The Contractor shall coordinate with both the 27 10 00 Contractor and District IT Department to insure a seamless integration of the IP-Based Paging System with the existing campus systems.**
- 2.29 **The speakers for the Classroom AV Systems shall serve as the paging component for general paging applications in the classrooms. Program the Classroom AV Systems for priority over-ride when a campus page is activated the local inputs are muted on the system. The page shall be routed to the classroom speakers. The PoleVault AV Switch shall be programmed to allow paging applications over the AV Sound System.**
- 2.30 **Contractor shall install the Extron IP-Based paging interface devices, Model #CC 100C, in the IDF Room at the equipment rack, provided by the 27 10 00 Contractor, for the Common Interior and Exterior Paging Zones connections. The Model #CC 100C interface devices shall be installed on the shelf in the equipment rack Provide (1) One Model #CC 100C interface device for each Page Zone. There shall be (2) Two Page Zones per building, One for the Interior Paging Speakers and One for the Exterior Paging Horns provided by the 27 10 00 Contractor. Order interface devices to be powered from a POE Ethernet port on the network switches.**

- 2.31 The connection from the “line out” terminal on the IP-Based paging interface devices to the amplifier input terminals shall be provided by the 27 20 00 Contractor.
- 2.32 The network connection to the campus LAN shall be provided by the 27 20 00 Contractor. Provide (2) Category-6 patch cables from the Model #CC 100C interface devices to the Network switches provided by the District IT Department. The devices must be connected to a POE powered Ethernet port on the switches. Color of patch cable TBD by the District IT Department. Length of patch cable shall be as required to connect to the network switch in the rack. Refer to patch cable section for patch cable requirements.
- 2.33 Contractor shall coordinate the IP Addresses for the Extron IP-Based paging interface devices in the IDF Room with the District IT Department. Set the IP-Addresses and line level output type from the interface device to the amplifier. Coordinate the audio output
- 2.34 Contractor shall furnish and install a dedicated server in the MDF Room for the IP-Based Paging System. Extron GlobalViewer Campus Communication Suite IP-Based Paging System software shall be loaded on the rack mounted server for the new IP Paging System. Provide server with the following minimum requirements:
- 2.34.1 Provide Dell Poweredge R340 rack mount server or approved equal. Minimum server configuration: Intel Xeon E-2124 3.3Ghz, 8M Cache, Turbo, 4-Core/4-Thread, 71 W processor; 16GB 2666MT/s DDR4 ECC UDIMM, Memory; 64 Bit Windows Server 2019 Essentials Edition OS; Microsoft IIS; Microsoft.NET 4.5; On Board Broadcom 5720 Dual Port 1 GB LOM Ethernet Interface; 1TB 7.2K RPM Sata 6Gbps 512N 3.5 “Hot Plug Hard Drive; 3.4” Chassis for up to (4) Hot plug hard drives: Dual Hot Plug 350W redundant power supplies; Nema 5-15P, 15-amp, 10-foot power cord; “ready Rails” static muting rails for 2 or 4 Post Rack; DVD +/RW Sata internal drive; USB keyboard and Optical Mouse.
- 2.34.2 Contractor shall install (2) Extron IP-Based paging interface device, Model #CC 100C, at the Server location in the existing Campus MDF Room, for the VOIP System connection to the Paging System. The Model #CC 100C interface device shall be installed on the shelf in the existing equipment rack. Order interface device to be powered from a POE Ethernet port on the network switches.
- 2.34.3 The connection from the “line out” terminal on the IP-Based paging interface devices to the Server’s 3.5mm Audio Input terminal shall be provided by the 27 20 00 Contractor. Provide a 3.5mm Audio patch cable, length as required, for the connection to the Server.
- 2.34.4 The network connection to the campus LAN shall be provided by the 27 20 00 Contractor. Provide (1) Category-6 patch cable from the Model #CC 100C interface device to the Network switches provided by the District IT Department. The device must be connected to a POE powered Ethernet port on the switches. Color of patch cable TBD by the District IT Department.

Length of patch cable shall be as required to connect to the network switch in the rack. Refer to patch cable section for patch cable requirements.

2.34.5 Provide a DisplayPort Patch Cable to connect the new Paging Server to the existing rack mounted LCD Monitor and KVM switch combination in the MDF Racks. Provide a DisplayPort patch cable, length as required, for the connection to the KVM Switch.

2.34.6 Contractor shall receive written confirmation of the server requirements with the District IT Director prior to ordering. Approval of the project submittals does not provide the Contractor approval of server for ordering purposes. Final server configuration shall be approved in writing with a copy submitted to the construction manager and project engineer. If the Server model is out-of-production or discontinued, the Contractor shall provide the manufacturer's recommended replacement with at least an equivalent for the minimum server requirements as stated in the specifications provided.

2.34.7 Contractor shall furnish and install the server in the existing MDF Room equipment racks or at the location designated by the District IT Department. Connect the server to the School's LAN network switch as designated by the District. Coordinate the installation and set-up with the District IT Department and the local IT support personnel.

2.35 Provide IP-Based Paging software for the project. The software shall be loaded on the Contractor furnished server. Contractor shall provide all programming for the paging announcements, pre-recorded emergency announcements and pass class bell notifications. Coordinate the pass class bell schedules and desired paging tone to be used with the District IT Department and the Site Principal. Software shall be as manufactured by Extron GlobalViewer Campus Communication Suite IP-Based Paging System software (No Approved Equal) platform. Provide latest version of software available at the time of installation.

2.35.1 Contractor shall furnish Link Licenses for the Extron IP-Paging System activation to interface with the Extron PoleVault PVS Switches. The switches shall serve as the interface in the Classrooms for paging capability via the AV System speakers.

2.35.2 Contractor shall interface the IP-Paging software with the District's VoIP call management software program. Provide all programming information required to allow the District to set the parameters for access to the existing call management software. Provide (1) Extron #CC 100C

2.35.3 Contractor is responsible for providing all licensing requirements and software updates (as required to bring product up to date) to drive the Classroom AV Systems PoleVault switches, IP-Based paging interface devices, speakers, horns, program tones, bell schedules and announcement controls.

2.35.4 Programming of speakers and horns for page coverage zones, tones, time schedules, pass class bell, pre-recorded emergency announcements and VoIP interface to be completed by the Contractor. The District will be responsible for providing IP addressing to the Contractor for the network to identify all system IP devices.

2.35.5 Contractor's responsible for providing MAC addressing and identification of Classroom AV Systems PoleVault switches, IP-Based paging interface devices or any other IP based device in the system. Provide spreadsheet list to the District IT department.

2.35.6 Contractor to provide a minimum of 6-hours of meeting time with the District to confirm all programming requirements. The Contractor shall provide Meeting Minutes and proposed bell schedules, access control codes, pre-recorded message requirements and proposed bell tones to the District and the Project Engineer for approval. Contractor shall not program system until programming proposals have been approved

Portable Systems

- 2.36 Contractor shall furnish (1) Portable ADA Assistive Listening Systems Kits that may be used for Conference Rooms or other small meeting spaces. The portable system is currently designated for use in Room D101 in the New Classroom Building.
- 2.37 Portable Equipment shall be furnished and spares supplied to the designated representative of the Client, along with complete documentation of the materials provided. Where applicable, deliver portable equipment in the original manufacturer's supplied packaging.
- 2.38 Contractor shall furnish (1) Portable ADA Assistive Listening Systems Kits that may be used for Conference Rooms or other small meeting spaces. The portable system is currently designated for use in Room D101 in the New Classroom Building.
- 2.38.1 Provide for each Kit; A self-contained portable wireless FM transmitter and receivers inside a self-contained carrying case. Portable ADA Assistive Listening system shall be as manufactured by Williams Sound Corporation, Phone 1-800-843-3544. Provide self-contained FM based system Model #FM ADA Kit 37 RCH. System kit shall contain the following items;
- 2.38.1.1 (1) PPA T46 transmitter, (4) PPA R37 receivers, (4) HED 027 headphones, (1) MIC 090 Mini Lavalier microphone, (1) MIC 049 conference microphone, (1) CCS 029 carrying case, (1) NKL 001 neck loop receiver, (1) ADA wall plaque and (5) BAT 026-2 "AA" batteries.

Training

- 2.39 **Contractor will provide a minimum of 12 clock hours of on-site training for site Technical and Administrative/Teaching Staff on the Classroom A/V systems.**

Training for personnel shall be provided by certified technology specialists. The scope of training shall encompass system operation and procedures. Technician training should include an integrated information overview, media retrieval procedures as well as operation procedures for local control configurations. The Contractor shall provide a detailed written outline clearly describing the proposed plan for all training, for approval by the Engineer and Owner's representative. Contractor shall submit at training schedule to the District to coordinate which District Technical staff shall be trained.

2.39.1 Training for Teaching and Administrative Staff shall include basic system concepts. Faculty and staff shall be taught how to power on/off the system, control volume, access inputs, attach microphones, replace batteries, and test system for basic operations and all other operational requirements for daily use of the systems. Training shall include use and operation of audio devices, techniques and troubleshooting tips. Trainers shall incorporate hands-on techniques to maximize staff opportunity to incorporate into their curriculum that is both meaningful and targeted for their student needs. Clearly written support materials should be provided to all training participants. Manual describing operation and use of the system shall also be provided.

2.39.2 Contractor shall provide on-site AV training from Extron by an Extron Trainer for the Technical Staff covering all the Extron components in the systems. All System Types - Contractor shall videotape at least (1) training session per each type of Classroom Audio-Visual System, in High Definition Video (1080p format), and save to a flash drive to turn over to the District. Training video shall be retained as property of the District.

2.40 Trainers shall provide Site or District Technicians with an in-depth technical overview of sound system equipment. Training should include basic overview of all equipment manuals and troubleshooting concepts. Site and District Technicians will be trained to provide setup, operation and application of sound systems. Technicians shall be instructed in the proper operation to replace all components of the sound systems. Clearly written documentation and support materials must be provided for each system. Provide support materials in a three-ring binder clearly for each system. A training manual describing operation and use of the system shall also be provided.

PART 3 - INSTALLATION AND EXECUTION

3.1 Verify that all electrical requirements including junction boxes, empty conduit and power circuits and receptacles are in place as shown on the drawings.

3.2 Receive, check, unload, handle, store, and adequately protect equipment and materials to be installed as part of the contract. Store in areas as directed by the owner's representative. Include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other related work whether or not expressly defined herein.

3.3 Installation practices shall follow "standard broadcast wiring" and installation practices, as excerpted from "Recommended Wiring Practices, "Sound System Engineering", (2nd

Edition) D. Davis, and Performed to the highest standards of acknowledged industry practices. Upon request the A/V Contractor shall furnish all equipment and labor to verify the compliance with the following:

Optical:

- 3.3.1 Center to corner light fall off shall be less than 50% for video/data projectors.
- 3.3.2 Center to corner light fall off shall be less than 35% for optical projectors.
- 3.3.3 Images shall be level and square with the appropriate aspect ratio.
- 3.3.4 Image shall be free from visible vibration.

Audio System:

- 3.3.5 Signal-to-noise ratio (including crosstalk): 55-dB minimum.
- 3.3.6 Total harmonic distortion: 0.1% maximum from 30 Hz to 15,000 Hz.
- 3.3.7 System frequency response: ± 1.0 dB, 20 Hz to 20,000 Hz.
- 3.3.8 Program reproduction system with point-source loudspeakers: Flat response from 63 Hz to 2.5 kHz ± 2 -dB, decreasing uniformly from a relative level of 0-dB at 2.5 kHz to a relative level of -10 -dB at 10 kHz as measured on axis of loudspeaker.
- 3.3.9 Sound output capability: Program levels of not less than 100 dB without objectionable distortion, rattles, or buzzes.
- 3.3.10 Hum and noise is inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.

Video System:

- 3.3.11 Signal-to-noise ratio (peak to RMS, unweighted DC to 4.2 MHz): 55-dB minimum.
- 3.3.12 Crosstalk (unweighted DC to 4.2 MHz): 45-dB minimum.
- 3.3.13 Frequency response: ± 0.5 dB to 4.2 Mhz.
- 3.3.14 Line and field tilt: 2% minimum.
- 3.3.15 Differential gain: 3% maximum.
- 3.3.16 Differential phase: 2° maximum.
- 3.3.17 System timing sync coincidence: within 50 nanoseconds.

3.3.18 Color timing: $\pm 2\%$ at 3.58 Mhz.

Radio Frequency (RF) System:

3.3.19 Visual Carrier level: +0 dBmV minimum and +16 dBmV maximum at system outlets for utilized channels.

3.3.20 Adjacent Channel Visual Carrier: 3-dB maximum differential at system outlets.

3.3.21 Non-adjacent Channel Visual Carrier: 0-dB maximum differential at system outlets.

3.3.22 Carrier-to-Noise Ratio: 42-dB minimum

3.3.23 Amplitude Response: Flat ± 1.0 Db

3.3.24 Signal-to-Noise Ratio: 45-dB minimum for the maximum level of the signal and the interference resulting from cross modulation from other signals on the system, after demodulation.

3.3.25 Outlet-to-Outlet Isolation: 25-dB minimum.

3.4 Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.

3.5 Where manufacturer does not provide bending radius information, minimum bending radius shall be 10 times cable diameter. Arrange and mount equipment and materials in a manner acceptable to the engineer and the owner.

3.6 Attach cables to permanent structure with suitable attachments at intervals of 48 to 60 inches. Support cables installed above removable ceilings. Install adequate support structures for 10-foot cable service loops at each TC.

3.7 Provide lacing bars for cable management in all of the sound systems cabinets. Contractor shall be responsible for providing neatly dressed cable bundles within the sound cabinet. Cables shall be dressed separately for Microphone and line level cables, speaker and monitor cables, control cables and power cables and video cables. All cables shall be neatly labeled with wrap around type written labels.

3.7.1 On the cable at the rear of the patch panel or termination location. Requires the use of a self-laminating wrap around label. Brady Label self-laminating 1.2" by 1.5" wrap around label Part # 29689 (NO ACCEPTABLE EQUAL).

3.8 All faceplates shall be labeled with type-written permanent labels securely attached to the faceplates identifying all A/V connections. (ie; Doc Cam, PC, Audio Only, etc.) Cables at the projector and A/V switch shall be also be labeled to match the faceplates.

