**THE SCHOOL DISTRICT OF PHILADELPHIA**
**SCHOOL REFORM COMMISSION**
**Office of Capital Programs**
**440 North Broad Street, 3rd Floor – Suite 371**
**Philadelphia, PA 19130**

**TELEPHONE: (215) 400-4730**

**Addendum No. 001**

**Subject:** **Building Automation System (BAS) Replacement**
**SDP CONTRACT NO. B-015c and B-016c of 2018/2019**

**Location**: **High School For Creative & Performing Arts (CAPA)**
**901 S Broad St.**
**Philadelphia, PA 19147**

**This Addendum, dated October 23, 2020, shall modify and become part of the Contract Documents for the work of this project. Any items not mentioned herein, or affected by, shall be performed strictly in accordance with the original documents.**

**Revise as indicated below or by attachment**

**1 Specifications**

1.1 ADD the following Specifications to the contractor documents:

- 02 4119 Minor Electrical Demolition
- 26 0500 Common Work Results for Electrical
- 26 0519 Low-Voltage Electrical Power Conductors and Cables
- 26 0526 Grounding and Bonding for Electrical Systems
- 26 0528 Hangers and Supports for Electrical Systems
- 26 0533 Raceways and Boxes for Electrical Systems
- 26 0535 Boxes for Electrical Systems
- 26 0553 Identification for Electrical Systems
- 26 0563 Acceptance Electrical Testing
- 26 2416 Panelboards
- 26 2726 Wiring Devices
- 26 2816 Enclosed Switches and Circuit Breakers
- 28 3100 Fire Detection and Alarm

**2 Drawings**

2.1 N/A

**3 Contractor questions:**

3.1 The List of Specs (section 00 0005) lists Div 26 and 28, but those divisions were not actually included in the set. Please provide.

RESPONSE: See attached specifications for Divisions 26 and 28.

**END OF ADDENDUM # 001**

# SECTION 02 4119

# SELECTIVE ELECTRICAL DEMOLITION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for demolition and salvaging existing electrical systems, wiring, raceways, supports, equipment and minor repair of underlying structure.

B. Related Sections:
   1. Division 01 – General Requirements

### 1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC)

### 1.03 SUBMITTALS

A. Submit demolition plan.

### 1.04 COORDINATION AND SEQUENCING

A. Coordinate all power outages with Owner.

B. Perform demolition in a manner not to delay or interfere with other operations of work in the Project and operations of the Owner.

### 1.05 SCHEDULING

A. Schedule all work with the Owner through the Owner's designated representative. Start no work in an area until a schedule has been prepared, submitted and approved.

B. Coordinate the work schedule with the Owner, Engineer, and other Contractors. Coordinate the work so not to interfere or conflict with the performance of work by the Owner and the Owner's tenants.

### 1.06 PROJECT/SITE CONDITIONS

A. Care shall be used so as not to impede the ongoing operations of the Owner.

B. Demolition work, as specified herein, is not intended to be performed as a wrecking operation but as work relative to the performance of the various construction operations of the Project.

C. Existing Conditions:
   1. Demolition information shown or otherwise indicated on the Drawings is based on visual field examination and existing record documents. While the information provided is believed to be correct, no assurance is implied relative to its total completeness or accuracy. Report discrepancies to Construction Manager for disposition of the Engineer before disturbing existing installations.



Addendum 01

2. The Contractor hereby distinctly agrees that neither the Construction Manager, the Engineer nor the Owner is responsible for the correctness or sufficiency of the information given and after his own Site Investigation:
   a. That he must have no claim for delay or extra compensation or damage on account of the information given; and
   b. That he must have no claim for relief from any obligation or responsibility under the Contract with respect to the above stated stipulations.

D. Protection: Exercise care during demolition work to confine demolition operations to the areas as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor will be completely responsible for replacement and restitution work, of whatever nature, at no expense to the Owner.
   1. Additionally, if public safety is endangered during the progress of the demolition work, provide adequate protective measures to protect the public and/or Owner personnel.
   2. Conform signs, signals and barricades to requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those products such as conduit, raceway, wire and cable, support devices, fasteners, and control devices as required for work of this Section are specified in other Sections.

B. Equipment along with machinery and apparatus, motorized or otherwise, used to perform the demolition may be chosen at the Contractor's discretion. However, the chosen equipment shall perform the work within the limits of the Contract requirements.

C. Patching Materials: Patching materials shall match, as nearly as practical, the existing material for each surface being patched.

## PART 3 EXECUTION

### 3.01 INSPECTION

A. Verify that measurements and existing circuiting arrangements are as shown on Drawings.

B. Equipment, machinery and apparatus, motorized or otherwise, used to perform the demolition work may be used as chosen at the Contractor's discretion, but which will perform the work within the limits of the Contract requirements.

C. Verify that abandoned wiring and electrical equipment serve only the abandoned facility.

### 3.02 DEMOLITION

A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor, except as otherwise specified. However, equipment used, and methods of demolition and removal will be subject to approval of the Construction Manager and the Engineer.
   1. Remove, relocate and extend existing installations to accommodate new construction as indicated and/or as required.

2. Remove exposed abandoned conduit systems, including abandoned conduit systems above accessible ceiling systems.
3. Remove wiring in abandoned conduit systems to source of power supply.
4. Maintain access to existing electrical installations, which remain active. Modify installations and provide access panels or plates as appropriate.
5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified in other Sections of these Specifications.
6. Wiring Devices:
   a. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduits serving them is abandoned and removed. Provide blank covers for abandoned outlets, which are not removed.
   b. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
7. Lighting:
   a. Disconnect and remove lighting fixtures as indicated on the Drawings. Remove associated brackets, stems, hangers and other accessories. Remove abandoned lighting outlets and associated conduit and wire if not reused for new lighting equipment.
8. Equipment:
   a. Disconnect and remove electrical equipment where so indicated on the Drawings.
   b. Disconnect and remove abandoned distribution equipment, panelboards, disconnect switches and motor starters as indicated on the drawings or as otherwise required due to the removal of associated equipment.
9. In exposed, through-structure conduit locations, the abandoned conduit(s) must be cut below the finished structural surface in order to perform surface patching.

B. System De-activation: Prior to demolition and removal work, de-activate existing electrical systems as indicated.

C. Use means and methods for permanent disconnection, which render the remaining electrical systems and apparatus in conformity with NFPA 70.

D. Provide temporary wiring and connections as required to maintain existing systems in service during construction. Remove same when no longer required.
   1. Conform temporary wiring to the requirements of NEC Article 305, General Requirements.

E. Remove all wiring from disconnected circuits, feeders, and equipment unless otherwise specified or indicated. Remove all exposed raceways and related supports. Cut all exposed raceways flush with floor and plug.

F. Coordinate electrical power outages with requirements in Section 26 0500 and applicable Section(s) of Division 01.
   1. De-energization of the electrical service to the building, as required for removal of existing and installation of new service and distribution equipment in the Main Electric Room, shall be scheduled to occur during the summer months, when school is not in session; outages shall NOT be permitted during the normal school year without express written permission of the District.

G. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor except as otherwise specified. Use equipment and methods that do not damage items to remain or salvaged and areas adjacent to demolition operations. Use methods that do not interfere with Owner's operations and which do not cause excessive dust. Remove debris as it accumulates.

H. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

I. Debris Removal: Dispose of demolition debris off site in a lawful manner. Containerize or otherwise store debris as work is in progress.

J. Patching: After demolition and removal work is performed patch the existing structure as required to match surrounding finish and appearance including the appropriate surface decoration.

K. Abandoned Electrical Equipment and Apparatus: Existing electrical equipment and apparatus in or on the structures not claimed as salvage by the Owner shall become the property of the Contractor and may not be disposed of on the site but removed and disposed of in a lawful manner off-site.

L. Salvage: The Owner shall have the right to claim as salvage any items and materials removed under the work of this Section. Should such right of salvage be exercised by the Owner, move and neatly store removed items on the site in a location agreeable to the Owner and in a manner approved by the Engineer.

END OF SECTION 02 4119

# SECTION 26 0500

# COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes the following:
1. Electrical equipment coordination and installation
2. Sleeves for raceways and cables
3. Sleeve seals
4. Common electrical installation requirements
5. Supporting devices for electrical components
6. Cutting and patching for electrical construction
7. Touchup painting

### 1.03 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. Provide: Furnish and install.

C. Directed: Directed by the A/E.

D. Indicated: Indicated in the Contract Documents.

E. Concealed: Hidden from normal sight. Includes items in shafts, pipe and duct spaces and above ceilings.

F. Exposed: Not concealed. Work within equipment rooms and all visible (normal sight) work shall be considered “exposed”.

### 1.04 SUBMITTALS

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

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Electrical System Studies.

### 1.05 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.06 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So that connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

E. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent, are tested to demonstrate successful interoperability.

1.07 GENERAL REQUIREMENTS

A. Nothing contained in these "SPECIFICATIONS" or shown on the "DRAWINGS" shall be so constructed as to conflict with any local, municipal, or State laws or regulations governing the installation of electric or other work specified herein, and all such ordinances and regulations, including the National Electrical Code, are hereby incorporated and made a part of these specifications. All such requirements shall be satisfied by the Contractor and at no additional cost to the Owner.

B. Due to the small scale of drawings, it is not possible to indicate all conduits, conductors, boxes, fittings, switches, and similar parts which may be required. The contractor shall investigate the structural and finish conditions affecting the work and arrange all work accordingly furnishing such parts and equipment as may be required to meet building conditions.

C. Contractor shall lay out work from dimensions of architectural and structural drawings and actual dimensions of equipment being installed. Layouts in congested areas should not be scaled from mechanical or electrical drawings.

D. The Drawings are indicative of the character and scope of the work and are not intended to show all the details.

E. The actual location of all wiring, outlets, and equipment shall be determined at the site.

F. The Drawings shall be carefully checked, to ensure that all equipment, as shown, will operate satisfactorily in the space allotted to it.

G. Generally, major equipment of the system is located on the floor plans and the interconnecting conduit and wiring are indicated on the diagrams or called for in the Specifications.

1.08 QUALITY ASSURANCE

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

B. Comply with all applicable requirements of NFPA 70, National Electrical Code.

C. Testing Agency: Use a NETA accredited electrical testing agency, or approved equal, that is accredited for the region in which the Contract work is performed. Refer to Section 26 0563.

1.10 REGULATIONS

D. All electrical work, equipment and material furnished or installed under this contract shall conform to the requirements of latest applicable codes and any other Governmental or Local Authorities having jurisdiction and all rules and regulations of the Utility Company involved. Nothing mentioned in the specifications or indicated on the drawings shall be construed to conflict with the mentioned codes, ordinances, and regulations.