3.9 Group cables according to signals being carried. To reduce signal contamination, form separate groups for the following:

- 3.9.1 Power cables.
- 3.9.2 Control cables.
- 3.9.3 Video cables.
- 3.9.4 Camera cables.
- 3.9.5 Audio cables for signals less than minus 20 dBm.
- 3.9.6 Audio cables for signals between minus 20 dBm and plus 30 dBm.
- 3.9.7 Audio cables for signals above plus 30 dBm.
- 3.9.8 Broadband RF cables.

- 3.10 Run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the back. Run other cables on the right side of an equipment rack.
- 3.11 Cut cables (except video, camera and RGBS cables, which must be cut to electrical length) to the length required by the run. All wire and cable shall be continuous and splice-free for the entire length of run. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of appropriate length.
- 3.12 Install no cable with a bend radius less than that recommended by the manufacturer.
- 3.13 Provide strain relief for cables. Provide connectors with metal shell/casings. Provide a minimum of three feet of free cable coiled in a floor pocket. Use spiral wrap to group similar cable types.
- 3.14 All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels, or equipment enclosures. Tin all terminated shield drain wires and insulate with heat-shrink tubing.
- 3.15 Land all field loudspeaker wiring entering each rack at terminal devices prior to connection to equipment or devices. Land loudspeaker level control cables at screw or tubular clamp type barrier blocks on the left side of the equipment rack as viewed from the rear. Make all connections to screw-type barrier blocks with insulated crimp-on spade lugs. Size all lugs properly to assure low-resistance connections.
- 3.16 Separately dress, route and land microphone and line level cables directly to equipment.
- 3.17 Use only rosin core 60/40 tin/lead solder for all solder connections.
- 3.18 Lace, tie or harness wire or cable in accordance with accepted professional practice. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Provide service loops where harness of different classes cross or where hinged panels are to be interconnected.

- 3.19 Patch Panel Assignments: Wire patch panels so that signal “sources” (outputs from) appear on the upper row or a row pair and “loads” (input to) appear on the lower row of a row pair.
- 3.20 Patch Panel Designation Strips: Use alphanumeric identifications and descriptive information on patch panel designation strips. Number the jack positions in each horizontal row sequentially from left to right. Letter the horizontal jack rows sequentially from top to bottom. Include the alphanumeric identification of each jack on the functional block drawings, and on reproductions of these drawings that shall be mounted in an appropriate location near the patch bays.
- 3.21 Each major component of equipment shall have the manufacturer's name, address, model number, and rating on a plate securely affixed in a conspicuous place. NEMA code ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be stamped in a location easily visible.
- 3.22 Upon completion of the work, remove all refuse and rubbish from and about the premises, and leave the relevant areas and equipment clean and in an operational state.
- 3.23 During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the owner.
- 3.24 Prior to final acceptance, provide minimum of three complete sets of drawings showing all cable numbers and construction details in accordance with the actual system installation. Revise the device layout drawings to represent actual installation locations and coordinate these with the electrical Contractor. The operation manual shall contain all instructions necessary for the proper operation of the installed system and manufacturer’s instructions. The maintenance manual shall contain all information required for the "proof of performance" as required and all manufacturers’ maintenance information.

Inspection and Test upon Completion

- 3.25 Check out and final connections to the system shall be made by the Contractor of the products installed. Technicians shall demonstrate operation of the complete system and each major component to the Owner.
- 3.26 System field wiring diagrams shall be provided to the owner by the system Installer (Contractor) prior to completion of the installation.
- 3.27 All materials and installation shall be guaranteed to be free of defects in material and workmanship for two years after final acceptance of installation and test.
- 3.28 Upon completion of the installation, four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source. Final payment shall not be made until operational and maintenance manuals have been received.

- 3.29 The Contractor shall be responsible to provide service within 24 hours (or by mutual consent) after notification by the Owner or his representative, within the hours of 8:00 AM to 5:00 PM from Monday through Friday. Service request forms shall be supplied by the Contractor and the faxing or mailing of such a request form shall constitute notification by the Owner of a service request.
- 3.30 The Contractor shall provide two "preventative maintenance" service calls, spaced six months apart, for cleaning of all source devices and overall inspection of the system.

PROJECT CLOSEOUT

- 3.31 Prior to completion of project, compile a complete equipment maintenance manual for all equipment supplied under sections of this division, in accordance with these specifications and as described below.
- 3.32 Equipment Lists and Maintenance Manuals:
 - 3.32.1 Prior to completion of job, Contractor shall compile a complete equipment list and maintenance manuals. The equipment list shall include the following items for every piece of material equipment supplied under this section of the specifications:
 - 3.32.1.1 Name, model, and manufacturer.
 - 3.32.1.2 Complete parts drawings and lists.
 - 3.32.1.3 Local supply for parts and replacement and telephone number.
 - 3.32.1.4 All tags, inspection slips, instruction packages, etc., removed from equipment as shipped from the factory, properly identified as to the piece of equipment it was taken from.
- 3.33 Maintenance manuals shall be furnished for each applicable section of the specifications and shall be suitably bound with hard covers and shall include all available manufacturers' operating and maintenance instructions, together with "as-built" drawings to properly operate and maintain the equipment. The equipment lists and maintenance manuals shall be submitted in duplicate to the Architect for approval not less than 10 days prior to the completion of the job. The maintenance manuals shall also include the name, address, and phone numbers of all subContractors involved in any of the work specified herein. Four copies of the maintenance manuals bound in single volumes shall be provided.

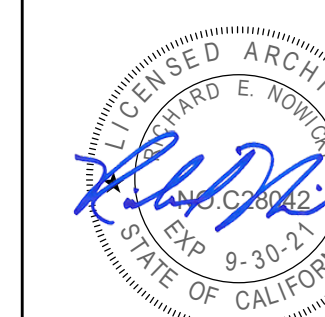
RECORD DRAWINGS

- 3.34 The Contractor shall maintain record drawings as specified in accordance with these specifications, and as noted below.
- 3.35 Drawings shall show locations of all concealed and exposed conduit runs, giving the number and size of conduit wires. Underground ducts shall be shown with cross section elevations and shall be dimensioned in relation to permanent structures to indicate their

exact location. Drawing changes shall not be identified only with referencing CORs and RFIs, the drawings shall reflect all the actual changes made.

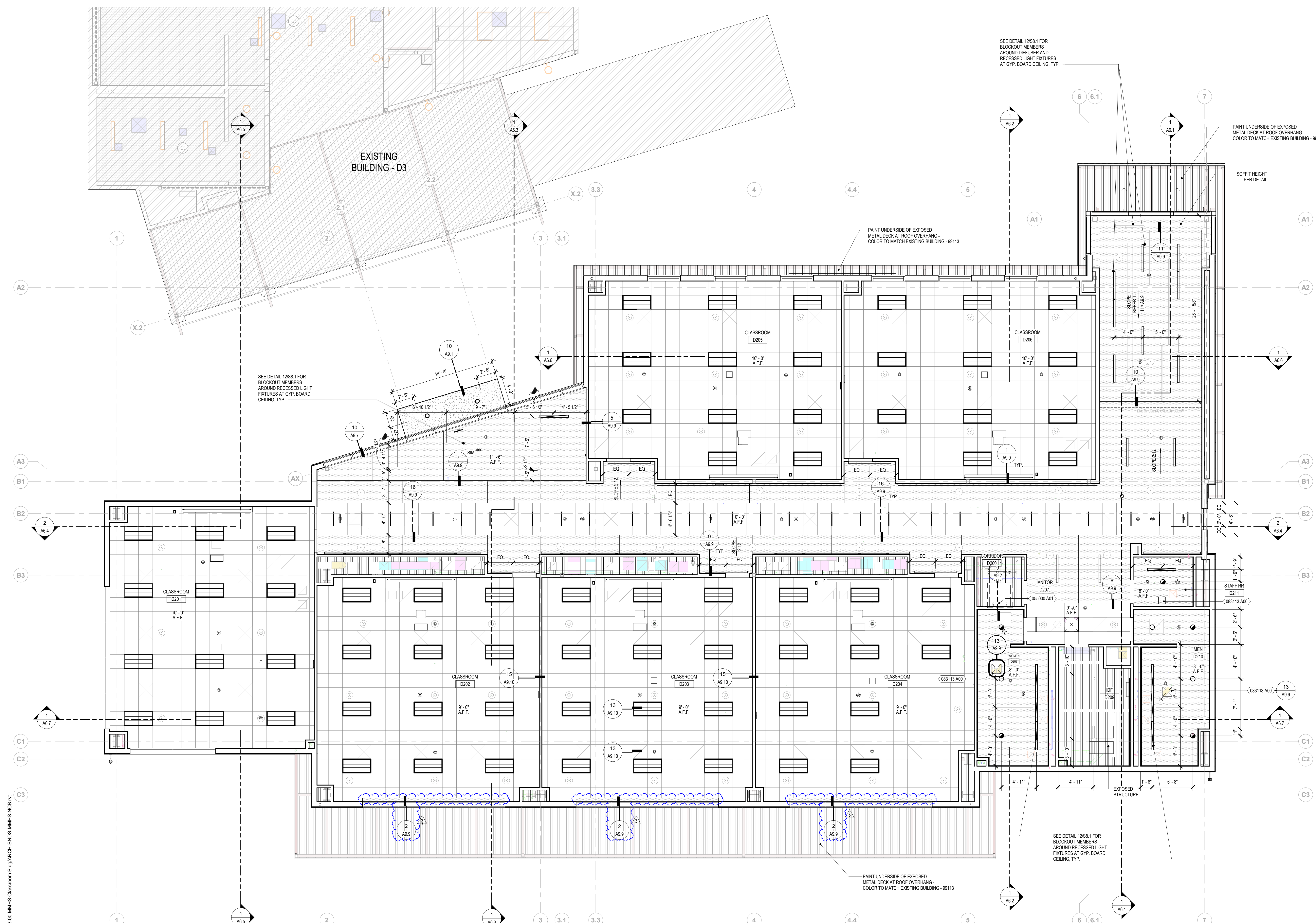
- 3.36 Final As-Built Drawing Submittals - Provide (1) hard bound copy of “E-size” As-Built drawings and (3) copies on USB Flash Drive in AutoCAD (2014 or newer version) format. A Hand marked-up copy of the original construction drawings will not be accepted as the final As-Built drawing submittal. Final As-Built drawings shall include copies of the floor plan drawings of each building, detailed As-built AV Diagrams including wire and connection type, elevations of all AV Cabinets, quantities of mic outlets and speaker locations, locations of all final cable routes, including conduits. In addition, the drawings shall include all outlet locations with cable identification label information.

END OF SECTION 272100



MURRIETA VALLEY USD
MURRIETA MESA HIGH SCHOOL
NEW CLASSROOM BUILDING

KEYNOTES
055000.A01 PREFABRICATED ALUMINUM LADDER
083113.A00 ACCESS DOOR AND FRAME



CEILING LEGEND

- EXPOSED METAL DECK
- 2'-0" x 2'-0" SUSPENDED PANELS PER ROOM FINISH SCHEDULE - ACP-1 - 085113
- PAINTED GYPSUM BOARD PER FINISH SCHEDULE - 092900 SEE DETAIL 5 / A9.9 & 12 / S8.1
- CONTROL JOINT - 092900
- PAINTED CEMENT PLASTER - MATCH EXISTING ADJACENT BUILDING - 092400 SEE ANCHORAGE DETAIL 7 / A9.3

+ X'-X" HEIGHT OF CEILING / SOFFIT

- SUPPLY AIR DIFFUSER
- RETURN AIR DIFFUSER
- EXHAUST AIR DIFFUSER
- CEILING ACCESS PANEL - 083113

LIGHT FIXTURES SEE ELECTRICAL DRAWINGS

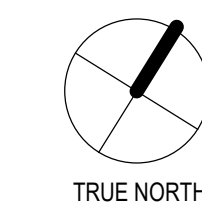
FIRE SPRINKLERS SEE FIRE SPRINKLER DRAWINGS

- GENERAL NOTES**
- CENTER SUSPENDED CEILING GRIDS EACH WAY WITHIN SPACE, UNLESS NOTED OTHERWISE
 - CENTER MECHANICAL AIR GRILLES BETWEEN LIGHTS / WALLS IN GYPSUM BOARD CEILINGS AS SHOWN
 - CENTER LIGHT FIXTURES WITHIN SPACES UNLESS NOTED OTHERWISE
 - CEILING HEIGHT IS 9'-0" A.F.F. UNLESS NOTED OTHERWISE
 - EXIT LIGHTS NOT SHOWN, SEE ELECTRICAL DRAWINGS
 - FOR TYPICAL CEILING NOTES AND DETAILS, SEE SHEETS A9.9, A9.10, A8.11, A8.12, & A9.13

BakerNowicki
design studio
731 Ninth Avenue, Suite A, San Diego, California 92101
619.795.2450
www.bnstudio.com

BLDG. D4
REFLECTED CEILING PLAN
LEVEL 2

NO. 3 DATE 1/24/2020 ISSUE Revision 3 PROJECT NO. 17028-00 DATE: 11/12/2019



BIM 360://17028-00 MMHS Classroom Bldg ARCH-BNDS-MMHS-NCB.rvt 1/22/2020 3:45:29 PM

NOTE: WINDOW SYSTEMS AND INTEGRATED ALUMINUM-FRAMED SUNSHADES ARE SUBJECT TO DEFERRED APPROVAL



MURRIETA VALLEY USD
MURRIETA MESA HIGH SCHOOL
NEW CLASSROOM BUILDING

FINISH LEGEND

SCHEDULE NOTES

GLASS TYPES	
GL-1	INSULATED UNIT, TINTED, TEMPERED - 088000
GL-4	1/4" SINGLE VISION, CLEAR, TEMPERED - 088000
GL-5	SPANDREL, TEMPERED - 088000

MATERIALS	
ALUM	ALUMINUM
HM	HOLLOW METAL
WD	WOOD
STL	STEEL
FF	FACTORY FINISH

WINDOW FRAME TYPES	
SF-1	ALUMINUM STOREFRONT - CENTER GLAZING - 084113
CW-1	ALUMINUM CURTAIN WALL - 6" DEEP - 084413

WINDOW GENERAL NOTES

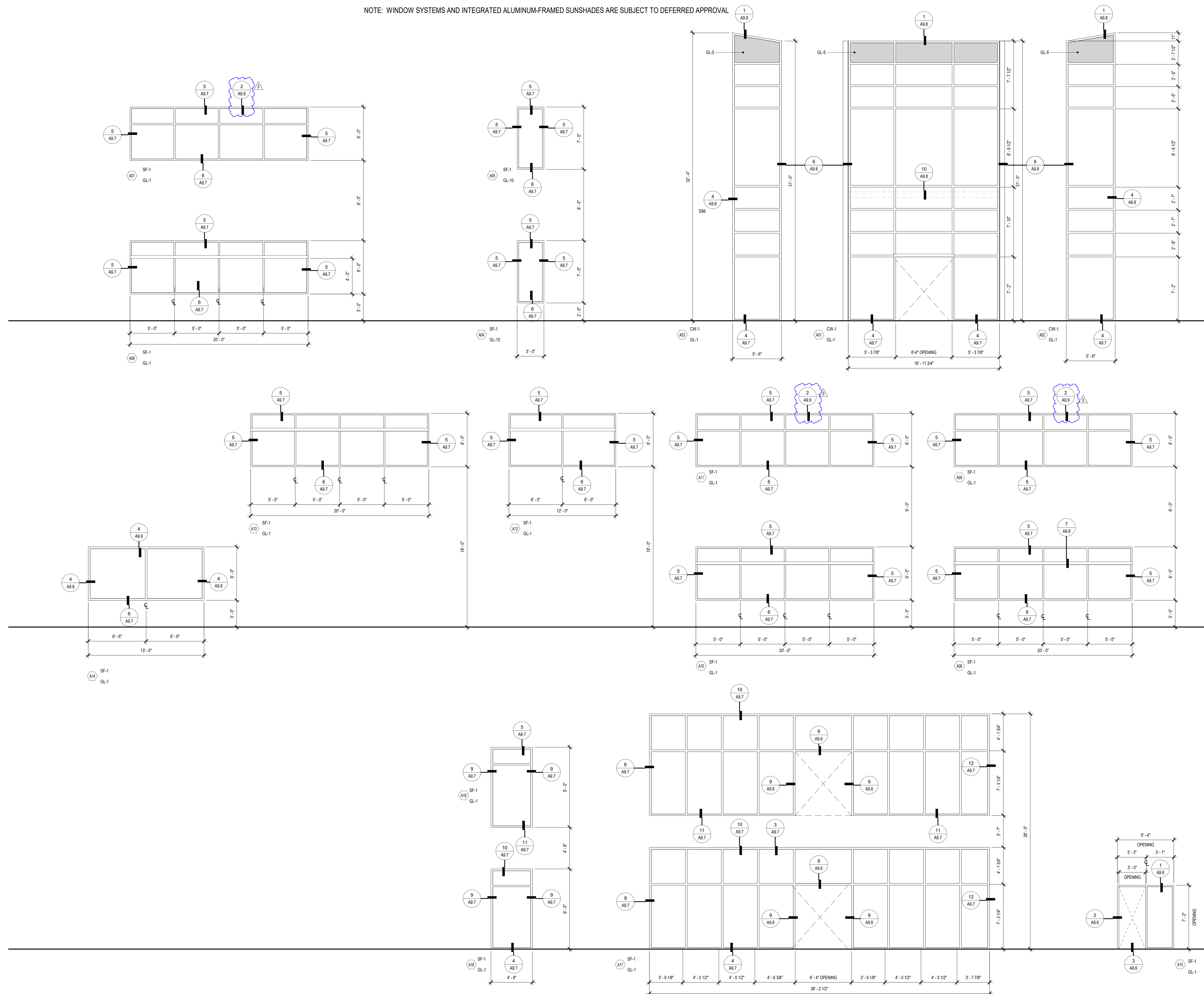
- WINDOW SYSTEMS AND INTEGRATED ALUMINUM-FRAMED SUNSHADES ARE SUBJECT TO DEFERRED APPROVAL.
- DIMENSIONS TO EDGE MULLIONS ARE TO FACE OF FRAME.
- FOR TYPICAL EXTERIOR WINDOW FLASHING DETAIL SEE 1/A8.7
- REFERENCE WINDOW TYPES FOR DOOR / WINDOW FRAME COMBINATIONS.
- WHEN WINDOW TYPES ARE IMMEDIATELY ADJACENT ONLY ONE VERTICAL MULLION OCCURS. REFERENCE PLANS AND ELEVATIONS, AND WINDOW DETAILS.
- REFERENCE FINISH SCHEDULES FOR WINDOW SHADE LOCATIONS.
- INSTALL WINDOW SHADES PER TYPICAL DETAILS.
- PROVIDE DRIP EDGE AT EXTERIOR ALUMINUM DOOR HEADS, BY DOOR MANUFACTURER. FINISH TO MATCH.
- ALL CLASSROOM DOORS STC - 31 - 081418
- FOR DOOR HARDWARE TYPES, REFER TO SPEC SECTION 087100.
- PROVIDE BACKING PER 1/A8.15 AT ALL WALL MOUNTED DOOR STOPS.



WINDOW SCHEDULE

NO.	DATE	ISSUE	PROJECT NO.	17028-00
3	1/24/2020	Revision 3	DATE:	11/12/2019

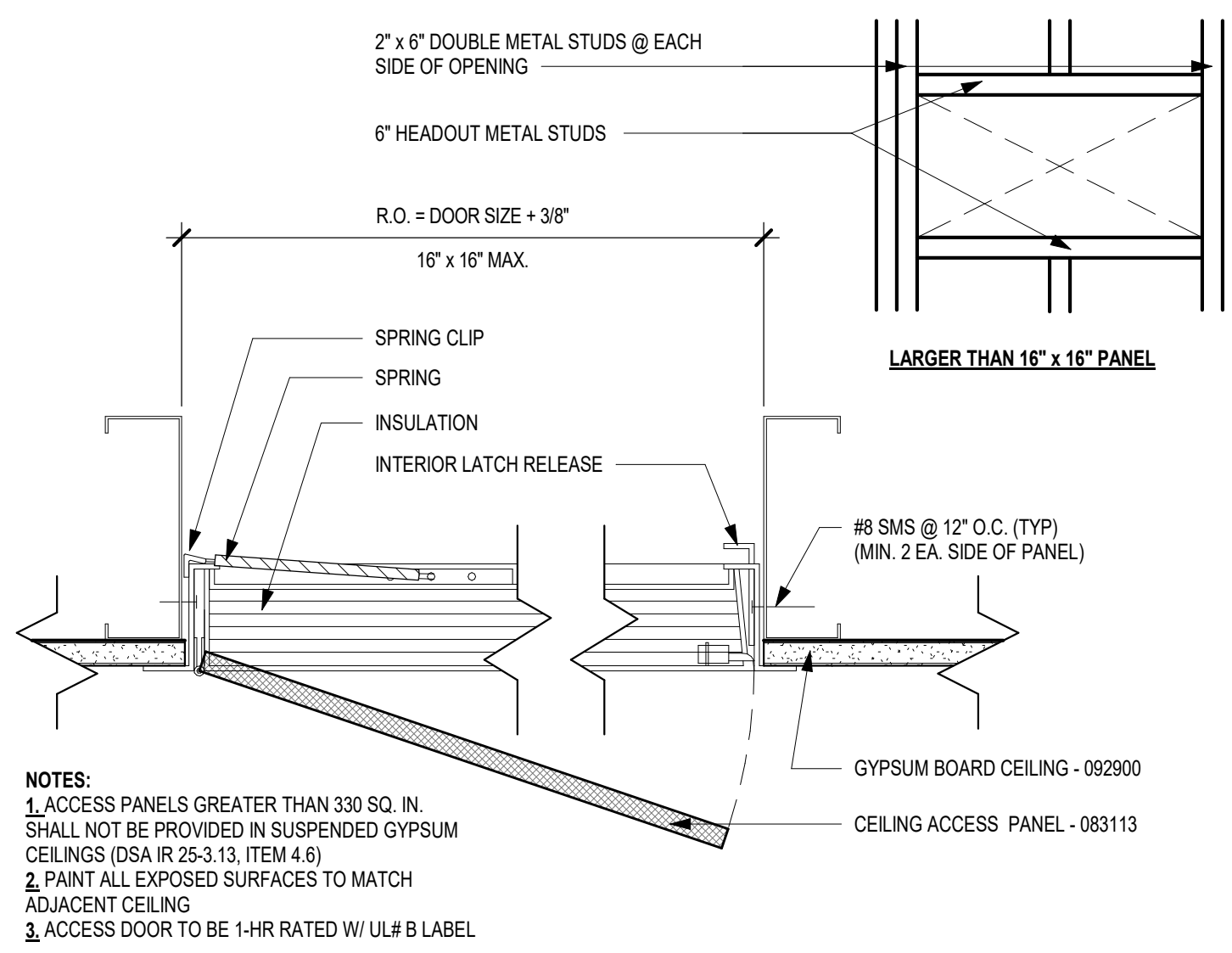
DRAWING
A8.2
AD3-A09



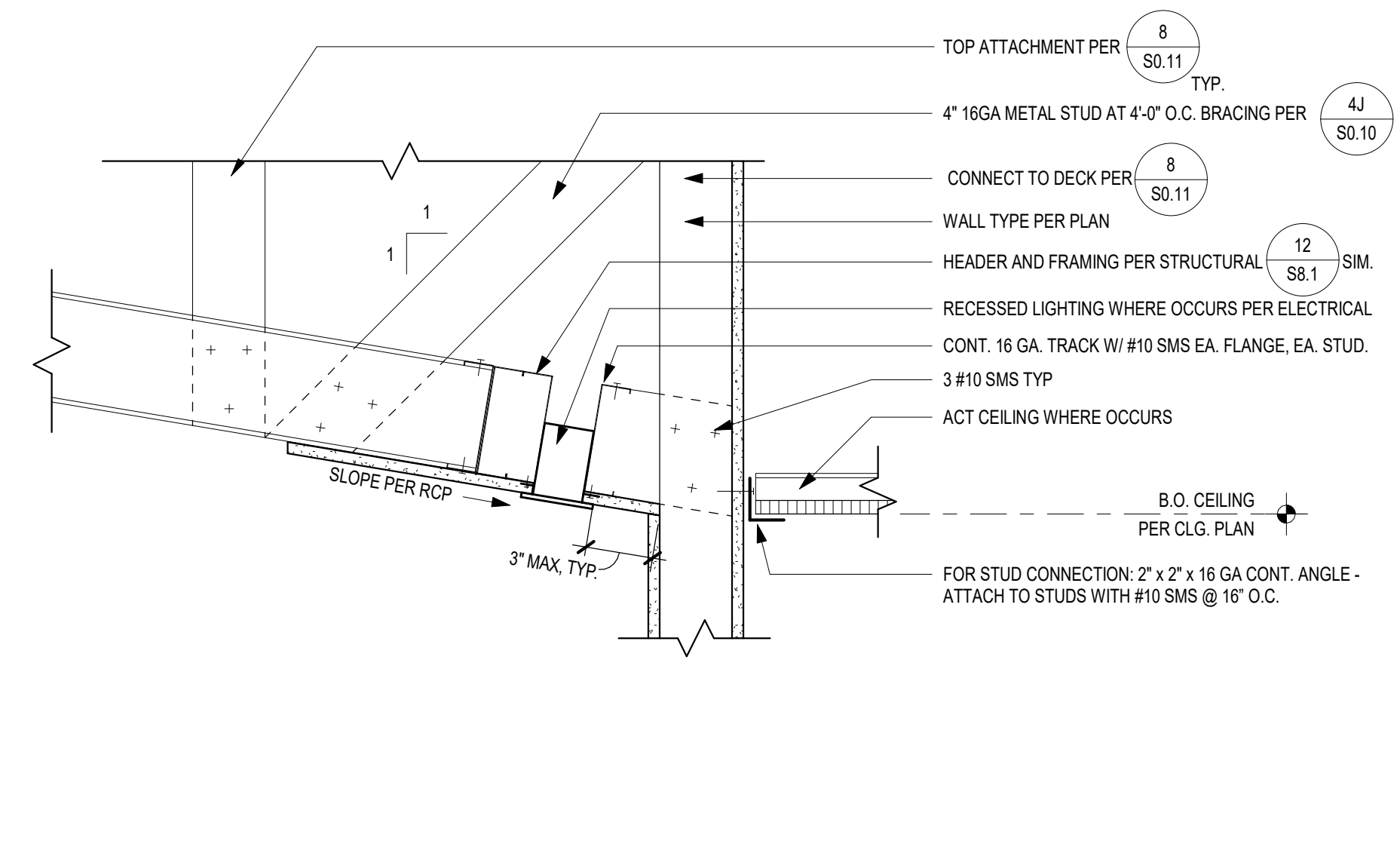
BIM 360://17028-00 MMHS Classroom Bldg ARCH-BNDS-MMHS-NCB.rvt
1/22/2020 10:35:29 AM