E. All materials furnished, and all work installed, shall comply with the latest issue of the codes, rules, regulations, and recommendations of the following bodies, unless otherwise noted:
1. American National Standards Institute (ANSI)
2. American Society of Testing and Materials (ASTM)
3. International Building Code (IBC)
4. International Energy Conservation Code (IECC)
5. Insulated Power Cable Engineers Associate (IPCEA)
6. Insulated Cable Engineers Associate (ICEA), formerly IPCEA.
7. Illuminating Engineering Society (IES)
8. Institute of Electrical and Electronic Engineers (IEEE)
9. National Electrical Code (NEC)
10. National Electrical Manufacturers Association (NEMA)
11. National Fire Protection Association (NFPA)
12. National Electrical Safety Code (NESC)
13. National Electrical Contractors Association (NECA)
14. Occupational Safety and Health Agency (OSHA)
15. Underwriters Laboratories, Inc. (UL)
16. City or Local Code(s)
17. Pennsylvania Department of Labor and Industry (L&I)
18. Pennsylvania Department of Health (DoH)
19. National Board of Fire Underwriters
20. Americans with Disabilities Act (ADA)
21. City of Philadelphia Electrical Code
22. Other codes, as applicable

1.11 ELECTRICAL SYSTEM STUDIES

A. Prepare and submit a Short Circuit, Arc-Flash, and Protective Device Coordination Study as specified in this Article.
1. Immediately after award of the Contract, collect all data needed to perform calculations for the studies.

a. Obtain, in writing, electrical utility source information and any other information required from the utility to perform the necessary studies directly from the serving utility.
b. The Owner will provide, as available, information about the portions of the facility's existing electrical system affected by the work performed under this Contract.
    1) The Owner will provide copies of the latest revision of the existing facility record drawings to the Contractor for use in defining existing equipment load requirements.
    2) Base the contribution of motors on actual motor loads as indicated on the equipment list, system one-line diagrams, and panel schedules.
    3) If the information provided is insufficient to perform the studies or represents unknown ratings of existing equipment, investigate and obtain the information required.
        a) Employ qualified technicians to obtain the necessary data.
c. Obtain data for new equipment directly from suppliers and other contractors working on the project.

2. Once the data needed is obtained, perform a preliminary computerized Short Circuit, Arc-Flash, and Protective Device Coordination Study, complete with initial calculations.
    a. At least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.
    b. After the Engineer provides his comments, submit four copies of the revised and corrected preliminary studies.
3. Include the following types of information common to each study:
    a. Calculations and tabulations.
        1) Ensure that the calculations in the Short Circuit, Arc-Flash, and Protective Device Coordination Study are sufficient to ascertain interrupting and/or withstand ratings of the equipment.
            a) Identify items of distribution system equipment that are not rated for the available fault current and provide corrective recommendations for consideration.
    b. Data on the computer programs used to perform calculations and tabulations.
    c. An appendix to each report that includes the information obtained from outside entities, agencies, electrical manufacturers, the serving utility company, field inspections, and other field sources such as the following:
        1) Copies of letters.
        2) Photographic records.
        3) Nameplate tracings.
        4) Actual data sources from which the data and information was obtained.

B. Final Project Report:
1. After the Engineer accepts the revised and corrected preliminary studies, prepare a report summarizing the results of the individual studies; and submit this Final Project Report to the Engineer for acceptance and approval.
    a. Include the following sections in the Final Project Report:
        1) Description.
        2) Purpose.
        3) Basis and scope of the study.
        4) A single line diagram of that portion of the power system that is included within the scope of the study.
        5) Computerized time versus current coordination graphs and corresponding printouts for protective devices.
            a) Include the feeder cable damage curves associated with the items being coordinated in these graphs.

b) Include the ANSI/NEMA MG 1 damage points for the motors in the system and the ANSI/IEEE C57.12.00 mechanical and electrical damage points on the curves.

6) Tabulations of the relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

7) Harmonic data at Points-of-Common-Coupling (PCC).

b. Submit ten bound copies of the Final Project Report for review and approval and two copies of record drawings showing the existing facility as it was before the work of this Contract was performed.

c. Once the Final Project Report has been approved, forward one additional bound final copy of the report to the Owner.

C. Short Circuit, Arc-Flash, and Protective Device Coordination Study:

1. Prepare the Short Circuit, Arc-Flash, and Protective Device Coordination Study under the supervision of a Professional Engineer, licensed in the Commonwealth of Pennsylvania, or have a NETA certified electrical testing laboratory employing technicians certified according to ANSI/NETA ETT prepare it.

a. Perform the short circuit portion of the Study in accordance with ANSI/IEEE C37.10, ANSI/IEEE C37.13, ANSI/IEEE 141, ANSI/IEEE 242, and ANSI/IEEE 399.

1) Calculate short circuit momentary duty values and interrupting duty values on the basis of the following short circuit conditions at every distribution transformer, secondary and primary terminal at every bus in every switchboard, motor control center, distribution panelboard, branch circuit panelboard and at terminals of utilization equipment whether it be Electrical, Process, HVAC, Plumbing or Instrumentation that is either 480V or 208V, 3-phase and rated 15 Amps or higher. Include:

a) Single line to ground fault.

b) Bolted three-phase line to ground fault.

c) Double line (line to line) to ground fault.

b. Perform the arc flash portion of the Study for the electrical distribution equipment in accordance with NFPA 70E and ANSI/IEEE 1584.

1) Perform the analysis under worst-case arc-flash conditions; and if applicable, describe in the final report how these conditions differ from worst-case bolted fault conditions.

2) Provide the following items for each circuit and arc location analyzed:

a) Printed hardcopy of calculations performed.

b) Arcing fault magnitude.

c) Device clearing time.

d) Duration of arc.

e) Arc flash boundary distances.

f) Working distance.

g) Arc flash incident energy.

h) Hazard risk category.

i) Personal-protective equipment classes.

j) Arc flash warning labels as specified in Section 26 05 23.

k) Recommendations and potential options for arc flash energy reduction to reduce the Incident Energy levels where they are calculated to be over the 40 cal/cm2.

l) Maintenance procedures/guidelines in accordance with the requirements of NFPA 70E for the Owner.

c. Coordinate protective devices with systems and equipment by providing the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, ratios and characteristics of associated current transformers, and breaker trip characteristics and settings and distribution system fuses.

1) Provide coordination plots for phase and ground protective devices on a system basis.
   a) Adhere to National Electrical Code restrictions and maintain proper coordination.
   b) Provide a sufficient number of separate curves to clearly indicate the coordination achieved.
2) Computer-generate time-current characteristics of the specified protective devices on log-log scale plots.
   a) Include complete titles, the respective one-line diagram and identifying legends, associated relays or fuse characteristics, significant motor starting characteristics, complete operating bands of low voltage circuit breaker trip curves and fuses.
   b) Indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush, through-fault current duration per ANSI/IEEE C57.12.59, dry-type transformers withstand, cable thermal overcurrent withstand limits, symmetrical fault currents and motor full load current, locked-rotor current, and magnetizing inrush in the coordination plots.
3) Provide the selection and settings of the protective devices separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings.
   a) Use the information from the Study to obtain optimum device protective and coordination performance.

2. In addition to the information common to the studies as listed in Subparagraph 1.11 A 3, include the following information specific to short circuit, arc-flash, and protective device coordination distortion only in the Short Circuit, Arc-Flash, and Protective Device Coordination Study:
   a. Complete short circuit and protective device coordination studies, including coordination plots, for the following electrical distribution systems serving the entire facility:
      1) Utility (primary) voltage service
      2) Low voltage service/distribution system.
      3) Low voltage 208Y/120 volts, 3 phase, 4 wire distribution systems.
   b. Power company supply and network characteristics, including the following:
      1) The base quantities selected.
      2) Source impedance data and impedance diagrams.
      3) One-line diagrams.
      4) Calculation methods and tabulations.
         a) Include short circuit tabulations of the fault impedance, X to R ratios, asymmetry factors, KVA, symmetrical and asymmetrical fault currents, and all multiplying factors.
      5) Conclusions and recommendations.
   c. Motor starting characteristics for motors 50 HP and above.
   d. Provide sufficient information in the study to ensure adequate protection of the cables, transformers, and other equipment; to indicate proper coordination between fuses and circuit breakers; and to determine areas of the system in which additional coordination may be required.
3. Submit Short Circuit, Arc-Flash, and Protective Device Coordination Study information with the equipment submittals for review by the Engineer.

1.12 PERMITS AND INSPECTIONS

A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary

plans, prepare all documents, and obtain all necessary approvals of all governmental agencies having jurisdiction. Obtain all required certifications of inspection and deliver same to the Architect.

1.13 RECORD DRAWINGS

A. The Contractor shall keep accurate records of all deviations in work as actually installed from work indicated. One complete set of Contract Documents shall be available at the construction site for indicating said deviations. The Contractor shall indicate routing of all feeders, junction boxes and the like.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping. Use UL listed materials as shown in a UL listed detail for the configuration of the penetration. Submit UL detail showing materials used.

2.03 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished for the project shall be new and of first quality, produced by manufacturers of recognized reputation for each line of material or equipment. The fact that materials or equipment offered are recently developed and untried may be sufficient justification for their rejection. All materials, fittings, devices, and equipment shall be those approved by the Underwriters Laboratories, Inc., and if of the class for which the Underwriters Laboratories, Inc., provides label service, they shall bear such labels.

B. Where there is more than one item of equipment furnished under this Contract, the Contractor shall furnish equipment of the same type and from the same manufacturer. In no case shall the Contractor furnish similar types of equipment from different manufacturers. One manufacturer shall furnish all similar types of equipment.

2.04 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give right of way to raceways and piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables or wireways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section, "Firestopping."

C. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with fire stop materials. Use UL listed materials as shown in a UL listed detail for the configuration of the penetration. Submit UL detail showing materials used.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

N. Sleeves shall be provided by the Contractor for the installation of conduit, etc. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.

O. Sleeves shall be provided for all conduit, etc. passing through concrete, masonry, plaster and gypsum wallboard construction. Caulk the annular space of sleeves with an elastic fire-resistant caulking compound to make installation fire, air and water tight.

P. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into space between conduits, etc., and sleeve during construction.

Q. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.

R. At all sleeves where objectionable noise can be transmitted, at smoke barriers, at walls above ceilings that extend to underside of the structure of floor above, or at fire rated separations, seal all openings between conduit, etc. and corresponding sleeves to prevent sound transmission and to maintain fire rating. Use UL approved resilient sealant for penetration seals. Submit method of sealing for approval. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals, as manufactured by Thunderline Corporation or approved equal, between pipe and sleeves.

S. Where conduit motion due to expansion and contraction will occur, provide sleeves of sufficient diameter, or permit free movement of conduit. Check construction to determine proper length for various locations; make actual lengths to suit the following:
   1. Terminate sleeves flush with walls, partitions, and ceilings.
   2. Terminate sleeves 2 inches above finished floor in equipment rooms or Wet Locations.
   3. In all other areas, terminate sleeves 1/2-inch above finished floors.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

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

3.04 FIRESTOPPING

A. Apply fire stopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Refer to Division 07 Section, “Firestopping”.

B. Use UL listed materials as shown in a UL listed detail for the configuration of the penetration. Submit UL detail showing materials used.

3.05 FIELD QUALITY CONTROL

A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

3.06 WORKMANSHIP

A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.

B. The quality of the workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to the acceptable quality is final.

3.07 WATERPROOFING

A. Under no circumstances shall any waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect. Penetrations required by this Contract shall be made watertight.

3.08 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.09 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
1. Raceways
2. Supporting devices for electrical components
3. Electricity-metering components
4. Concrete bases
5. Cutting and patching for electrical construction
6. Touchup painting

3.10 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint: Paint materials and application requirements are specified in Division 09 Section, "Painting."
1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.11 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

C. Conduit and Equipment to be painted: Clean all conduits exposed to view in completed structure by removing plaster and dirt. Remove grease, oil, and similar material from conduit and equipment by wiping with clean rags and suitable solvents in preparation for paint.

D. All Items with Factory Finish: Remove cement, plaster, grease and oil, and leave all surfaces, including cracks and corners, clean and polish. Touch up any scratched or bare spots to match finish. The Architect may approve factory finish as prime coat. See “Painting” Section.

E. Electrical equipment and materials exposed to public and in finished areas shall be finish-painted after installation to coordinate with surrounding walls. Surfaces shall be thoroughly cleaned for receiving paint. Paint color coordination shall be as directed, and on adjacent surfaces to insure proper matching of quality and color with surrounding areas.

F. All electrical apparatus and equipment in equipment rooms shall be provided with a factory finish coat. All panels in public spaces, corridors, etc. shall be provided with a factory prime coat and field finish painted to match surrounding finishes.

G. Site Cleaning: Remove from site all packing cartons, scrap materials, and other rubbish relating to electrical installation.

3.13 MECHANICAL EQUIPMENT WIRING

A. Furnish and install all conduit and power wiring to all safety switches, motor starters, start/stop switches, HOA switches, and thermal switches, and make final power connections to all mechanical equipment.

B. Provide all safety switches, motor starters, start/stop switches to mechanical equipment as indicated on the Contract Drawings.

C. All safety disconnect switches, motor starters, start/stop buttons, HOA switches, thermal switches, etc. for HVAC equipment, plumbing equipment, and motorized door operators shall be installed by the Electrical Contractor.

D. All control wiring shall be the responsibility of the respective Contractor supplying the equipment.

E. Coordination: Refer to Division 23 Section, “HVAC Instrumentation and Controls” to coordinate work with other trades relative to smoke damper, air handling units, and other control functions.

END OF SECTION 26 0500

# SECTION 26 0519

# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting low voltage cable, shielded cable, and accessories.

B. Related Sections:
   1. Section 26 0500 – Common Work Results for Electrical
   2. Section 26 0526 – Grounding and Bonding for Electrical Systems
   3. Section 26 0553 – Identification for Electrical Systems
   4. Section 26 0533 – Raceways and Boxes for Electrical Systems
   5. Section 26 0563 – Acceptance Electrical Testing

### 1.02 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 1202 - Standard for Flame-Propagation Testing of Wire and Cables

C. National Electrical Manufacturer's Association (NEMA):
   1. NEMA WC 26/EEMAC 201 - Binational Wire and Cable Packaging Standard
   2. ANSI/NEMA WC 57 - Standard for Control, Thermocouple Extension, and Instrumentation Cables

D. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC)

E. Underwriter's Laboratories, Inc. (UL):
   1. UL 13 - Standard for Power-Limited Circuit Cables
   2. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords
   3. UL 1685 - Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

F. Insulated Cable Engineers Association (ICEA):
   1. ICEA T-29-520 - Vertical Cable Tray Flame Test @ 210,000 BTU

### 1.03 DESIGN REQUIREMENTS

A. Conductors in Raceway and Conduit Systems:
   1. Provide conduit systems for installing wiring that is outside of equipment.
   2. Except for raceway or conduit for control wires or where otherwise indicated on the Contract Drawings, design raceway and conduit systems so that the maximum number of

low-voltage current carrying conductors (per NFPA 70, Article 310) in each raceway or conduit does not exceed three, plus a ground.

B. Cable Tension Design Requirements:
   1. Design conduit runs so that the tension limits set by the wire and cable manufacturers will not be exceeded.
      a. Provide additional pulling points as required to limit the tension to acceptable levels.

C. Product Data and Catalog Cuts:
   1. Submit low-voltage ground, power, and control wiring product data as listed below for the products provided as the Work of this Section; and clearly indicate the usage of each product on the data submitted.
      a. Wires and cables.
      b. Lugs.
      c. Connectors.
      d. Tapes.
      e. Pulling lubricant.
      f. Tools used to crimp connectors.

D. Use of Trade Names:
   1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
      a. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.

## 1.04 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of General Conditions:
   1. Product Data:
      a. Wires and cables
      b. Lugs
      c. Connectors
      d. Tape
      e. Pulling lubricant
   2. Samples:
      a. Wire samples
   3. Quality Assurance/Control Submittals:
      a. Certificates:
         1) Testing agency/quality verification
      b. Manufacturer’s Instructions:
         1) Cable manufacturer’s recommendations
      c. Qualification Statements:
         1) Documented experience of the installing firm
         2) Qualifications of the licensed electricians supervising the Work

## 1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installer Qualifications:

a. To install the Work of this Section, employ the services of a firm specializing in installing wire, cable, and accessories, and that has a minimum of 3 years experience doing so.
   1) Submit the documented experience of the firm installing the wire, cable, and accessories.
b. To supervise installation of the Work of this Section, employ licensed electricians.
   1) Submit the qualifications of the licensed electricians supervising the Work of this Section.

B. Regulatory Requirements:
1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70, and to all other applicable state, local, and national governing codes and regulatory requirements.

C. Certifications:
1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available or unless standards do not exist for the products.
   a. Provide copper conductors listed and labeled by UL for all wiring.
2. Submit evidence of testing agency/quality verification, listing, and labeling for each product with the submitted product data either by providing a printed mark on the data or by attaching a separate listing card.
   a. For items without such evidence, submit a written statement from the product manufacturer that indicates why it does not have quality assurance verification.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Imprint insulated conductors with the date of manufacture, the wire type, and the manufacturer.
2. Package wire and cable in conformance with the requirements of NEMA WC 26/ EEMAC 201.
3. Protect items from damage during delivery, handling, and installation.
   a. Comply with the cable manufacturer's recommendations for inspection, handling, storage, temperature conditioning, bending and training limits, pulling limits, and calculation parameters for installing cable.
   b. Submit the cable manufacturer's recommendations for inspection, handling, storage, temperature conditioning, bending and training limits, pulling limits, and calculation parameters for installing cable

B. Acceptance at Site:
1. Wire and cable manufactured more than 12 months before delivery to the Site is unacceptable for use under this Contract, and will be rejected.

C. Storage and Protection:
1. Store products indoors on blocking or pallets.
2. Protect items from damage during storage.

PART 2 PRODUCTS

2.01 LOW VOLTAGE CONDUCTORS

A. Conductor Design Requirements:
1. Provide conductors of proper size and ampacity ratings based on Article 310 of NFPA 70.
a. Provide copper conductors that have 98 percent conductivity.
b. Unless otherwise indicated on the Contract Drawings, at a minimum provide conductors of the following American Wire Gauge (AWG) sizes:
1) For power and branch feeder circuits: 12 AWG.
a) For power and branch feeders, provide solid copper low-voltage conductors for sizes up to and including 10 AWG; provide stranded copper low-voltage conductors for 8 AWG and larger sizes.
2) For control circuits: 14 AWG.
3) For alarm and status circuits: 14 AWG.

B. Insulation Design Requirements:
1. Provide low voltage ground, power, and control wiring having the proper insulation types as follows:
a. For exterior, wet, and damp locations: Type XHHW-2
b. For wiring that is wholly in dry indoor locations: dual-rated Type THHN/THWN.
c. For ground wires: THW may be used at the Contractor's option.

2. Color Coding of Wires:
a. Insulation shall be color coded in accordance with requirements of Section 26 05 53.

3. Available Manufacturers:
a. Continental Wire & Cable Company
b. SouthWire
c. General Cable
a. CME Wire & Cable Inc.
b. Or Approved Equal

2.02 MATERIALS

A. 600 Volt Rated Multi-Conductor Cable:
1. Provide multi-conductor cable that is suitable for use indoors or outdoors; exposed or concealed; as open wiring; in any raceway, underground duct, or cable tray.
a. Provide cable that is UL listed for 90 degrees Celsius dry or wet, for direct burial, for cable tray use, and as sunlight resistant.
2. Assemble the cable with non-hygroscopic fillers and binder tape.
a. Insulated Conductors:
1) Provide uncoated stranded copper conductors, complying with the requirements of ASTM B 8 for Class B conductors.
2) Provide cross-linked polyethylene type XHHW-2 insulation rated for 600 volts.
b. Grounding Conductors:
1) Provide uninsulated copper conductors.
c. Cover the overall assembly with a single strip of interlocked aluminum tape, and then apply an outer final jacket of black flame-retardant PVC.
3. Available Manufacturers:
a. General Cable Technologies Corporation
b. The Okonite Company

c. Or Approved Equal

2.03 ACCESSORIES

A. Cable Pulling Lubrication and Lubricant:
1. Lubricant shall provide reduced tension on all types of cable jackets, dry to a thin lubricating film that retains its lubricity for an extended period and won't cement in the cables.
2. The cable pulling lubricant shall produce a low coefficient of friction on a wide variety of cable jacket materials. The lubricant shall be UL listed. It shall be easy to handle and adhere well to the cable. Where appropriate, it shall also be tested and approved for use with CSPE (chlorosulfonated polyethylene) fire-retardant cable jackets where these materials are utilized.
3. The lubricant shall be UL or CSA Listed and Labeled and shall pass the IEEE 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable. It shall pass physical compatibility tests on LLDPE, XLPE, CPE, and PVC cable jacket or sheath materials. It shall not stress crack polyethylene per ASTM Standard 1693. There shall be no significant changes in the conductive properties of XLPE and EPR semi-conducting compounds when the lubricant's effect on volume resistivity is tested according to IEEE Standard 1210.
4. Lubricant to be specification-grade type that does not promote flame propagation when used with fire-retardant cables and systems, is harmless to humans, environmentally safe, and compatible with all common cable jacket materials
5. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes. The lubricant shall have less than a 6.0% solids residue after drying for 24 hours at 105°C.
6. Where CPE insulated wire and/or cable is rated for Low Smoke / Zero Halogen type, only Polywater Type LZ shall be utilized.
7. Specific lubricants for fiber-optic and other special cable installations shall be determined by the cable / lubricant manufaturers and the Contractor shall provide submittal information, including MSDS documentation and other information verifying suitability of products and general specification compliance as outlined herein.
8. Available Manufacturers:
a. PolyWater - DynaBlue
b. 3M - Type WL
c. Greenlee - Type GEL

B. Grounding Braid:
1. Provide conformable, all-metal (tinned copper wires), corrosion resistant, woven grounding braid having a high current-carrying capacity approximately that of 6 AWG wire, such as.
2. Available Manufacturers:
a. 3M, Scotch, Scotch® 25 Electrical Grounding Braid,
b. Plymouth
c. Permacel
d. Or Approved equal

C. Tapes:
1. Vinyl Insulating Tape:
a. Provide UL-listed flexible polyvinyl chloride (PVC) backed insulating tape with a pressure sensitive adhesive, such as black Scotch® 33+ Vinyl Electrical Tape, that is

resistant to abrasion, acids, alkalis, and copper corrosion; resistant to, hot, cold and wet weather; and resistant to damage from UV sunlight exposure.