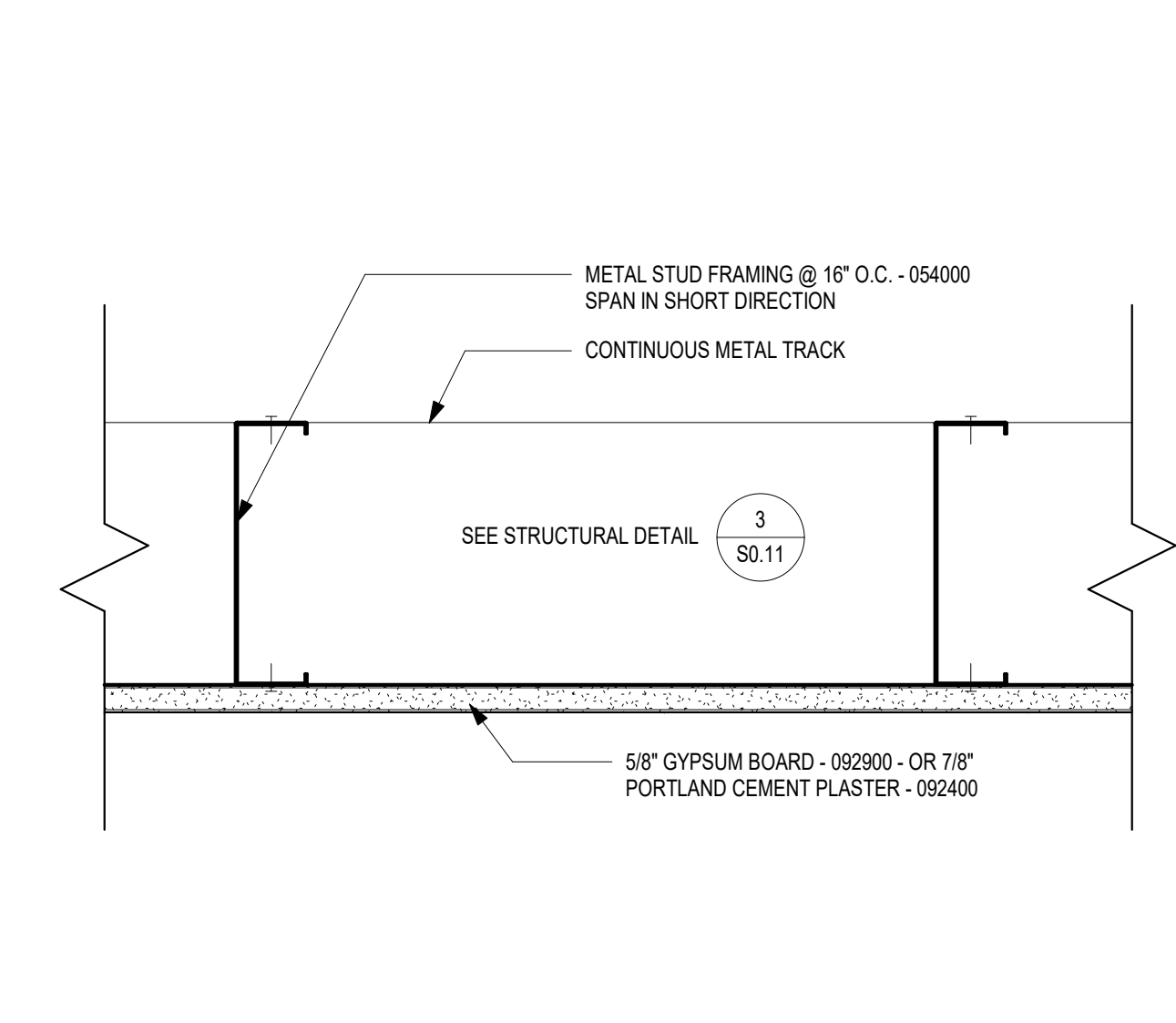
MURRIETA VALLEY USD
MURRIETA MESA HIGH SCHOOL
NEW CLASSROOM BUILDING



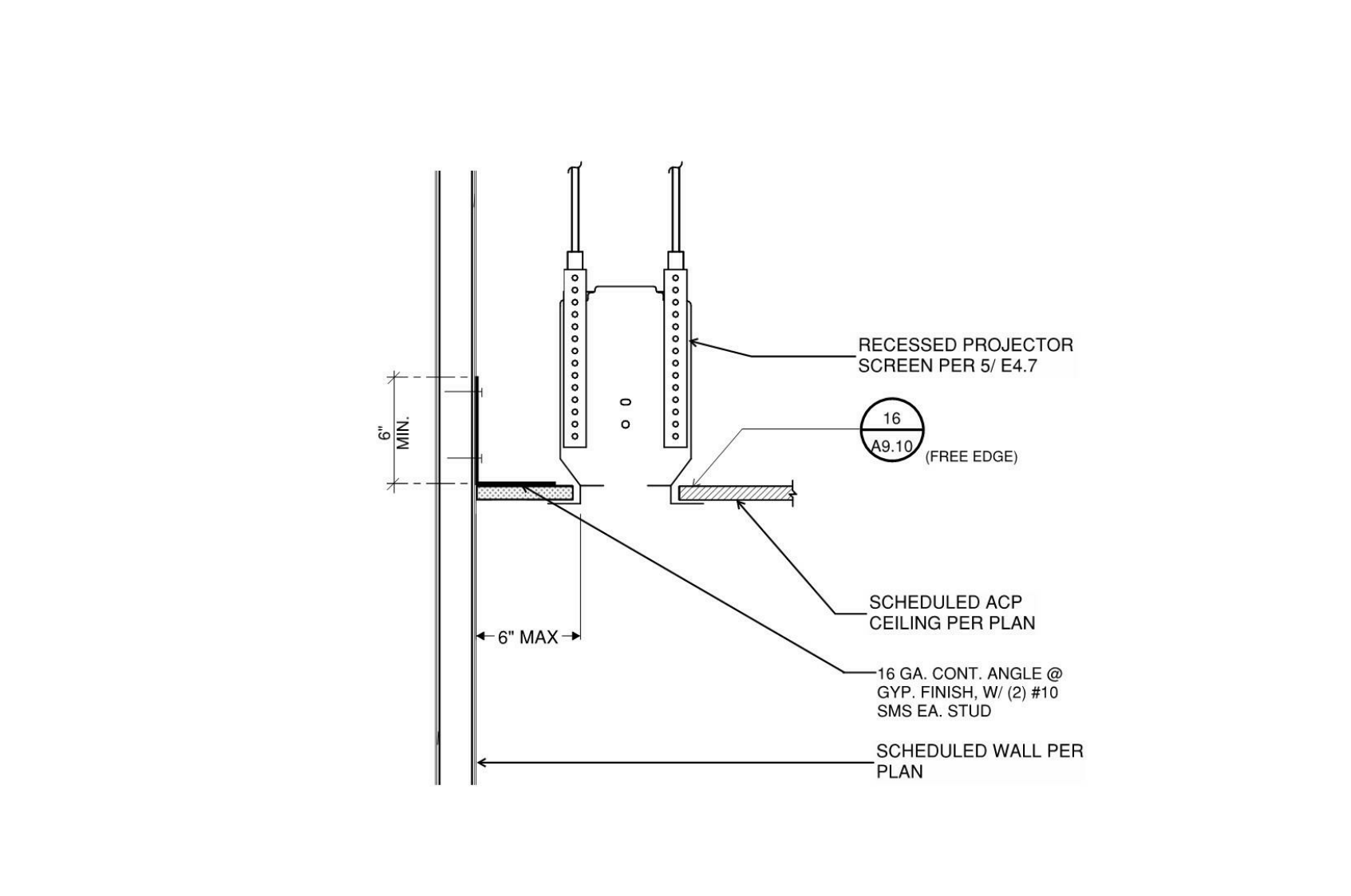
13 CEILING - ACCESS PANEL @ MS FRAMING
A3.1 3" = 1'-0"



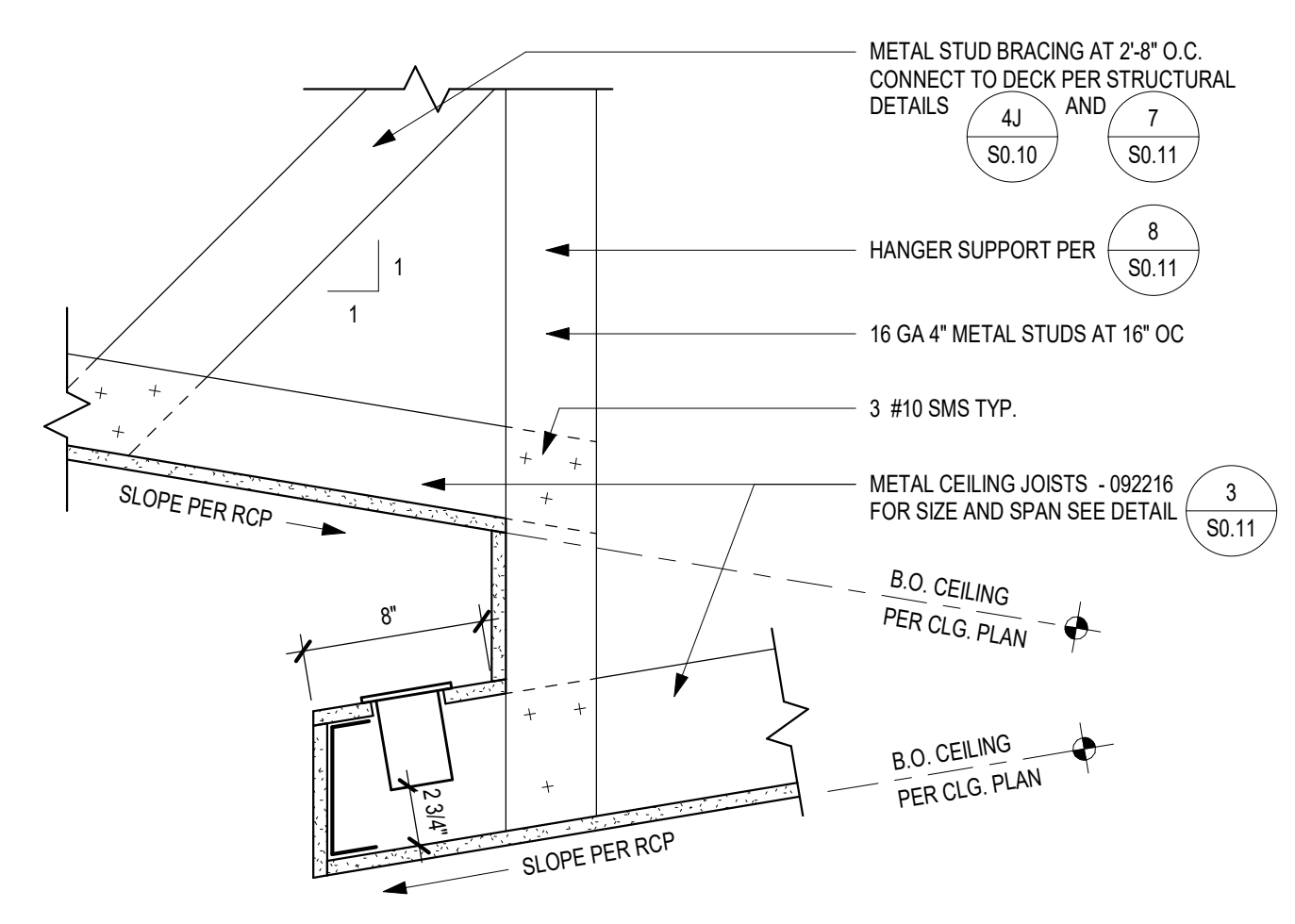
9 LIGHT COVE @ CEILING
A3.1 1 1/2" = 1'-0"



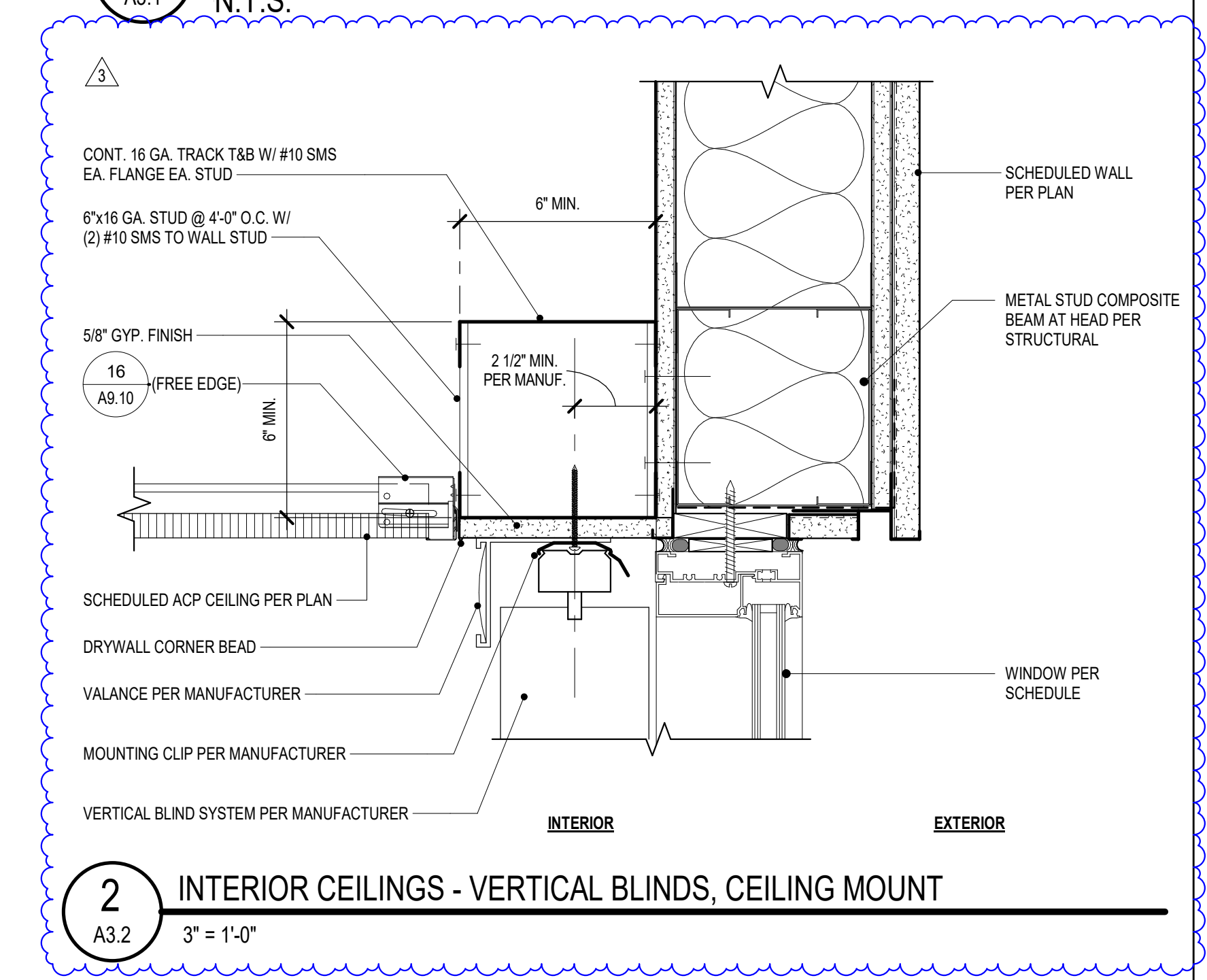
5 INTERIOR CEILINGS - LESS THAN 10'-0" JOIST SPAN
A3.1 3" = 1'-0"



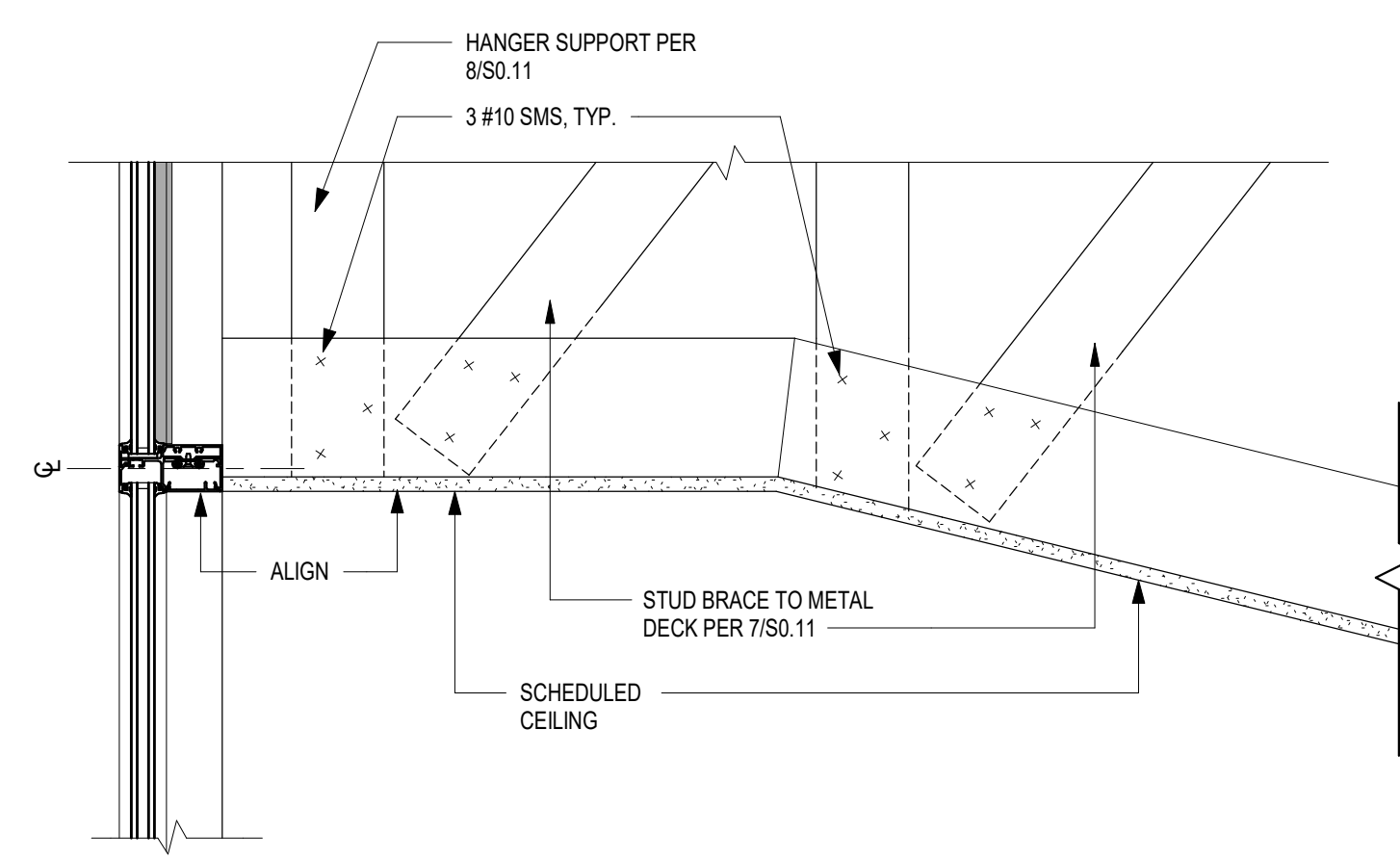
1 INTERIOR CEILINGS - RECESSED PROJECTOR SCREEN
A3.1 N.T.S.



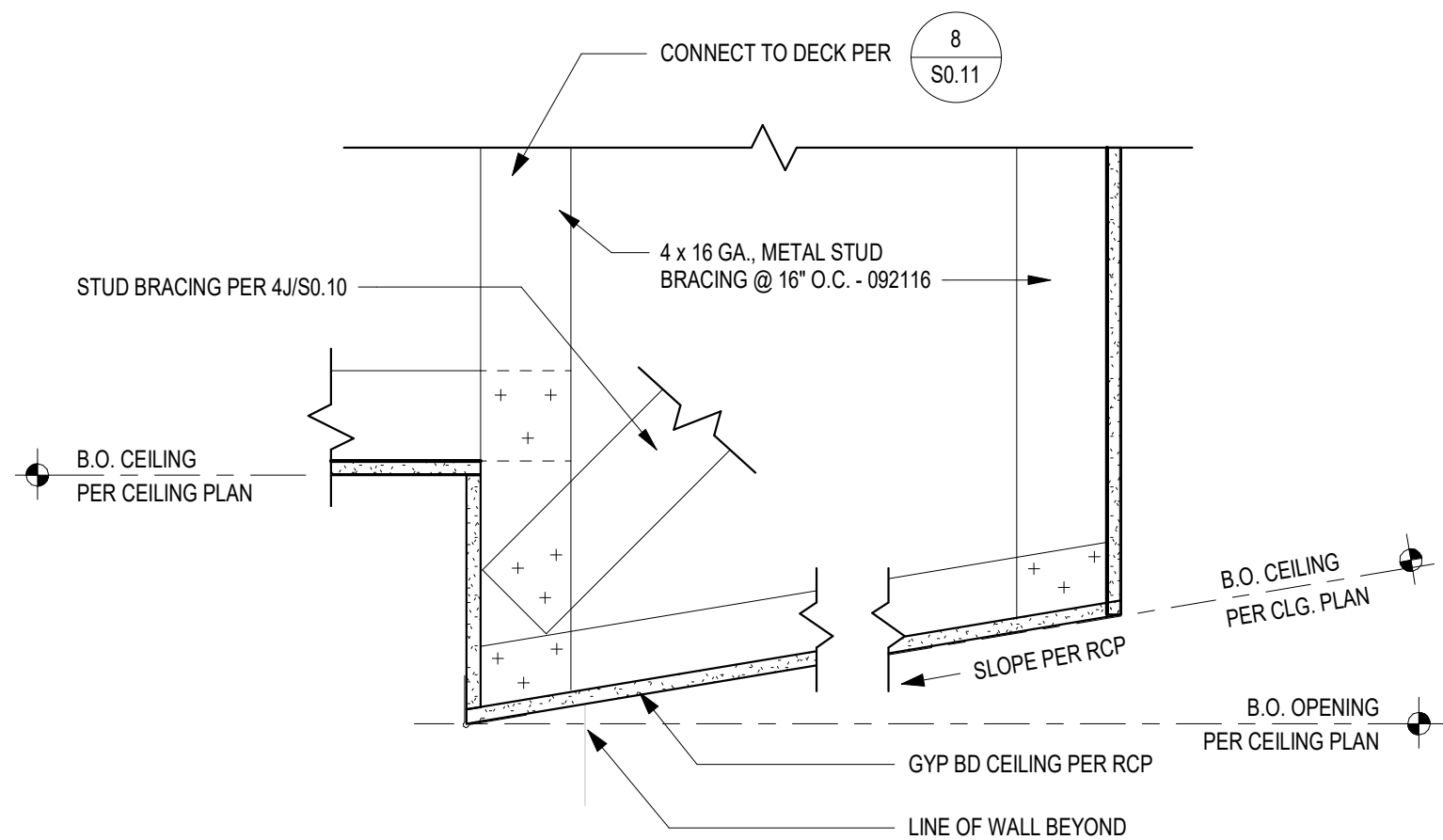
10 LIGHT COVE @ ANGLED CEILING OVERLAP
A3.2 1 1/2" = 1'-0"



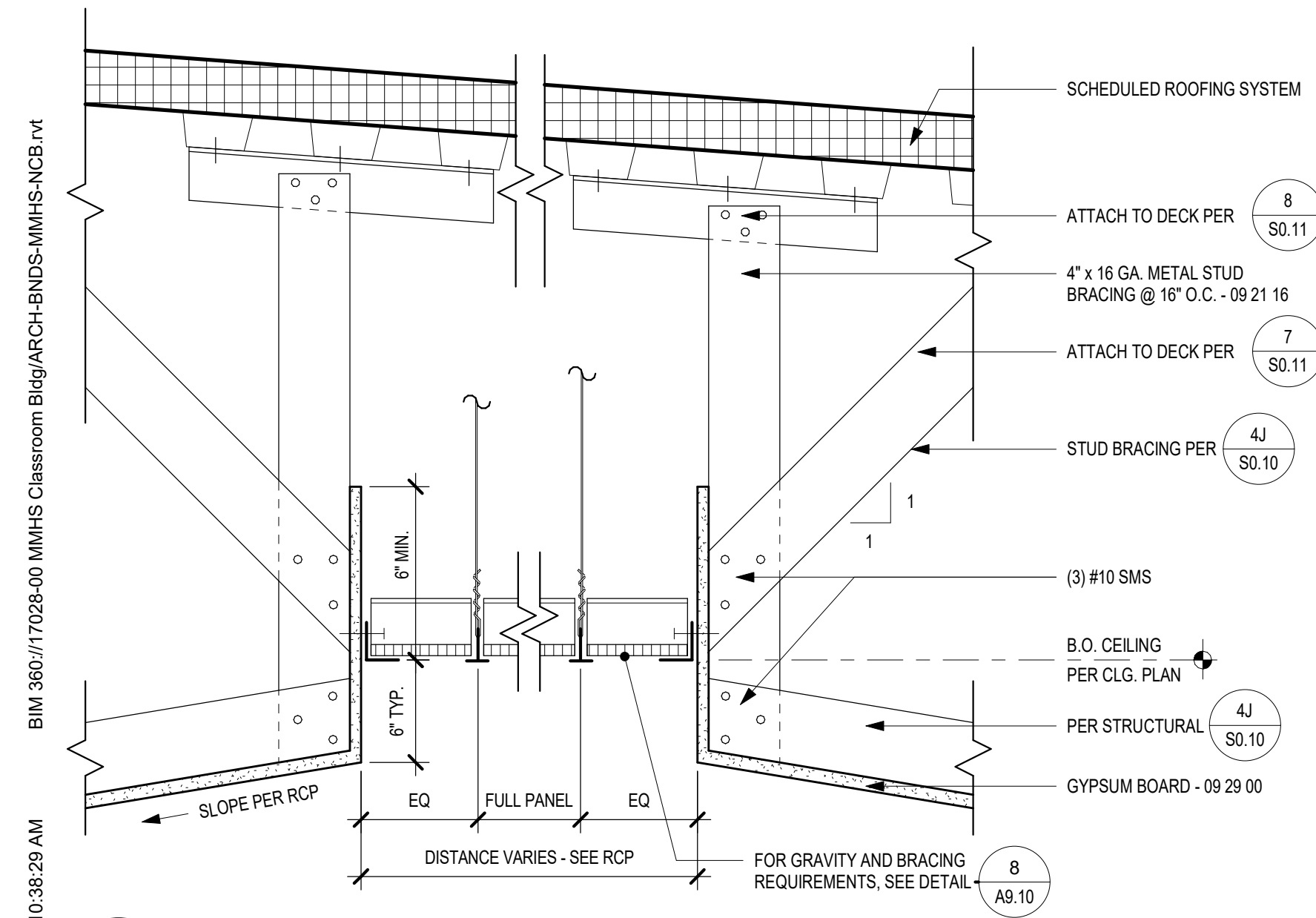
2 INTERIOR CEILINGS - VERTICAL BLINDS, CEILING MOUNT
A3.2 3" = 1'-0"



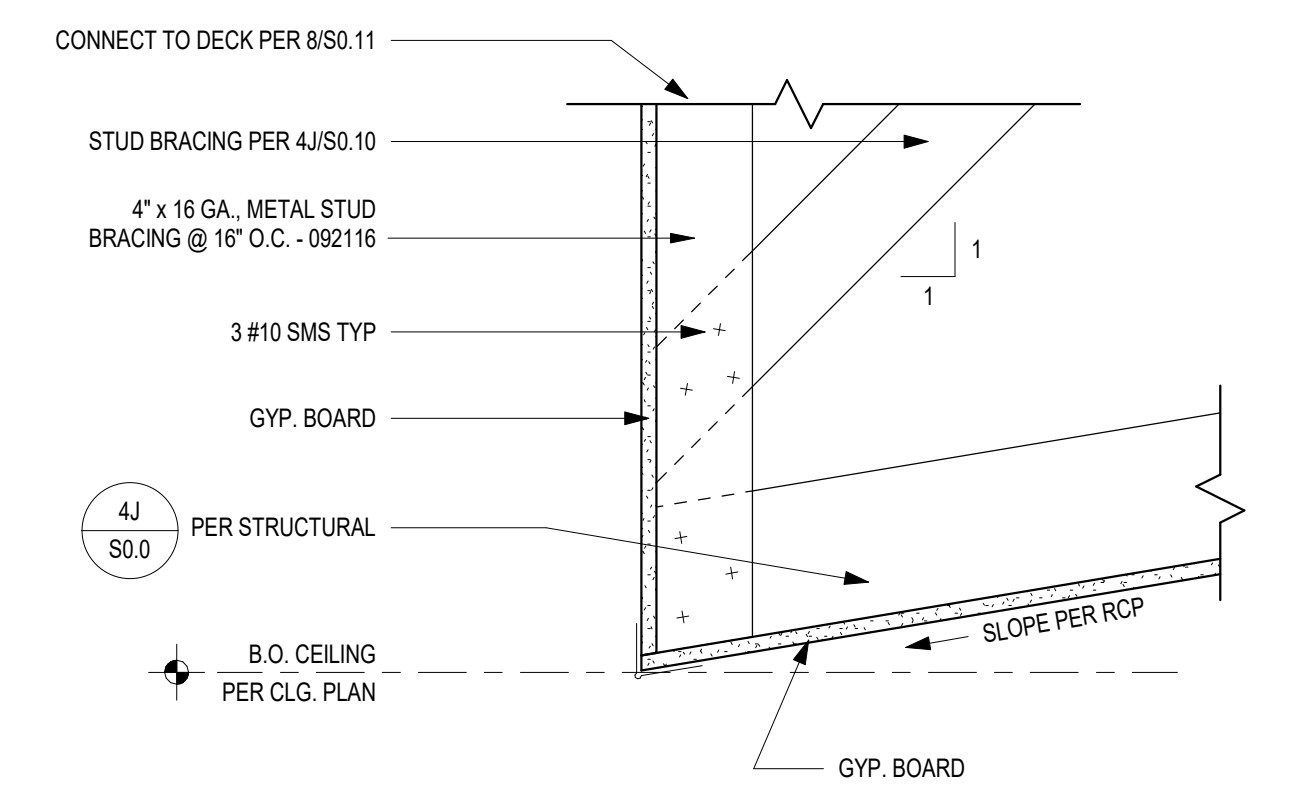
11 ANGLED CEILING @ LOBBY CURTAIN WALL
A3.2 1 1/2" = 1'-0"