2. Rubber Splicing Tape:
   a. Provide highly conformable, linerless, self-bonding, ethylene rubber (EPR), high-voltage (through 69 kV) insulating tape formulated to provide excellent thermal dissipation of splice heat, and designed to insulate splices and terminate cables whose overload temperatures can reach 130 degrees Celsius, such as Scotch® 130C Linerless Rubber Splicing Tape.
3. Available Manufacturers:
   a. 3M, Scotch
   b. Plymouth
   c. Permacel
   d. Or Approved equal

D. Wire and Cable Connections:
1. Grounding Connectors:
   a. Provide grounding connectors conforming to the requirements of Section 26 05 26 Grounding and Bonding for Electrical Systems.
2. Connectors for Service Wires and Cables, and for Wires and Cables Larger Than Number 6:
   a. Split Bolt Connectors or Compression Type Connectors:
      1) Provide UL-listed split bolt connectors or compression type connectors for making parallel or butt splices of stranded copper wire.
      2) Use companion preformed plastic insulating covers or tape insulation conforming to NFPA 70 (NEC) requirements.
   b. Mechanical compression connectors:
      1) Provide mechanical compression connectors that are capable of connecting single or multiple conductors, and of being installed with one wrench.
         a) Type: Compact, two-hole mechanical compression connectors having two clamping bolts.
            (1) Connector Body: Provide a high copper bronze or brass alloy body.
            (2) Bolts: Provide brass or bronze bolts; plated steel screws are unacceptable.
            (3) Fasteners: Provide silicon-bronze fasteners for bolting connectors to connections.
   c. Crimped Compression Connectors:
      1) Provide two-hole crimped compression type connectors fabricated from high conductivity, seamless, electrolytic wrought copper, electrolytically tin-plated, and color coded to match the dies.
      2) Provide crimped compression type connectors with adequate area to conduct the electrical current.
      3) To crimp connectors, provide crimping tools from the same manufacturer that manufactured the connectors.
3. Control Wiring Connections:
   a. For control wiring connections at terminal boards, provide crimped nylon-insulated ring terminals.
   b. For control wiring splices, provide nylon insulated butt splices with insulation grips.
   c. For joining more than two control wires, provide junction boxes with terminal boards.
4. Connectors for Other Conductors:
   a. Any of the applicable types listed for larger wire may be provided.
   b. Screw Terminal Connections:

1) For making terminal connections of stranded copper wire to screw terminals, provide nylon insulated crimped compression terminals with copper barrel on the wire.
2) For making terminal connections of solid copper wire to screw terminals, provide screw lock connectors.

c. Wire Nuts:
1) For making splices of copper wire, provide pre-insulated, UL-listed, solderless connectors of the spring-lock or compression type that can be installed by hand or using tools.
2) For site lighting, wire nuts used in underground or below grade locations is prohibited. There only permitted use for site lighting is within a pole base.

d. Available Manufacturers:
1) Thomas & Betts Corp.
2) Tyco Electronics, AMP Inc.
3) Ilsco Corp.
4) FCI-Burndy® Products
5) Or Approved equal

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. 600 Volt Rated Multi-Conductor Cable:
a. 70,000 BTU/hr Vertical Tray Flame Test:
1) 600 Volt rated multi-conductor cable must pass the vertical tray flame test requirements of UL 1569, IEEE 383, and IEEE 1202.
b. 210,000 BTU/hr Vertical Tray Flame Test:
1) 600 Volt rated multi-conductor cable must pass the vertical tray flame test requirements of ICEA T-29-520.

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 EXAMINATION

A. Inspect all conduits, junction boxes, electrical vaults, and handholes to verify that they are clean, that they do not have burrs, that conduits are properly aligned, and that they are complete.
1. Ensure that on all conduits without threaded hubs, two locknuts are installed.
2. Ensure that in all conduits with wires larger than No. 10, bushings are installed.
3. Ensure that grounding bushings and fittings are installed at all places specified in Section 26 0526, “Grounding and Bonding”.
4. Verify that proper sized boxes are installed.

B. Verify that boxes and conduit fittings conform to the bending requirements specified in Article 314 of NFPA 70 (NEC).

## 3.03 PREPARATION

A. Verify that pulling calculations have been made and are available for long conduit runs and pulls as indicated in this Section.

B. Do not begin installing wiring until other work which might cause damage to the wires, cables, or conduits has been completed.
   1. Correct deficiencies in conduits, junction boxes, and raceways that have been discovered by the inspection required in Paragraph 3.02.A.

C. Prepare conduits to receive wire and cable.
   1. Swab the conduits with a nylon brush and steel mandrel.
   2. Pre-lubricate the conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

D. Verify that a means of controlling the pulling tension on the wire or cable is installed on the mechanical assist devices furnished for pulling cable.

E. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.

## 3.04 INSTALLATION

A. Low Voltage Ground, Power, and Control Wiring:
   1. Install Type CL2P, FPLP, or CMP cable as required by the application in accordance with the requirements of NFPA 70 (NEC).
      a. For exposed low voltage wiring, use plenum cable.
      b. For low voltage wiring concealed from view, only install wiring in the accessible locations permitted by the Contract Drawings.
   2. Neutral Conductors:
      a. For each single-phase and each multi-phase feeder, provide separate neutrals.
      b. For branch circuits, except at three-phase, wye-connected panelboards, provide separate neutral conductors.
         1) For three-phase, wye-connected panelboards, a common, or “shared”, neutral from three (3) adjacent single-pole circuit breakers, or from the poles of the same multi-pole circuit breaker, may be provided unless otherwise specified.
            a) Do not utilize shared neutrals for receptacle circuits.
            b) Do not utilize shared neutrals for control circuits or circuits serving electronic equipment.
            c) Do not utilize shared neutrals for circuits serving LED lighting fixtures.
      c. Size each neutral conductor the same as the largest phase conductor.
   3. Equipment Ground Conductors:
      a. Provide a green equipment ground conductor with all runs.
         1) Provide equipment ground conductor wire type as specified in Section 26 0526, Grounding and Bonding.

B. Pulling Cable:
   1. Establish a feed-in located at the highest elevation of the run, and pull cables down grade using flexible cable feeds to convey cables into raceways through the feed-in point opening.
      a. Furnish quadrant blocks located properly along the cable run.

b. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer.
   1) Measure the cable pulling tension on all runs pulled with mechanical assistance and for all cable runs where calculations are required to be submitted by using a dynameter.
   2) Remove cables subjected to excessive bending and tension and that are cracked or have damaged or nicked outer jackets from the Site, and replace these cables with new undamaged cables.
      a) If pulling tension is exceeding during pulling, remove the affected cables and mark them as not to be reused.
c. Lubricate cables with lubricants during pulling.

C. Terminating Cable:
1. Terminate cable using materials and methods indicated or specified herein, or in accordance with the written instructions of the cable manufacturer or termination kit manufacturer.
   a. For equipment connections, provide split bolt or compression type connectors, mechanical compression connectors, or crimped compression type connectors as specified and approved by the equipment manufacturer; for all other types of connections provide connectors of one of the types specified:
2. Protect insulated power and lighting cable terminations from accidental contact, deterioration of coverings, and moisture by using proper terminating devices and materials.

D. Splicing Wire and Cable:
1. All new conductors shall be continuous from end to end without splices, except where indicated on the drawings or with the special written permission of the Engineer on a case-by-case basis where the Contractor can demonstrate that installation without splices is not practical.
2. If permitted as noted above, splice cables in accessible locations.
3. Within outlet or junction boxes, make wire and cable splices that conform to the requirements of NFPA 70 (NEC).
   a. Install these outlet or junction boxes in accessible locations.

E. Wiring Identification:
1. Color code all wires and cables as indicated in Section 26 0553.
2. Identify all power wiring by circuit and panelboard numbers.
3. Identify all control wiring with wire numbers.
4. Provide additional electrical identification of cabling and wiring as specified in Section 26 0553, “Identification for Electrical Systems”.

F. Refer to Section 26 0500 for requirements for measuring and recording of conductor lengths.

## 3.05 FIELD QUALITY CONTROL

A. Site Tests:
1. Prior to energizing wire and cable, field test wires and cables as specified in Section 26 0563, “Acceptance Electrical Testing”.

B. Verify that control wiring wire numbers correspond to the numbers indicated in the record drawings.

END OF SECTION 26 0519

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# SECTION 26 0526

# GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

### 1.03 SUBMITTALS

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

B. Qualification Data: For testing agency and testing agencies field supervisor.

C. Field quality-control test reports.

### 1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

## PART 2 PRODUCTS

### 2.01 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
1. Solid Conductors: ASTM B 3
2. Stranded Conductors: ASTM B 8
3. Tinned Conductors: ASTM B 33
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Clamps and Non-Welded Connectors:
1. Provide bronze or brass clamps and connectors that are UL Listed for use below grade
2. All bolts and other materials shall be bronze or brass; plated-steel screws or other hardware are unacceptable
3. Provide bolts, nuts, lock-washers, and similar hardware designed not to damage ground wire.

2.03 GROUND RODS

A. Provide UL Listed, sectional ground rods fabricated using an electrolytic plating process to copper clad a medium carbon steel core.

B. Diameter: 3/4 inch.

C. Length: 10 feet.
1. To obtain longer length rods, join rod sections using copper-clad rod couplers.

2.04 COATING COMPOUND

A. Provide permanently pliable, moldable, un-backed, black rubber-based coating materials for covering or coating ground clamps and connectors

B. Coating Physical Properties:
1. Solids/Density: 100 percent; 12 pounds per gallon
2. Penetration: Within 90 to130 when tested in accordance with ASTM D 5
3. Water Absorption: 0.10 percent, maximum, when tested in accordance with ASTM D 570
4. Dielectric Strength: 500 volts/mil when tested in accordance with ASTM D 149
5. Volume Resistivity: 2,000 megohm-inches, or 5,000 megohms-cm, when tested in accordance with ASTM D 257
6. Service Temperature: Minus 40 degrees to 160 degrees Fahrenheit; and having no melting point; flammability, or slow burning when tested in accordance with ASTM C 653
7. Chemical Resistance:
   a. Resistant to alcohol, water, aqueous hydrochloride, and sodium hydroxide
   b. Dissolved by carbon tetrachloride, naphtha gasoline, mineral spirits, and benzene.
8. Cohesive/Adhesive: Adheres to metals, concrete, and itself.

## PART 3 EXECUTION

### 3.01 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits
2. Lighting circuits
3. Receptacle circuits
4. Single-phase motor and appliance branch circuits
5. Three-phase motor and appliance branch circuits
6. Flexible raceway runs

### 3.02 INSTALLATION

A. General:
1. Layout the electrical work to suit actual field conditions and in accordance with accepted industry standard practice
2. Verify existing conditions are as expected and ready for installation of grounding materials prior to commencement of the installation
   a. Perform field measurements to discover offsets and fitting requirements
   b. Locate on-site utilities and other obstructions in the area of work and verify that interferences will not occur.
3. Clean paint, grease, and other such insulating materials from contact points of grounds
4. After inspection by Owner's Representative, and prior to backfilling the excavation, apply protective coating compound to all grounding connections located underground.
   a. Coatings shall be allowed to cure for the minimum required time period, as recommended by the coating manufacturer, prior to backfilling of the excavation.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

D. Grounding and Bonding for Piping:
1. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

C. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify the Engineer promptly, and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

# SECTION 26 0528

# HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, cleaning, and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.