7 ANGLED CEILING @ WALL OPENING
A3.1 1 1/2" = 1'-0"

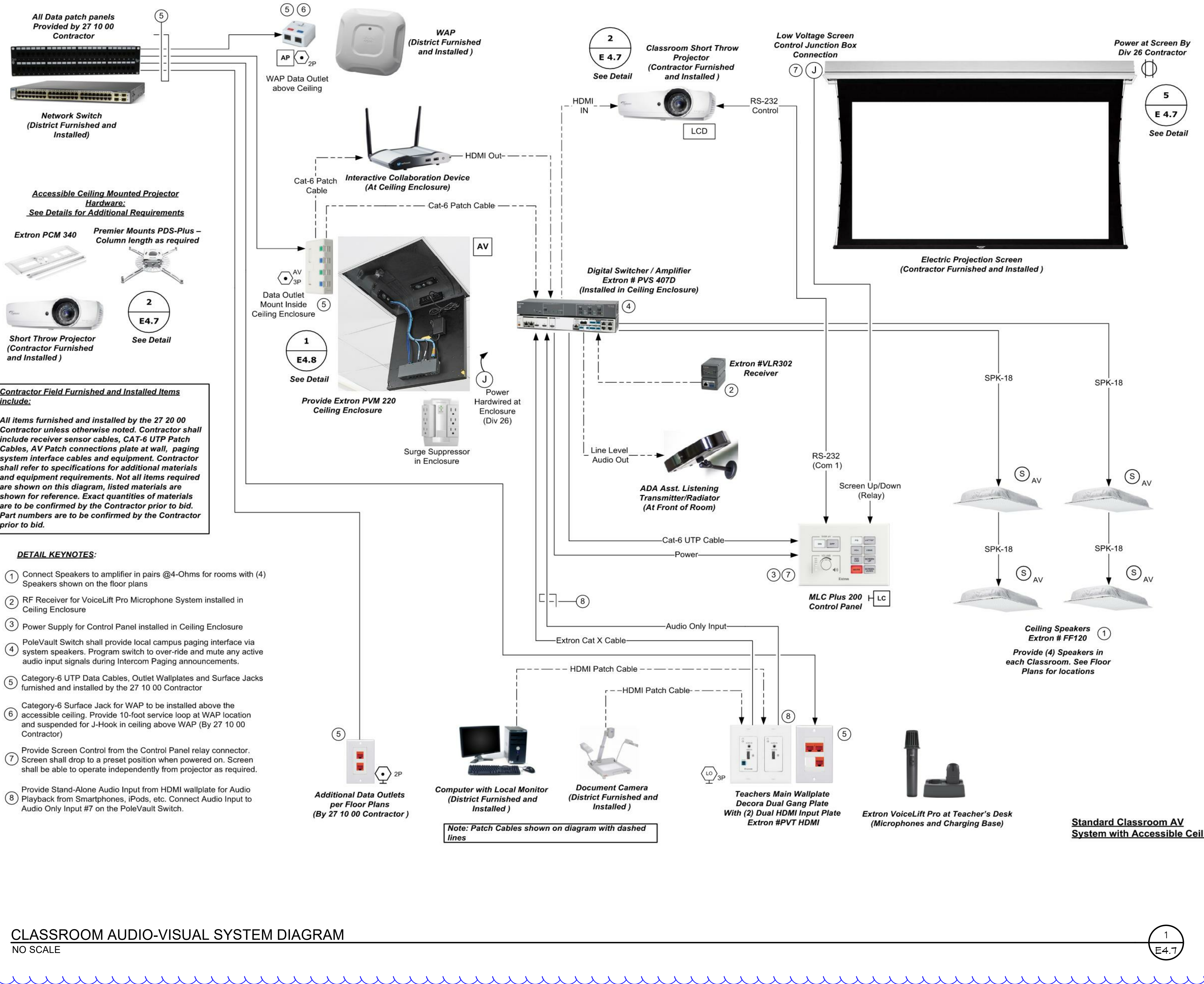


16 CEILING - CORRIDOR SOFFIT
A3.1 1 1/2" = 1'-0"



8 ANGLED CEILING @ VERTICAL SOFFIT
A3.1 1 1/2" = 1'-0"

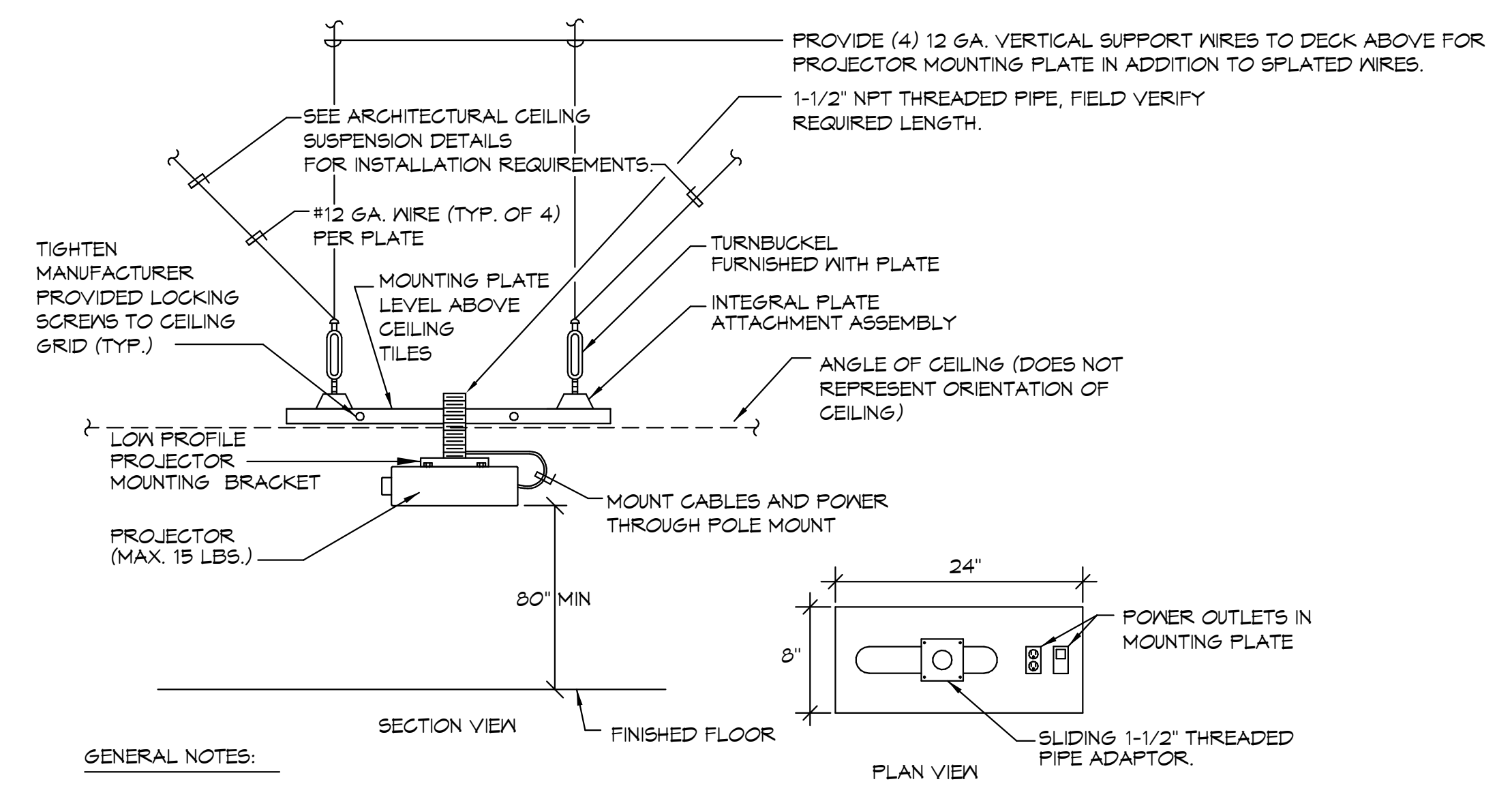
BIM_360/17028-00 MMHS Classroom Bldg ARCH-BNDS-MMHS-NCB.rvt
1/22/2020 10:35:29 AM



CLASSROOM AUDIO-VISUAL SYSTEM DIAGRAM
NO SCALE

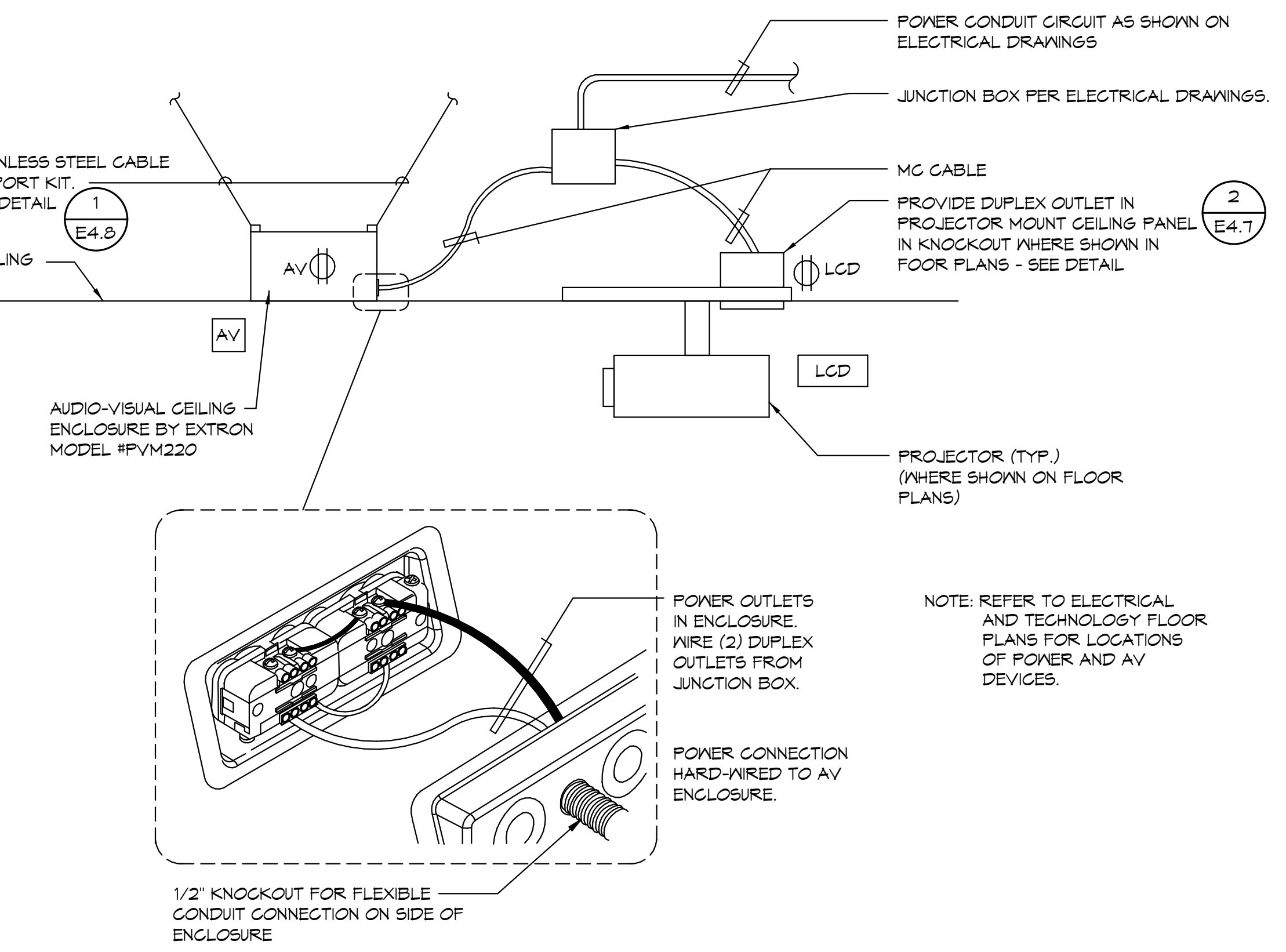
- DETAIL KEYNOTES:**
1. Connect Speakers to amplifier in pairs @4-Ohms for rooms with (4) Speakers shown on the floor plans
 2. RF Receiver for VoiceLift Pro Microphone System installed in Ceiling Enclosure
 3. Power Supply for Control Panel installed in Ceiling Enclosure
 4. PoleVault Switch shall provide local campus paging interface via system speakers. Program switch to over-ride and mute any active audio input signals during Intercom Paging announcements.
 5. Category-6 UTP Data Cables, Outlet Wallplates and Surface Jacks furnished and installed by the 27 10 00 Contractor
 6. Category-6 Surface Jack for WAP to be installed above the accessible ceiling. Provide 10-foot service loop at WAP location and suspended for J-Hook in ceiling above WAP (By 27 10 00 Contractor)
 7. Provide Screen Control from the Control Panel relay connector. Screen shall drop to a preset position when powered on. Screen shall be able to operate independently from projector as required.
 8. Provide Stand-Alone Audio Input from HDMI wallplate for Audio Playback from Smartphones, iPods, etc. Connect Audio Input to Audio Only Input #7 on the PoleVault Switch.