B. Related Section:
   1. Section 26 0500 – Common Work Results for Electrical

### 1.02 REFERENCES

A. American Iron and Steel Institute (AISI):
   1. AISI Standard Steels (Handbook)

B. American Society for Testing Materials (ASTM):
   1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel
   2. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated - Welded and Seamless
   3. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   4. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   5. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
   6. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi, Minimum Tensile Strength
   7. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
   8. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts
   9. ASTM A 575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
   10. ASTM A 576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
   11. ASTM A 635/A 635M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled
   12. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
   13. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
   14. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials



Addendum 01

C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts maximum)

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC)
   2. NFPA 258 - Standard Research Test Method for Determining Smoke Generation of Solid Materials

F. Society of Automotive Engineers International (SAE):
   1. SAE J 429 - Mechanical and Material Requirements for Externally Threaded Fasteners

G. The Society for Protective Coatings (SSPC):
   1. SSPC Painting Manual:
      a. SSPC-SP 2 - Hand Tool Cleaning
      b. SSPC-Paint 15 - Paint Specification No. 15, Steel Joist Shop Paint, Type I, Red Oxide Paint, Type II, Asphalt Coating
      c. SSPC-Paint 20 - Paint Specification No. 20, Zinc-Rich Primers (Type I, “Inorganic,” and type II, “Organic”)

H. Underwriters Laboratory, Inc. (UL):
   1. UL 568 - Nonmetallic Cable Tray Systems
   2. UL 635 - Standard for Insulating Bushings
   3. UL 870 - Standard for Wireways, Auxilliary Gutters, and Associated Fittings
   4. UL 884 - Standard for Underfloor Raceways and Fittings
   5. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops
   6. UL 2239 - Hardware for the Support of Conduit, Tubing, and Cable

I. U. S. General Services Administration (GSA)
   1. Federal Specifications:
      a. A-A-1922A - Shield, Expansion (Caulking Anchors, Single Lead)
      b. FF-S-107C (2) - Screws, Tapping and Drive

1.03 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of Supplementary Conditions SC-19 Shop Drawings/Samples, and Section 26 0500, Basic Electrical Materials and Methods:
   1. Product Data:
      a. Provide product data and catalog cuts for the products provided under this Section.
   2. Shop Drawings:
      a. Provide Shop Drawings for equipment backboards and support structures not directly fastened to walls.
      b. Provide Shop Drawings of hanging supports for conduit.
   3. Quality Assurance/Control Submittals:
      a. Design Data:
         1) Provide structural calculations for the following items:

a) Equipment backboards and support structures not directly fastened to the walls.
b) Hanging supports for conduit.
2) Detailed drawings of proposed departures from the original design.

b. Certificates:
1) Testing Agency/Quality Verification:
a) With the product data for electrical hangers and supports, provide evidence of quality verification, listing, and labeling by the Electrical Testing Agency (ETA); either by a printed mark on the data, or by a separate listing card.
b) If an item does not have ETA quality assurance verification, provide a written quality assurance verification statement from the product manufacturer indicating why the item does not have the specified quality assurance verification.
(1) Such quality assurance verification statements are subject to approval by the Owner and the Engineer.
2) Manufacturers' Certificate of Compliance.

c. Qualification Statements:
1) Manufacturers' qualifications.

## 1.04 QUALITY ASSURANCE

A. Qualifications;
1. Electrical Testing Agency (ETA) Qualifications:
a. Use the Electrical Testing Agency (ETA) qualified as specified in Section 26 05 00, Common Work Results for Electrical.
2. Manufacturers' Qualifications:
a. Provide electrical support framing made by manufacturers that have been manufacturing support framing for a minimum of 5 years, and who carefully controls their operations to ensure that excellent product engineering, quality, safety, and reliability are achieved.
b. Submit the manufacturer's qualifications to the Engineer for approval.

B. Certifications:
1. Electrical Testing Laboratory (ETL) Certification:
a. Provide products that are listed and labeled by Underwriters Laboratory, Inc. (UL) or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
2. Manufacturers Certificate of Compliance:
a. Submit a manufacturer's Certificate of Compliance certifying that both the galvanizing and the products meet the requirements of the ASTM standards.

## 1.05 DELIVERY, STORAGE AND HANDLING

A. Packaging, Shipping, Handling, and Unloading:
1. Deliver, store, and handle the hangers and supports in accordance with Section 26 05 00 Common Work Results for Electrical, and as specified herein.
2. Deliver material to Site in the original factory packaging.

B. Storage and Protection:
   1. Shelter and store the components under cover and supported off the ground and floors on blocking.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Carbon Steel Shapes:
   1. Provide shapes of the sizes specified and as indicated on the Contract Drawings:
   2. Provide steel shapes complying with the following material specifications for the type of steel shape listed:
      a. Steel Sections: ASTM A36/A 36M
      b. Steel Tubing: ASTM A 500, Grade B
      c. Plates: ASTM A 283/A 283M
      d. Sheets: ASTM A 1011/A 1011M
      e. Pipe: ASTM A 53/A 53M, Grade B, Schedule 40, hot-dipped, zinc-coated

B. Welding materials:
   1. Provide welding materials complying with the requirements of AWS D1.1/D1.1M for the type of material being welded.

### 2.02 MANUFACTURED UNITS

A. Metal U-Channel Electrical Support Framing Systems and Fittings:
   1. Carbon Steel U-Channel Support Framing Systems:
      a. Provide 1-5/8-inch nominal size U-channel supports fabricated from 12-gauge carbon steel electrolytically galvanized with a zinc-coating thickness commensurate with Service Condition SC 1 (mild) in conformance with the requirements of ASTM B 633.
         1) For Type II ASTM B 633 galvanized finishes, fabricate the framing from steel complying with the requirements for Grade 33 specified in ASTM A 1011/A 1011M.
         2) For Type III ASTM B 633 galvanized finishes, fabricate the framing from steel complying with the requirements of ASTM A 575, ASTM A 576, ASTM A 635/A 635M, or ASTM A 36/A 36M.
      b. Where combination members are required, spot-weld the members on 3-inch centers.
      c. Provide 1-3/8-inch or larger depths, except where supports are mounted directly to walls 13/16-inch or larger depths may be provided.
      d. Provide metal framing systems and fittings for metal framing systems from a single manufacturer.
      e. Manufacturers:
         1) Unistrut Corporation, Unistrut® Metal Framing System, www.unistrut.com.
         2) Thomas & Betts, Kindorf®, http://elec-cat.tnb.com.
         3) Cooper B-Line®, Inc., www.b-line.com.
         4) Power-Strut, www.power-strut.com.
         5) Approved Equal.

2. PVC-Coated Steel U-Channel Support Framing Systems:
   a. Provide U-channel supports, fittings, threaded rod, and hardware fabricated from PVC-coated carbon steel.

B. Conduit Supports:
1. Malleable Iron Conduit Supports:
   a. Provide one-hole style galvanized malleable iron fasteners with pipe straps similar to those as manufactured by Thomas & Betts.
   b. Provide support devices consisting of threaded rods, channel supports, and conduit straps/fasteners.
2. Stamped Steel Conduit Supports:
   a. Provide one-hole style galvanized stamped steel fasteners with pipe straps similar to those as manufactured by Thomas & Betts.
   b. Provide support devices consisting of threaded rods, channel supports, and conduit straps/fasteners.
3. Manufacturers:
   a. Thomas & Betts, http://www-public.tnb.com/contractor/docs/superstrut.pdf.
   b. Approved equal

C. Cable Supports:
1. Provide voltage rated cable supports fabricated from hot-dip galvanized malleable iron with a threaded collar.
2. Provide tapered wedging cable plugs fabricated from hard fiber, impregnated hardwood, or canvas bakelite for the cable supports.
3. Manufacturers:
   a. EGS Electrical Group, O-Z/Gedney, Inc., Type "M"
   b. Approved equal

D. Bolts, Nuts, and Washers:
1. For bolts, nuts, and washers smaller than 1/4-inch trade size, provide 316 stainless steel fasteners complying with the requirements of ASTM A 325.
2. For fastening galvanized components, provide stainless steel bolts, nuts, and washers galvanized in accordance with the requirements of ASTM A 325.

E. Anchors and Fasteners:
1. Drive (Deep-Pitch) Screws:
   a. Provide Type 316 stainless steel self-tapping type drive (deep-pitch) screws that comply with the requirements of FF-S-107C (2).
2. Drilled-In Anchors and Fasteners:
   a. Provide drilled-in anchors and fasteners that comply with the requirements of FF-S-107C (2).
   b. Masonry Anchors:
      1) Provide masonry anchors designed to accept both machine bolts and threaded rods as fasteners.
         a) Provide SAE J 429 Grade 2 machine bolt fasteners fabricated from AISI Type 316 stainless steel.
         b) Provide nuts and washers conforming to the requirements of ASTM A 563.
      2) Provide masonry anchors consisting of an expansion shield and expander nut contained inside the shield.
         a) Expander Nuts:

(1) Fabricate square expander nuts with their sides tapered inward from the bottom to the top.
(2) Design the expander nuts to simultaneously climb the bolt or rod thread and expand the shield as soon as the threaded expander nut reaches and bears against the shield bottom when being tightened.

b) Expansion Shields:
(1) Provide expansion shield bodies consisting of four legs, the inside of each tapered toward the shield bottom, or nut end.
(2) The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.

3) Masonry Anchor Material:
a) Provide die cast Zamac No. 3 zinc alloy having a minimum tensile strength of 43,000 psi.

4) Manufacturers:
a) U.S.E. Diamond, Inc., FORWAY System, , www.mktfastening.com

c. Concrete Anchors:
1) Carbon Steel Anchor/Fastener:
a) Provide UL listed one-piece studs (bolts) with integral expansion wedges, nuts, and washers.
b) Provide carbon steel anchor/fasteners complying with the physical requirements specified in FF-S-325 for Group II, Type 4, Class 1.

2) Stainless Steel Anchor/Fastener:
a) Provide one-piece AISI Type 303 or 304 stainless steel studs (bolts) with integral expansion wedges, AISI Type 316 stainless steel nuts, and AISI Type 316 stainless steel washers.
b) Provide stainless steel anchor/fasteners complying with the physical requirements of FF-S-325 for Group II, Type 4, Class 1.

3) Acceptable Manufacturers:
a) U.S.E. Diamond, Inc.; SUP-R-STUD, www.mktfastening.com
b) Hilti Fastening Systems; KWIK-BOLT, hilti.com.
c) Molly Fastener Group; PARABOL
d) Phillips; RED HEAD Wedge-Anchor, www.phillipsfastener.com.

3. Hammer drive-type explosive charge drive-type anchors and fastener systems are unacceptable.
4. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are unacceptable.

## 2.03 ACCESSORIES

A. Wall Seals:
1. Provide a hydrostatic seal to fill the annular space between conduit and through structure openings.
2. Manufacturer:
a. PSI-ThunderLine/Link-Seal Corp., Link-Seal®, www.linkseal.com.

B. Fire Seals:
1. Where conduit penetrates fire-rated walls, floors, partitions, and ceiling, provide approved fire seals to ensure that the fire rating is maintained.
2. Provide a fire seal system which is UL-listed for the application.
a. Provide fire seal compound or a mechanical seal for fire rating of 2 hours or less.

3. Manufacturers:
   a. Compound Fire Seals:
      1) Dow Corning Corporation, www.dowcorning.com
      2) 3M, http://solutions.3m.com/en_US/
   b. Mechanical Fire Seals:
      1) PSI-ThunderLine/Link-Seal Corp., www.linkseal.com
   c. Through-Wall Barrier Fire Seals:
      1) Cooper Crouse-Hinds, http://crouse-hinds.com

2.04 FABRICATION

A. Fit and shop assemble items in the largest sections practical for delivery to the Site.

2.05 FINISHES

A. Prime paint non-galvanized steel items.
   1. Prepare surfaces to be primed in accordance with the requirements of SSPC-SP 2.
      a. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   2. Prime Painting: Apply one coat of primer.

B. Galvanizing items specified above as galvanized.
   1. Galvanize the items after fabrication in accordance with the requirements of ASTM A 123/A 123M.
   2. Provide a minimum galvanized coating of 1.25 ounces per square foott (380 grams per square meter).

C. Touch-Up Primer:
   1. For un-galvanized metal surfaces: Provide primer complying with the requirements of SSPC-Paint 15 for Type I, Red Iron Oxide.
   2. For galvanized surfaces: Provide primer complying with the requirements of SSPC-Paint 20 for Type I, Inorganic Zinc-Rich Primer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Field Measurement:
   1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
      a. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.
   2. Carefully investigate the structural and finish conditions, and other construction work, at the Site which may affect the work of this Section.

## 3.02 PREPARATION

A. After carefully investigating structural and finish conditions and other in-place construction work, produce detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
   1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
   2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
   3. Show equipment backboards and support structures not directly fastened to the walls on the Shop Drawings.
   4. Indicate the location and details of conflicting utility construction and slopes on the Shop Drawings.
   5. Submit the Shop Drawings to the Engineer for approval prior to performing the Work of this Section.

B. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
   1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.
   2. Arrange electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, and similar spaces.

## 3.03 INSTALLATION

A. Install electrical Work in conformance to the requirements of NFPA 70 for wiring methods general requirements, and to other applicable Articles of the NEC governing methods of wiring.

B. Installing Anchors and Fasteners:
   1. For anchoring or fastening applications in masonry and hollow-core precast concrete structural elements, provide masonry anchors as specified herein.
   2. For anchoring or fastening applications in cast-in-place concrete and solid precast concrete structural elements, provide concrete anchors as specified herein.
   3. Threaded Bolts:
      a. Draw threaded bolted connections up tight using 316 stainless steel lock washers to prevent the bolt or nut from loosening.
   4. Drilled-In Expansion Anchors:
      a. Install expansion anchors in strict accordance with manufacturer's instructions and the following.
         1) Drill holes to the required diameter and depth in accordance with anchor manufacturer's instructions for the size of anchor being installed.
         2) Minimum Embedment:
            a) Embed expansion anchors to four and one-half bolt diameters minimum unless otherwise indicated on the Contract Drawings.

C. Installation of U-Channel Support Framing Systems: per Table 26 0528-1 below:

| Table 26 0528-1 U-Channel Support Framing Selection | | |
|---|---|---|
| **Condition 1** | **Condition 2** | **Type** |
| Aboveground | Interior Dry Locations | Carbon steel |
| | Interior, Sub-Basement | PVC-Coated steel |

D. Installing Conduit Supports:
   1. For interior locations, provide stamped steel conduit supports.

E. Panelboard/Enclosure Feed Risers:
   1. Furnish and install cable supports in feeder risers as required by the underwriters.

F. In areas designated as wet, NEMA 3, NEMA 3R, NEMA 4X, NEMA 12, or NEMA 13 as defined in NEMA 250; and in the Sub-Basement of the building; conform work to the following:
   1. Secure equipment and conduit to no fewer than two 7/8-inch minimum depth, PVC-coated steel channels mounted vertically on the walls.
   2. Utilize stainless steel hardware.

G. Field Fabrication:
   1. Fabricated Items:
      a. Fabricate backboards, backboard supports, equipment supports, conduit supports, and the other items as detailed on the Contract Drawings.
         1) Hot-dip galvanize mild-steel fabrications in accordance with the requirements of ASTM A 153/A 153M.
      b. Supply components required for the anchorage of fabrications.
         1) Except where specifically noted otherwise, fabricate anchors and related components from the same material as the fabrication and apply the same finish.
   2. Tightly fit and secure joints.
      a. Make exposed joints butt tight, flush, and hairline.
      b. Weld fabricated assemblies in accordance with AWS D1.1/D1.1M.
         1) Continuously seal joined members using intermittent welds and plastic filler.
         2) Dress welds smooth and free of sharp edges and corners.
      c. Grind exposed joints flush and smooth with the adjacent finish surface.
   3. Ease exposed edges to a small uniform radius.
      a. Cut all backboard corners to a 1-inch radius.
   4. For the attachment of work and for bolted connections, accurately drill or punch holes for the fasteners as required.
      a. Burned holes are unacceptable.
      b. Provide holes no more than 3/32-inch larger than the fasteners.
   5. Exposed Mechanical Fastenings:
      a. Except where specifically noted otherwise in the Contract Documents, provide flush countersunk screws or bolts; unobtrusively located, and consistent with the design of the component.
   6. Fabrication Tolerances:
      a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
      b. Maximum offset between faces: 1/16 inch (1.5 mm).
      c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
      d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).

e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.04 REPAIR/RESTORATION

A. Coatings:
1. Repair damage to coatings.
a. Touch up damaged coating surfaces, using the specified primer for primed steel surfaces, and using zinc-rich primer for galvanized steel surfaces.

3.05 FIELD QUALITY CONTROL

A. Inspection:
1. Verify the adequacy of coatings.
2. Inspect the items provided under this Section for adherence to the fabrication tolerances specified above, and correct any discrepancies:

3.06 PROTECTION

A. Protect the items provided under this Section from damage during the work of other trades.

END OF SECTION 20 0528

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SECTION 26 0533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for devices installed in boxes.

1.03 DEFINITIONS

A. FMC: Flexible metal conduit.

B. RGS: Rigid galvanized steel conduit.

C. LFMC: Liquidtight flexible metal conduit.

1.04 SUBMITTALS

A. Product Data: For raceways and fittings, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

1.05 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.06 COORDINATION

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 METAL CONDUIT AND TUBING

A. Available Manufacturers:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company
7. Manhattan/CDT/Cole-Flex
8. O-Z Gedney; Unit of General Signal
9. Wheatland Tube Co.
10. Or Approved Equal

B. Rigid Galvanized Steel Conduit: ANSI C80.1.

C. FMC: Zinc-coated steel.

D. LFMC: Flexible steel conduit with PVC jacket.

E. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.03 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company
3. Erickson Electrical Equipment Co.
4. Hoffman
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division
9. Scott Fetzer Co.; Adalet-PLM Division
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation
12. Walker Systems, Inc.; Wiremold Company (The)
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

F. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.04 FACTORY FINISHES

A. Finish: For surface raceway, wireway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

A. Indoors:
1. Exposed: Rigid galvanized steel.
   a. All feeder conduits shall be RGS.
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations, including the Boiler room and Sub-Basement.
3. Damp or Wet Locations: Rigid galvanized steel conduit.
4. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   a. Damp or Wet Locations: NEMA 250, Type 3R.

B. Minimum Raceway Size: 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Galvanized Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.02 INSTALLATION

A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Install temporary closures to prevent foreign matter from entering raceways.

D. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

E. Make bends and offsets so inside diameter is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

F. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

G. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.

H. Tighten set screws of threadless fittings with suitable tools.

I. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

L. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations, including the Boiler room and Sub-Basement. Install separate ground conductor across flexible connections.

M. Grounding Conductors in Raceways: Install a separate, green, ground conductor in all raceways.

N. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

O. Fire stopping: Use UL listed materials as shown in a UL listed detail for the configuration of the penetration. Submit UL detail showing materials used.

## 3.03 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

## 3.04 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533

# SECTION 26 05 35

# BOXES FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
1. Requirements for furnishing, installing, connecting, cleaning, and protecting electrical pull and junction boxes.

B. Related Section:
1. Section 26 05 00 – Common Work Results for Electrical.
2. Section 26 05 26 - Grounding and Bonding Electrical Systems.
3. Section 26 05 28 - Hangers and Supports for Electrical Systems.
4. Section 26 05 63 – Acceptance Testing of Electrical Systems.
5. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
6. Section 26 05 33 – Conduits for Electrical Systems.

### 1.02 REFERENCES

A. National Electric Manufacturer's Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
3. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

B. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC).

### 1.03 DESIGN REQUIREMENTS

A. Product Data:
1. Submit Product Data and catalog cuts of the materials and equipment proposed to be used to satisfy the requirements of this Section.

### 1.04 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.
1. Product Data:
   a. List of the proposed materials.
   b. Catalog cuts of steel outlet boxes for general purpose applications used with steel conduit systems.
   c. Catalog cuts of cast outlet boxes for general purpose applications used with steel conduit systems.
   d. Catalog cuts of sheet metal boxes for general purpose applications in dry and outdoor locations.
   e. Catalog cuts of equipment and control device enclosures for all areas except outdoor and corrosive locations.



Addendum 01

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Installer Qualifications:
a. To supervise installation of the Work of this Section, employ licensed electricians.

B. Certifications:
1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and listed and labeled or approved for the application intended as indicated or specified, unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
a. Provide products that are approved, listed, and labeled for the short circuit currents, voltages, and currents indicated or specified to be applied.

1.06 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Pack, ship, handle, and unload products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

B. Storage and Protection:
1. Store products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Use of Trade Names:
1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
2. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.