Contractor Field Furnished and Installed Items Includes:
All items furnished and installed by the 27 20 00 Contractor unless otherwise noted. Contractor shall include receiver sensor cables, CAT-4 UTP Patch Cables, AV Patch connections plate at wall, paging system interface cables and equipment. Contractor shall refer to specifications for additional materials and equipment requirements. Not all items required are shown on this diagram, listed materials are shown for reference. Exact quantities of materials are to be confirmed by the Contractor prior to bid. Part numbers are to be confirmed by the Contractor prior to bid.

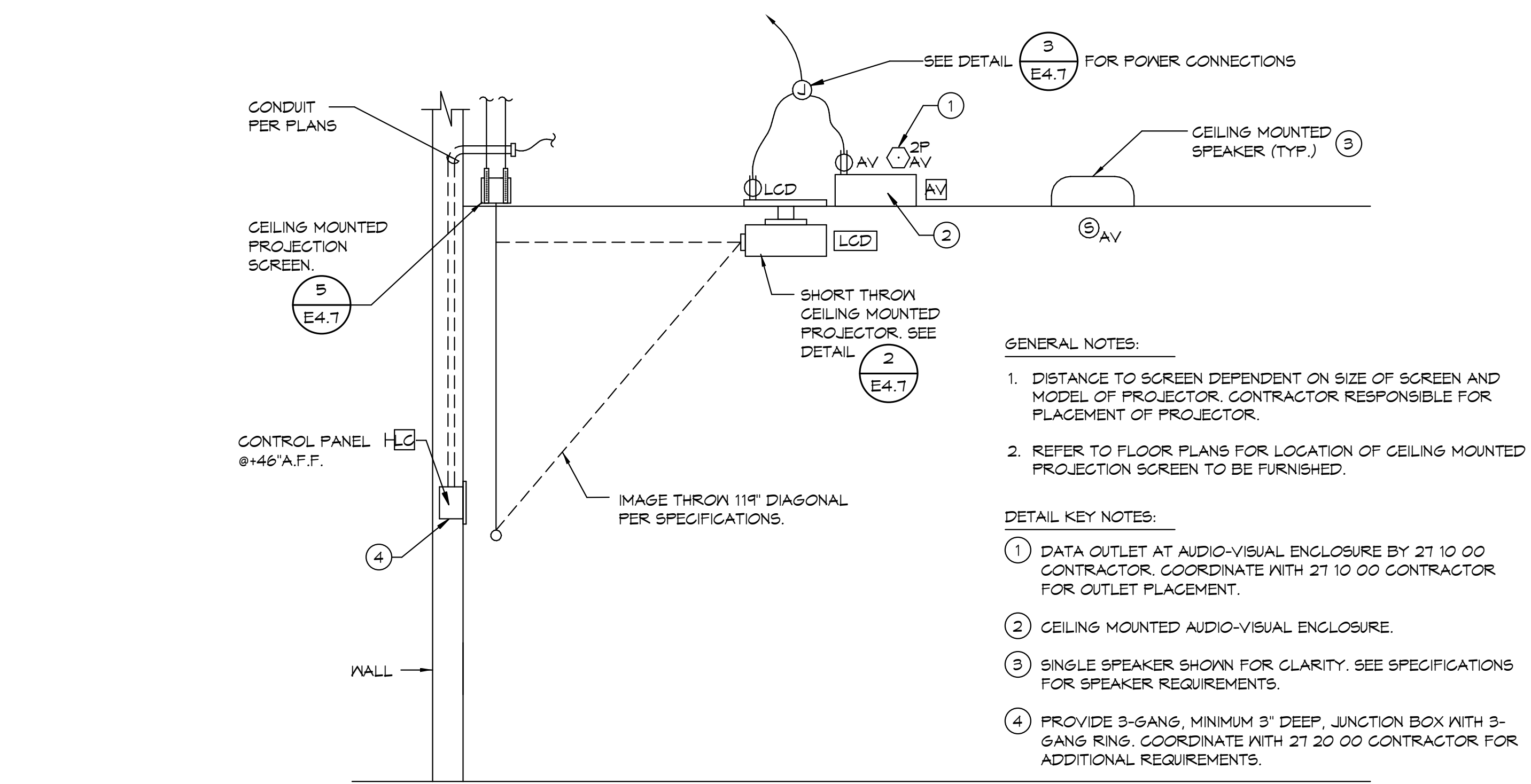


CEILING PROJECTOR MOUNTING DETAIL
NO SCALE

- GENERAL NOTES:**
1. AUDIO/VISUAL CONTRACTOR (212000) TO FURNISH AND INSTALL ALL COMPONENTS UNLESS OTHERWISE NOTED.
 2. COORDINATE WITH ELECTRICAL AND MECHANICAL CONTRACTORS EXACT PLACEMENT OF PROJECTOR MOUNT.
 3. MOUNTING PLATE DOES NOT REST IN CEILING TILE. MOUNTING PLATE IS SECURED TO CEILING GRID PER MANUFACTURER'S INSTRUCTIONS. ONLY POLE PENETRATES THROUGH CEILING TILE.
 4. SEE SPECIFICATIONS FOR UNIVERSAL PROJECTOR MOUNT. PROJECTOR MOUNT SHALL BE ADJUSTED TO FIT FINAL PROJECTOR PROVIDED.

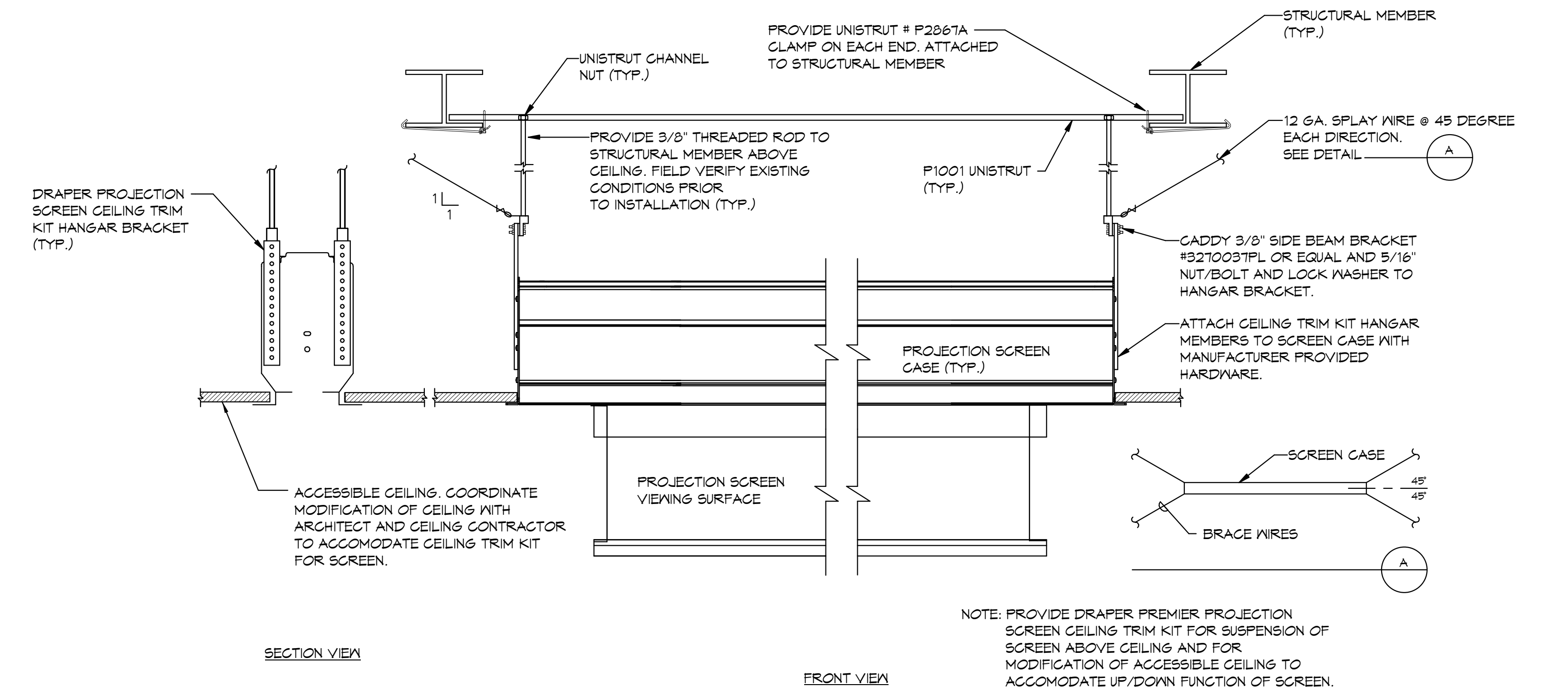


CEILING ENCLOSURE / PROJECTOR - POWER CONNECTION
NO SCALE



TYPICAL CEILING MOUNTED PROJECTOR INSTALLATION - ACCESSIBLE CEILINGS
NO SCALE

- GENERAL NOTES:**
1. DISTANCE TO SCREEN DEPENDENT ON SIZE OF SCREEN AND MODEL OF PROJECTOR. CONTRACTOR RESPONSIBLE FOR PLACEMENT OF PROJECTOR.
 2. REFER TO FLOOR PLANS FOR LOCATION OF CEILING MOUNTED PROJECTOR SCREEN TO BE FURNISHED.
- DETAIL KEY NOTES:**
1. DATA OUTLET AT AUDIO-VISUAL ENCLOSURE BY 27 10 00 CONTRACTOR. COORDINATE WITH 27 10 00 CONTRACTOR FOR OUTLET PLACEMENT.
 2. CEILING MOUNTED AUDIO-VISUAL ENCLOSURE.
 3. SINGLE SPEAKER SHOWN FOR CLARITY. SEE SPECIFICATIONS FOR SPEAKER REQUIREMENTS.
 4. PROVIDE 3-GANG, MINIMUM 3" DEEP, JUNCTION BOX WITH 3-GANG RING. COORDINATE WITH 27 20 00 CONTRACTOR FOR ADDITIONAL REQUIREMENTS.



RECESSED TENSIONED PROJECTION SCREEN MOUNTING DETAILS
NO SCALE

- GENERAL NOTES:**
1. DISTANCE TO SCREEN DEPENDENT ON SIZE OF SCREEN AND MODEL OF PROJECTOR. CONTRACTOR RESPONSIBLE FOR PLACEMENT OF PROJECTOR.
 2. REFER TO FLOOR PLANS FOR LOCATION OF CEILING MOUNTED PROJECTOR SCREEN TO BE FURNISHED.
- DETAIL KEY NOTES:**
1. DATA OUTLET AT AUDIO-VISUAL ENCLOSURE BY 27 10 00 CONTRACTOR. COORDINATE WITH 27 10 00 CONTRACTOR FOR OUTLET PLACEMENT.
 2. CEILING MOUNTED AUDIO-VISUAL ENCLOSURE.
 3. SINGLE SPEAKER SHOWN FOR CLARITY. SEE SPECIFICATIONS FOR SPEAKER REQUIREMENTS.
 4. PROVIDE 3-GANG, MINIMUM 3" DEEP, JUNCTION BOX WITH 3-GANG RING. COORDINATE WITH 27 20 00 CONTRACTOR FOR ADDITIONAL REQUIREMENTS.

JOHNSON CONSULTING ENGINEERS, INC.
Power | Lighting | Multimedia
Communications | Data Networking
12875 Brookrunner Place, Suite 300
Poway, CA 92064
P 858.679.4030 | F 858.513.0559
www.jcbe-inc.com

BakerNowicki design studio
731 Ninth Avenue, Suite A, San Diego, California 92101
619.795.2450
www.bnstudio.com

AUDIO-VISUAL DETAILS

NO. DATE ISSUE PROJECT NO. 000000
3 1/24/2020 ADDENDUM #3 DATE: 11/12/2019

DRAWING **E4.7**
AD3-E01

SUBSTITUTION REQUEST
(During the Bidding Phase)

Project: Murrieta High School - New Classroom Substitution Request Number: _____
24105 Washington Ave, Murrieta, CA 92562 From: New Millennium Building Systems
To: Erin Ryan-Todd, Project Manager Date: 25 January 2020
Erickson-Hall Construction Company A/E Project Number: _____
Re: p: 760-796-7700 e: eryl@ericksonhall.com Contract For: _____
Long-span Acoustical Roof Deck

Specification Title: 05 31 00 STEEL DECKING Description: "D4" 2x18ga. Epic ER2R shown S.08
Section: 2.2/A Page: 2 Article/Paragraph: Deck Profile: Epic ER2.0A


Proposed Substitution: 2.0" Versa-Dek S ES (in lieu of Epic Epicore ER2R)
Manufacturer: New Millennium Building Systems Address: 7575 W. Jefferson Blvd. Phone: 602-680-9019
Fort Wayne, IN 46804
Trade Name: 2.0" Versa-Dek S ES Model No.: 2.0 VSES

Attached data includes product description, specifications, drawings, custom color/pre-selected color availability, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation. **No changes to the Contract Documents required if substitution is approved.**

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E/ design, detailing, and construction costs caused by the substitution.

Submitted by: Alex Therien, AIA, LEED AP
Signed by: 
Firm: New Millennium Building Systems
Address: 7575 W. Jefferson Blvd.
Fort Wayne, IN 46804
Telephone: 602-680-9019

A/E REVIEW AND ACTION

- Substitution approved - Submit bid/proposal based on accepted substitution.
- Substitution approved as noted - Submit bid/proposal based on accepted substitution - as noted.
- Substitution rejected - Submit bid/proposal for specified materials.
- Substitution Request received too late - Submit bid/proposal for specified materials.