2.02 MANUFACTURED UNITS

A. Steel Outlet and Device Boxes for General Purpose Applications:
1. For general purpose applications in dry, flush (in-wall) locations only, provide UL Listed galvanized steel outlet and device boxes conforming to NEMA OS 1.
a. Boxes shall be fabricated from steel not less than 0.062" thickness.
b. Boxes shall have standard trade size knockouts to facilitate conduit and cable connector attachments.
c. Boxes shall be equipped with one 10-32 tapped hole for ground wire attachment.
2. Manufacturers:
a. Appleton Electric
b. O-Z/Gedney
c. Crouse Hinds
d. Thomas & Betts
e. Or Approved Equal

B. Cast Outlet Boxes for General Purpose Applications:
1. For Use with Steel Conduit Systems:

a. For use with steel conduit systems, provide UL Listed small cast steel or cast malleable iron outlet boxes with threaded hubs that meet the NEMA 250 requirements for Type 12 enclosures.
b. If covers are indicated or specified, provide cast steel or cast malleable iron covers with neoprene gaskets.
   1) Provide captive Type 316 stainless steel mounting screws for the covers.
c. If fixture hangers are indicated or specified, provide ball type cast steel or cast malleable iron fixture hangers with neoprene gaskets.
   1) Provide captive Type 316 stainless steel mounting screws for the fixture hangers.
d. Finish:
   1) Provide outlet boxes, covers, and hangers with an electroplated zinc coating, followed first by a dichromatic prime, and then by an aluminum polymer finish coating conforming to NEMA FB 1.
e. Manufacturers:
   1) Appleton Electric
   2) O-Z/Gedney
   3) Crouse Hinds
   4) Thomas & Betts
   5) Killark
   6) Or Approved equal.

C. Sheet Metal Junction and Pull Boxes for General Purpose Applications:
1. For general purpose applications in dry locations, provide small sheet steel pull and terminal boxes and covers that meet the NEMA 250 requirements for Type 12 enclosures with continuously welded and ground smooth seams, and having no holes or knockouts.
   a. Cover:
      1) Provide overlapping sheet steel screw covers with captivated screws for each box.
      2) Provide a means of bonding on the cover.
   b. Gasket: Provide an oil resistant cover gasket for each box.
   c. Mounting Brackets:
      1) Provide 12-gauge steel wall-mounting brackets.
   d. Finish:
      1) Provide polyester powder coating applied over phosphatized surfaces.
      2) Color: ANSI Z55.1 Number 61 gray.
2. Manufacturers:
   a. Pentair, Screw Cover SC Junction Boxes
   b. Rittal Corp
   c. Milbank Manufacturing
   d. Or Approved Equal

D. Equipment and Control Device Enclosures:
1. For all areas except outdoor and corrosive locations, provide enclosures with hinged doors that meet the NEMA 250 requirements for Type 4 or 12 enclosures, depending on Contract requirements.
   a. Enclosure Cabinet:
      1) Provide sheet steel boxes having continuously welded seams, ground smooth.
      2) Provide enclosures having no holes or knockouts.
   b. Enclosure Door:
      1) Provide overlapping sheet steel hinged doors, having a continuous hinge with a removable heavy gauge hinge pin and door clamps with screws to provide a watertight seal or to exclude liquids and contaminants.
      2) Provide a means of bonding on the door.
   c. Door Gasket:
      1) Provide an oil resistant door gasket for each box.

d. Security:
   1) Provide a mechanism for padlocking the enclosure.
e. Finish:
   1) Provide polyester powder coating applied over phosphatized surfaces.
   2) Color: ANSI Z55.1 Number 61 gray.
f. Manufacturers:
   1) Pentair, Single-Door Type 4 Enclosures or Type 12 and Type 13 Enclosures
   2) Rittal Corp
   3) Milbank Manufacturing
   4) Or Approved Equal

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 EXAMINATION

A. Verify that conduit stub-ups to be mated with electrical boxes and enclosures are the correct type and size, and are at the proper location.

3.03 INSTALLATION

A. Junction Boxes and Pull Boxes for General Purpose Applications:
   1. For general purpose applications in dry locations, provide small sheet steel pull and terminal boxes that meet the NEMA 250 requirements for Type 12.
   2. Provide boxes that are fabricated from the same type of material as the conduit with which the boxes are used.

B. Equipment and Control Device Enclosures:
   1. For all areas except outdoor and corrosive locations, provide enclosures that meet the NEMA 250 requirements for Type 4 or 12 enclosures, depending on Contract requirements.
   2. For outdoor locations, provide enclosures with covers that meet the NEMA 250 requirements for Type 3R enclosures.

C. Installing Boxes for Electrical Outlets and Devices:
   1. Install boxes level and plumb within 1/16-inch of vertical or horizontal over the length of the box.
   2. Unless otherwise indicated on the drawings, devices boxes for interior or exterior wiring devices of buildings shall be recessed within the wall construction. The installation of surface mounted device boxes is prohibited.
   3. Install device boxes at a uniform height as indicated on the Contract Drawings.
      a. Mount all adjacent boxes in alignment at the same mounting height.
      b. Mount outlet boxes for equipment within 18-inches of the equipment power connection.
   4. Do not install flush mounting boxes back-to-back in walls.
      a. Provide a minimum separation of 6 inches.
      b. Provide a minimum separation of 24 inches in acoustic rated walls.
   5. When installing boxes outside, provide cast boxes.
      a. For interior unfinished locations mount these boxes on spacers to be 1/8-inch from wall unless box has built-in raised pads to perform the same function.
   6. When installing boxes for single devices, two devices, or wall outlets, install 4-inch square boxes with appropriate plaster rings.

a. Space boxes on opposite sides of the wall 6 inches apart.
b. Openings for boxes in finished walls must be within 1/16-inch of the box.
1) Correct all oversize openings in accordance with the specifications for the wall material.

7. Outlet boxes must be of the one-piece type, the use of expandable sheet metal boxes is prohibited.
8. Support cast boxes for outlet and device using one of the following methods:
a. Mount the boxes directly to the structure using 4 or more anchors.
1) Attach mounting screws to feet located outside of the box interior.
2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.

D. Installing Boxes for Other than Electrical Outlets and Devices:
1. Accurately punch holes for conduit openings using a hydraulic punch and punches sized for the conduit to be installed.
2. Install a conduit breather in the top of the box and a conduit drain fitting in the bottom of all boxes not located in bone-dry areas that are at least 100 feet from a hose-bib.
3. Support boxes for other than electrical outlets and devices using one of the following methods:
a. Mount the boxes directly to the structure using 4 or more anchors.
1) Attach mounting screws to feet located outside of the box interior. or seal the screw holes to prevent water penetration.
2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.
d. Mount the box on U-channel and structural supports conforming to Section 26 05 28, Hangers and Supports.

E. Make up all conduit connections to boxes in accordance with the requirements of Section 26 05 33, Conduit and Tubing.

F. Install wiring in boxes in accordance with the requirements of Section 26 05 19, Low-Voltage Wire, Cable, and Accessories.

G. Ground boxes in conformance with Section 26 05 26, Grounding and Bonding.

## 3.04 REPAIR/RESTORATION

A. Touch up damaged coatings on electrical boxes and enclosures.

## 3.05 FIELD QUALITY CONTROL

A. Site Tests:
1. Test all boxes to verify that they are properly connected to the grounding system.

B. Inspection:
1. Inspect flush boxes to verify that the opening between the box and the wall finish is less than 1/16-inch.
2. Inspect flush boxes to verify that each box is flush with the wall, or protrudes less than 1/16-inch, and is not set behind the wall surface.

3. Inspect surface mounted boxes to verify that they are level and plumb within 1/16-inch as specified.

3.06 CLEANING

A. Waste Management and Disposal:
1. Clear and dispose of waste materials in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

3.07 PROTECTION

A. Except for surfaces to be painted, mask electrical boxes to protect them from paint overspray or over-brushing during painting operations.

B. Protect boxes against damage from other work.

END OF SECTION

# SECTION 26 0553

# IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes the following:
1. Identification for raceways
2. Identification for conductors and control cable
3. Warning labels and signs
4. Equipment identification labels/signs
5. Miscellaneous identification products

B. The extent of electrical identification is indicated by drawings.

### 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product specifications and installation instructions for each identification material and device required. Include data substantiating that materials comply with requirements.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

### 1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

D. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical marking and labeling identification systems.

E. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

1.05 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification products which may be incorporated in the work include, but are not limited to, the following:
1. Almetek Industries, Inc.
2. W.H. Brady Co.
3. Cole-Flex Corp.
4. Griffolyn Co.
5. Ideal Industries, Inc.
6. LEM Products, Inc.
7. National Band and Tag Co.
8. Radar Engineers Div., EPIC Corp.
9. Seton Nameplate Co.
10. Tesa Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Cable/Conductor Identification Bands: Provide manufacturer's standard aluminum wrap-around cable/conductor markers, of size required for proper application, and numbered to show circuit identification, or provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered, plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

C. Plasticized Tags: Provide manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples: DANGER, CAUTION, DO NOT OPERATE).

D. Self-Adhesive Plastic Signs: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application (as examples: 208 VOLTS, EXHAUST FAN, RECTIFIER). Unless otherwise indicated or required by governing regulations, provide orange signs with black lettering.

E. Engraved Plastic-Laminate Signs: Provide engraving stock melamine plastic laminate signs, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

F. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

G. Fasteners: Self-tapping stainless-steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS:

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.05 ARC FLASH WARNING LABELS

A. Arc Flash Warning Labels shall be prepared in accordance with NFPA 70, NFPA 70E, IEEE-1584 latest editions and ANSI Z535.
1. Minimum label size shall be 4" x 6" as provided by Duralabel or Brady with applicable header information identifying both warning and danger based upon the findings.
2. Minimum information to be included on the Arc Flash label shall consist of the following:
a. Prefaced electrical warning including universal symbol identification, approved safety color, and preface description noting that arc and shock hazard are present. Note where dual labeling is provided/required with the use of arc flash reduction maintenance settings within the equipment, such labels shall be uniquely identified by a different label safety color l, as approved by the Owner. Consult the Owner for acceptable color schemes to be used for the equipment.

b. Statement noting that personnel protective equipment (PPE) requirements are required. Also clearly identify all equipment as “Dangerous” where work on energized equipment is otherwise prohibited and/or where no safe PPE protection so exists.
c. Calculated arc flash hazard boundary, in inches.
d. Calculated arc flash hazard at 18 inches, in calories/cm$^2$.
e. Arc flash hazard risk category, including descriptive summary of required PPE items necessary for entry into energized equipment.
f. Voltage classification and description of conditions present for shock hazard.
g. Insulated glove classification rating, as required for contact conditions and measurements.
h. Limited approach boundary, in inches.
i. Restricted approach boundary, in inches.
j. Prohibited approach boundary, in inches.
k. Available short circuit current.
l. Unique equipment locator identification, corresponding to applicable device abbreviation identifiers utilized for the electrical system study / one-line diagram prepared by Contractor as specified in Section 26 0500.
m. Name, address & phone number of the responsible engineer, engineering company or agency contracted to perform the analysis. Also include the preparer’s name, where prepared by a subcontract to the named company or agency contracted to perform the analysis report.
n. Respective contract (job) number for the analysis report.
o. Preparation date of the issued/approved Arc Flash Study (analysis) supporting the equipment labeling, as installed.
p. Suffix cautionary warning that “Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements.”

## 2.06 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch thick for signs up to 20 sq. in. and 1/8-inch thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.07 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

## 2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 EXECUTION

### 3.01 APPLICATION

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.