Signed by: _____ Date: _____

Supporting Data Attached: Drawings Product Data Samples Tests Reports Photographs

- X Side-by-side Comparison versus the basis-of-design product.
- X link to ICC Report: <https://icc-es.org/report-listing/esr-2657/>

construction schedule or milestones for the Project; and, (7) Contractor agrees to pay for any DSA Fees or other Governmental Plan check costs associated with this Substitution Request. (See General Conditions Section 3.6)

The undersigned states that the following paragraphs are correct:

1. The proposed Substitution does not affect the dimensions shown on the Drawings.
2. The undersigned will pay for changes to the building design, including Architect, engineering, or other consultant design, detailing, DSA plan check or other governmental plan check costs, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse effect on other trades, the Contract Time, or specified warranty requirements.
4. Maintenance and service parts will be available locally for the proposed substitution.
5. In order for the Architect to properly review the substitution request, within five (5) days following the opening of bids, the Contractor shall provide samples, test criteria, manufacturer information, and any other documents requested by Architect or Architect's engineers or consultants, including the submissions that would ordinarily be required under Article 3.7 for Shop Drawings along with a document which provides a side by side comparison of key characteristics and performance criteria (often known as a CSI side by side comparison chart).
6. If Substitution Request is accepted by the District, Contractor is still required to provide a Submittal for the substituted item pursuant to Article 3.7 and shall provide required Schedule information (including schedule fragments, if applicable) for the substituted item as required under Article 8.3.2.1. The approval of the Architect, Engineer, or District of the substitution request does not mean that the Contractor is relieved of Contractor's responsibilities for Submittals, Shop Drawings, and schedules under Article 3.7 and 8.3.2 if the Contractor is awarded the Project.

Name of Bidder: _____

By: _____

District: _____

By: _____

SHOP DRAWING & SUBMITTAL REVIEW

- No Exception Taken Make Corrections Noted
- Rejected Revise and Resubmit
- Submit Specific Item

This review is only for general conformance with the design concept of the project and general compliance with the information given the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for: dimensions to be confirmed and correlated at the job site; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her work with that of all other trades; and for performing all work in a safe and satisfactory manner.

KNA STRUCTURAL ENGINEERS

Date 1/28/20 By TC



NEW MILLENNIUM
BUILDING SYSTEMS

Project:
Location:

Murrieta Mesa High School New Classroom
Murrieta, CA

Deck Area	S3.12 Bldg .4 Sloped Roof Framing Plan		
			Notes
Product Description			
Type	2.0 Versa-Dek® S ES	ER2R	
Height (in.)	2	2	
Steel Thickness (Gauge / in.)	18 GA / 0.0474	18 GA / 0.0474	
Steel Yield Strength, F _y (KSI)	40 / A653 Grade 40	40 / A653 Grade 40	
ICC Report	ESR-2657	ESR-2047	
Deck Weight (PSF)	3.56	3.6	
Profile Section Properties			
Moment of Inertia, I _d (in ⁴ /ftw)	0.674	0.630	See ESR-2657 page 7 & ER-2047 page 4
Section Modulus, Positive Bending, S _p (in ³ /ftw)	0.514	0.470	
Section Modulus, Negative Bending, S _n (in ³ /ftw)	0.475	0.430	



VERSA-DEK® SES ROOF (ASD)

2" high x 6" pitch x 24" wide

SECTION PROPERTIES

fy=40 ksi

GAGE	Wd	I _b (DEFLECTION)	Sp	Sn	Rbe			Rbi			Va
					2"	3"	4"	4"	5"	6"	
22	2.22	0.422	0.307	0.273	718	826	918	1408	1518	1618	3023
20	2.70	0.511	0.390	0.346	1022	1172	1298	1999	2150	2287	3650
18	3.56	0.674	0.514	0.475	1702	1939	2139	3318	3557	3773	4790
16	4.49	0.848	0.646	0.615	2596	2941	3231	5047	5393	5707	5984



ASD DESIGN		MAXIMUM SUPERIMPOSED UNIFORM ASD LOADS (psf)											
Span	Load Combinations	SINGLE SPAN				DOUBLE SPAN				TRIPLE SPAN			
		GAGE											
		22	20	18	16	22	20	18	16	22	20	18	16
5' - 0"	D+L (Strength)	194	247	326	400	170*	215*	295*	381*	211*	267*	366*	400*
	D+L (Deflection)	194	247	326	400	170	215	295	381	211	267	366	400
	L (Deflection)	148	179	236	297	170	215	295	381	211	267	366	400
5' - 6"	D+L (Strength)	160	203	268	337	140*	178*	244*	315*	175*	221*	303*	392*
	D+L (Deflection)	160	199	263	330	140	178	244	315	175	221	303	392
	L (Deflection)	111	134	177	223	140	178	244	315	175	221	303	392
6' - 0"	D+L (Strength)	134	170	225	283	118*	149*	205*	265*	147*	186*	255*	330*
	D+L (Deflection)	126	153	201	253	118	149	205	265	147	186	255	330
	L (Deflection)	85	104	137	172	118	149	205	265	147	186	255	324
6' - 6"	D+L (Strength)	114	145	191	240	100*	127*	174*	225*	125*	159*	218*	281*
	D+L (Deflection)	99	119	158	198	100	127	174	225	125	159	218	281
	L (Deflection)	67	81	108	135	100	127	174	225	125	153	203	255
7' - 0"	D+L (Strength)	98	125	164	207	86*	109*	150*	194*	108*	137*	188*	243*
	D+L (Deflection)	79	95	126	158	86	109	150	194	108	137	188	243
	L (Deflection)	54	65	86	108	86	109	150	194	101	123	162	204
7' - 6"	D+L (Strength)	85	108	143	179	75*	95*	130*	169*	94*	119*	163*	211*
	D+L (Deflection)	63	77	101	127	75	95	130	169	94	119	163	211
	L (Deflection)	44	53	70	88	75	95	130	169	82	100	132	166
8' - 0"	D+L (Strength)	74	95	125	157	66*	83*	114*	148*	82*	104*	143*	185*
	D+L (Deflection)	52	63	83	104	66	83	114	148	82	104	143	185
	L (Deflection)	36	44	58	72	66	83	114	148	68	82	109	137
8' - 6"	D+L (Strength)	66	84	110	139	58*	73*	101*	131*	73*	92*	127*	164*
	D+L (Deflection)	43	52	69	86	58	73	101	131	73	92	127	164
	L (Deflection)	30	36	48	60	58	73	101	131	57	69	91	114
9' - 0"	D+L (Strength)	58	74	98	123	51*	65*	90*	116*	65*	82*	113*	146*
	D+L (Deflection)	36	43	57	72	51	65	90	116	65	82	111	139
	L (Deflection)	25	31	40	51	51	65	90	116	48	58	76	96
9' - 6"	D+L (Strength)	52	66	88	110	46*	58*	80*	104*	58*	73*	101*	131*
	D+L (Deflection)	30	36	48	60	46	58	80	104	58	71	94	118
	L (Deflection)	22	26	34	43	46	58	80	104	41	49	65	82
10' - 0"	D+L (Strength)	47	60	79	99	41*	52*	72*	93*	52*	66*	91*	118*
	D+L (Deflection)	25	31	41	51	41	52	72	93	50	61	80	100
	L (Deflection)	18	22	30	37	41	52	71	89	35	42	56	70
10' - 6"	D+L (Strength)	42	54	71	89	37*	47*	65*	84*	47*	60*	82*	106*
	D+L (Deflection)	22	26	35	44	37	47	65	84	43	52	69	86
	L (Deflection)	16	19	26	32	37	47	61	77	30	36	48	60
11' - 0"	D+L (Strength)	38	49	64	81	34*	43*	59*	76*	43*	54*	74*	96*
	D+L (Deflection)	19	23	30	37	34	43	59	76	37	45	59	74
	L (Deflection)	14	17	22	28	33	40	53	67	26	32	42	53
11' - 6"	D+L (Strength)	35	44	59	74	31*	39*	54*	70*	39*	49*	68*	88*
	D+L (Deflection)	16	19	26	32	31	39	54	70	32	39	51	64
	L (Deflection)	12	15	19	24	29	35	47	59	23	28	37	46

5' - 0"	D+L (Strength)	194	← Max. superimposed ASD dead + live load (psf) (governed by strength limitation)
	D+L (Deflection)	194	← Max. superimposed ASD dead + live load (psf) (governed by deflection limitation of L/240 or 1")
	L (Deflection)	148	← Max. superimposed ASD live load (psf) (governed by deflection limitation of L/360 or 1")

↑ Vertical load span (center to center spacing)

- Wd** Weight of deck (uncoated), psf
- I_b** Moment of inertia for deflection per foot of deck width, (in⁴)/ft
- Sp** Section modulus for positive bending per foot of deck width, (in³)/ft
- Sn** Section modulus for negative bending per foot of deck width, (in³)/ft
- Va** Allowable shear value per foot of deck width, plf
- Rbe** Allowable exterior web crippling value per foot of deck width, plf
- Rbi** Allowable interior web crippling value per foot of deck width, plf
- D** Uniform dead load, psf
- L** Uniform live load, psf

- Notes:**
- Bending strength based on allowable flexural stress of 24 ksi.
 - Loads marked with asterisk (*) are governed by moment & shear or interior reactions (web crippling) assuming 4" of interior bearing.
 - An upper limit of 400 psf has been applied to the loads.
 - Deck length over 40'-0" require inquiry and special accommodations. Please contact NMBS for further information.

The section properties table is based on AISI S100-07/S2-10 North American Specification for the Design of Cold-Formed Steel Structural Members with Supplement No. 2. Acoustical profile is also available.

REQUEST FOR SUBSTITUTION AT TIME OF BID

Pursuant to Public Contract Code section 3400, bidder submits the following request to Substitute with the bid that is submitted. I understand that if the request to substitute is not “an/or equal” or is not accepted by District and I answer “no” I will not provide the specified item, then I will be held non-responsive and my bid will be rejected. With this understanding, I hereby request Substitution of the following articles, devices, equipment, products, materials, fixtures, patented processes, forms, methods, or types of construction:

	Specification Section	Specified Item	Requested Substituted Item	Contractor Agrees to Provide Specified Item if request to Substitute is Denied ¹ (circle one)	District Decision (circle one)
1.				Yes No	Grant Deny
2.				Yes No	Grant Deny
3.				Yes No	Grant Deny
4.				Yes No	Grant Deny
5.				Yes No	Grant Deny
6.				Yes No	Grant Deny
7.				Yes No	Grant Deny
8.				Yes No	Grant Deny
9.				Yes No	Grant Deny
10.				Yes No	Grant Deny
11.				Yes No	Grant Deny
12.				Yes No	Grant Deny

This Request Form must be accompanied by evidence as to whether the proposed Substitution (1) is equal in quality, service, and ability to the Specified Item; (2) will entail no change in detail, construction, and scheduling of related work; (3) will be acceptable in consideration of the required design and artistic effect; (4) will provide no cost disadvantage to the District; (5) will require no excessive or more expensive maintenance, including adequacy and availability of replacement parts; (6) will require no change of the

¹ Bidder must state whether bidder will provide the Specified Item in the event the Substitution request is evaluate and denied. If bidder states that bidder will not provide the Specified Item the denial of a request to Substitute shall result in the rejection of the bidder as non-responsive. However, if bidder states that bidder will provide the Specified Item in the event that bidder’s request for Substitution is denied, bidder shall execute the Agreement and provide the Specified Item(s). If bidder refuses to execute the Agreement due to the District’s decision to require the Specified Item(s) at no additional cost, bidder’s Bid Bond shall be forfeited.



NEW MILLENNIUM
BUILDING SYSTEMS

Northern Arizona University: Wall Aquatic Center, 824 San Francisco Street, Flagstaff, AZ 86011.
Owner: Northern Arizona University
Architect: Sink Combs Dethlefs Architects, Denver, Colorado.
Structural: Holben, Martin & White, Tucson, Arizona.

White Center Library, Seattle, 1409 SW 107th St, Seattle, WA 98146.
Owner: King County Library System
Architect: NBBJ Architects, Seattle, Washington.
Engineer: Coughlin Porter Lundeen, Seattle, Washington.

Roberts Pavilion Recreations Center, 690 N. Mills Ave, Claremont, CA 91711.
Owner: Claremont McKenna College
Architect: John Friedman/Alice Kim Architects, Los Angeles, California
Engineer: Simpson Gumpertz & Heger, Los Angeles, California.

Irvington High School, 41800 Blacow Road, Fremont, CA 94538.
Owner: Fremont Unified School District:
Architects: SVA Architects, Oakland, California.
Engineer: Tipping Mar, Berkeley, California.

Cedar Grove Elementary School, 2702 Sugarplum Drive, San Jose, CA 95148.
Owner: Evergreen School District
Architect: AEDIS Architects, San Jose, California.
Engineer: Tipping Mar, Berkeley, California.

SER Ninos Children's Library, 5815 Alder Drive, Houston, TX 77081
Owner: City of Houston, Owner's rep: Bob Brooks, BPM Group
Architect: Merriman Holt Powell Architects, Houston, Texas.

Judith Resnik Middle School, 4495 SW Verano Parkway, Von Ormy, TX
Owner: Southwest ISD
Architect: Pfluger Architects, San Antonio, Texas
Engineer: Alpha Consulting Engineers, Inc., San Antonio, Texas

Legacy High School, 13608 Watson Road, Von Ormy, TX
Owner: Southwest ISD
Architect: Pfluger Architects, San Antonio, Texas
Engineer: Alpha Consulting Engineers, Inc., San Antonio, Texas

Westside Natatorium, 650 Wallenberg Drive, El Paso, TX 79912
Owner: City of El Paso
Architect: In*Situ, El Paso, Texas
Engineer: HKN Engineers, El Paso, Texas.

Rio Steam K-8 Academy, Oxnard, CA. 2710 North Ventura Road, Oxnard, CA 93036
Owner: Rio School District
Architect: Architecture for Education, Pasadena, California.
Engineer: KPFF, Pasadena, California.



**Claremont McKenna College, Roberts Pavilion Recreations Center,
690 N. Mills Ave, Claremont, CA 91711. (909)621-8000
John Friedman/Alice Kim Architects. Install Date: June 2015.**



The Urban School of San Francisco, Academics + Athletics Building
1563 Page Street, San Francisco, CA 94117
Pfau+Long Architects. Install Date: January 2016.



Evergreen School District: Cedar Grove Elementary School
2702 Sugarplum Drive, San Jose, CA 95148.
AEDIS Architects. Install Date: October 2016.