B. Accessible Raceways, Over 600 Volts: Identify the voltage carried in conduit or raceway by providing voltage labeling markers on all accessible raceways, or by other means as approved or directed by the School District.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands: Revise list below to suit Project.
1. Control Wiring: Green and red.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
   a. Indoor Equipment: Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:
   a. Unit Substations
   b. Switchboards, panelboards, electrical cabinets, and enclosures
   c. Access doors and panels for concealed electrical items
   d. Emergency system boxes and enclosures

e. Disconnect switches
f. Enclosed circuit breakers
g. Motor starters
h. Push-button stations
i. Contactors

H. Arc Flash Warning Labels: For each arc location or circuit analyzed as part of the Arc Flash Study required by Section 26 0500, furnish and install an Arc Flash Warning label.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied.
2. Colors for 208/120-V Circuits:
a. Phase A: Black
b. Phase B: Red
c. Phase C: Blue

H. Color-Coding for Phase and Voltage Level Identification, Over 600 Volts: Conform to requirements of the Local Electric Utility Company.

I. Painted Identification: Prepare surface and apply paint according to Division 09, “Painting” Section(s).

END OF SECTION 26 0553

# SECTION 26 0563

# ACCEPTANCE ELECTRICAL TESTING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of materials to performance test electrical systems and equipment.
   1. Items Supplied Under This Section:
      a. Electrical System Testing
      b. Thermographic Testing
      c. Ground System Testing
      d. Equipment Testing
      e. Test Procedure
      f. Test Report

B. Related Sections:
   1. Division 01 – General Requirements
   2. Division 26 Sections, As Applicable

### 1.02 REFERENCES

A. Applicable Documents and Testing Requirements of:
   1. America National Standards Institute (ANSI): as applicable, including:
      a. ANSI C2 - National Electrical Safety Code
      b. ANSI Z244.1 - American National Standards for Personnel Protection.

   2. National Electrical Manufacturer's Association (NEMA): as applicable, including:
      a. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
      b. NEMA PB 2.1 – Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

   3. American Society for Testing and Materials (ASTM), as applicable.
   4. Institute of Electrical and Electronics Engineers (IEEE), as applicable.
   5. National Fire Protection Association (NFPA), as applicable, including:
      a. NFPA 70 - National Electrical Code (NEC)
      b. NFPA 70E - Electrical Safety Requirements for Employee Workplaces.

   6. Insulated Cable Engineer's Association (ICEA), as applicable.
   7. State and Local Codes and Ordinances as applicable.
   8. Occupational Safety and Health Administration (OSHA), as applicable, including:
      a. Title 29 - Parts 1907, 1910 and 1936.

   9. InterNational Electrical Testing Association (NETA) as applicable, including:
      a. ATS-2017 - Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
      b. MTS-2015 - Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems.

1.03 SUBMITTALS

A. Submit documentation as required by this Section of the Contract to the Design Engineer in strict accordance with the provisions of Section 26 05 00 for review, comments and subsequent approval.

B. Submission to include the following:
   1. Field inspection report as required for each item of material and/or equipment outlined herein.

C. Test Reports:
   1. Each test report prepared by the respective testing firm(s) comply, where applicable, to all stipulations specified in Section 26 0500 for Operation, Maintenance and Installation Manuals with reference to preparation, paper requirements, indexing and binders. Include in each test report the following:
      a. Summary of project
      b. Description of equipment tested
      c. Description of test
      d. Test results
      e. Conclusions and recommendations
      f. Appendix, including appropriate test forms
      g. Identification of test equipment used
      h. Signature of responsible test organization authority
      i. Furnish five copies of each completed report to the Design Electrical Engineer no later than 30 days after completion of each test. Assemble and certify the testing firm each final test report, which must be submitted to the Design Engineer for review, comments and subsequent approval.

1.04 QUALITY ASSURANCE

A. Qualifications of Testing Laboratory: Select an independent nationally recognized testing laboratory that is independent from electrical contractor that either is a member of The International Electrical Testing Association or meets the following qualifications:
   1. Is nationally recognized as an electrical testing laboratory.
   2. Has been regularly engaged in the testing of electrical systems and equipment for at least 2 years.
   3. Is independent from the electrical contractor, the Owner, the Engineer and all other contractors on the job.
   4. Has at least one Professional Engineer on staff that is licensed in the State where the project site is located.
   5. Derives more than 75 percent of its income from electrical testing.
   6. Owns or leases sufficient calibrated equipment to do the testing required.
   7. Has a means to trace all test instrument calibration to The National Institute of Standards and Technology.

B. Membership in the International Electrical Testing Association (NETA) shall be considered evidence of meeting items A. 1. through and including A. 5

C. Testing shall be done under the supervision of a technician certified by International Electrical Testing Association or by technicians that are both certified by the National Society of Professional Engineers and experienced in electrical testing with 5 years of testing experience.

D. The testing laboratory shall supervise or perform all testing of equipment and oversee setting of all circuit breakers and calibration of all instruments.

E. The testing firm used must be approved by the Engineer.

F. Include the cost of such tests in the Contractors Bid Price for the applicable bid item.

1.05 GENERAL REQUIREMENTS

A. Field Inspection:
1. This Contractor is responsible for a complete inspection of all equipment, prior to testing and energizing to ascertain that it is free from any damage, scratches, or missing components and that all power connections are correct, and that they are tight in conformance with recommended standard practice. The inspection is to also include a check of control wiring, terminal connections and all bolts and nuts.
2. Perform field inspection by this Contractor during a time when the Field Engineer and the Design Engineer are present to witness each inspection and its performance.
3. Correct any deficiencies found during the inspection by this Contractor prior to the energizing and testing of the equipment.

1.06 SCHEDULING

A. Schedule all testing with work of other contractors to ensure an orderly sequence of startup and completion of work.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 ELECTRICAL INSPECTIONS AND TESTS

A. Perform, supervise, and furnish all test equipment needed to perform tests and provide safety measures, procedures and equipment required for each test.

B. Schedule all testing with the Construction Manager (CM). Perform testing in the presence of the CM, except when the CM approves in writing the conducting of a specific test without being present.

C. Notify all involved parties including the Construction Manager prior to tests, advising them of the test to be performed and the scheduled date and time.

D. Coordinate the tests with others involved.

E. Prepare written test procedures and forms used in the test reports and submit for approval prior to commencement of testing.

F. Include in each test report the following information:

1. Job title
2. Date of test
3. Equipment, system or cable identification
4. Type of test
5. Description of test instrument and date of latest calibration
6. Section of specification defining test along with description of test and evaluations as reported by the testing company
7. Test results (correct all readings at 20 degrees C)
8. Signature of person supervising test
9. Signature of Contractor
10. Space for Construction Manager's signature.

G. Refer to individual tests and inspections hereinafter specified for any additional or specified requirements.

H. Test Instrument Calibration:
1. The testing firm is to have a calibration program, which assures that all applicable test instrumentation are maintained within rated accuracy.
2. The accuracy is to be directly traceable to The National Institute of Standards and Technology.
3. Instruments are to be calibrated in accordance with the following frequency schedule.
   a. Field Instruments: Analog - 6 months maximum
      Digital - 12 months maximum
   b. Laboratory Instruments: 12 months
   c. Leased specialty equipment: 12 months

4. Make dated calibration labels visible on all test equipment.
5. Keep records up-to-date, which show date and results of instruments calibrated or tested.
6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
7. Calibrating standard is to be of higher accuracy than that of the instrument tested.

I. Safety and Precautions:
1. Safety practices are to include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act of 1970-OSHA
   b. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4
   c. Applicable State and Local safety operating procedures
   d. IETA Safety/Accident Prevention Program
   e. Owner's safety practices
   f. National Fire Protection Association - NFPA 70E
   g. ANSI Z244.1 American National Standards for Personnel Protection

2. Perform all tests with apparatus de-energized except where otherwise specifically required.

3. The testing firm is to have a designated safety representative on the project to supervise all testing operations with respect to safety.

3.02 TESTING TO BE PERFORMED BY CONTRACTOR

A. The Contractor is required to obtain copies of NETA ATS-2017 and MTS-2015, and to keep at least one copy of each at the project site, to use as reference for testing requirements.

B. Continuity Test: Make test for continuity and correctness of wiring and identification on all conductors installed.

C. Wire and Cable:
1. Test all wires and cables sized No. 2 and larger in accordance with NETA ATS-2017.
2. Perform visual, mechanical, and electrical tests on all No. 4 and No. 6 power cables that operate at voltages exceeding 150 volts to ground in accordance with NETA ATS-2017.
3. Perform visual, mechanical, and electrical tests on all other wires and cables in accordance with NETA ATS-2017.
4. Replace any wires which have been damaged.
5. Correct causes of all readings which do not meet the acceptable minimum insulation readings are as stated in NETA ATS-2017. Exceed the nominal expected temperatures for the actual load.
6. Retest items requiring correction.

D. Surge Protective Devices (SPDs):
1. Visually and mechanically inspect the SPD unit and connections.
2. Use an AC voltmeter to check all voltages and ensure that normal operating voltages of the power system match the voltage rating on the SPD nameplate.
3. Check LED status indicators on the display panels and suppression modules to confirm normal status.
4. Press the alarm test button to confirm the audible alarm and LED.
5. Operate the alarm silence switch to confirm proper operation.

E. Ground Fault Circuit Interrupter (GFCI) Receptacles:
1. Test all GFCI receptacles as specified in Section 26 2726.

F. Lighting Tests:
1. Emergency, standby, equipment and lighting test-trip all incoming utility power and ascertain that all standby and emergency equipment operates. Replace and correct defective equipment. Operate battery systems for emergency lighting without power for 90 minutes and correct all defects and retest.

3.03 TESTING TO BE PERFORMED BY THE TESTING LABORATORY

A. The Contractor shall select, hire and pay an independent, nationally recognized electrical testing laboratory to perform all testing specified in this Article. Obtain Owner's approval of the testing laboratory and the testing laboratory's proposed test procedure prior to commencement of any tests.

B. Set all adjustments for all overcurrent protection devices in accordance with the protection and coordination study required by Section 26 0500.

C. Visually and mechanically inspect and electrically test items of equipment (as listed and required hereinafter) using the procedures of NETA ATS-2017. When a test for a particular item is not called out in ATS, test using the procedures in NETA MTS-2015.

D. Thermographic Inspection:
1. Perform thermographic inspection of the electrical equipment and installations, provided under this Project and as listed below, in accordance with NETA ATS-2017, and these Specifications. The following equipment is to be scanned:
   a. Switchboards: all ratings
   b. Switchgear: all ratings
   c. Service Entrance Equipment: all ratings
   d. Lighting Panelboards: all ratings
   e. Power Panelboards: 50-Ampere and larger
   f. Dry Type Transformers: 10 kVA and larger
   g. Individually Mounted Circuit Breakers: 100 amp and larger
   h. Disconnect Switches: 100 amp and larger
   i. Elevator Shunt-Trip Fused Disconnect Switches: all ratings
   j. Individually Mounted Motor Starters Size: Size 1 and larger
   k. Motors: 30 HP and larger

2. Provide report including the following items:
   a. Items scanned
   b. Whether item passed or failed
   c. All items in NETA ATS-2017
   d. The probable cause
   e. Severity of defect
   f. Recommended corrective measures
   g. Video recording of test.

3. Scan using an infrared camera with video scanner output to a display screen with a range of at least 1 degree C to 75 degrees C with an accuracy of 0.1 degree C and with the following equipment:
   a. One 7 degree telephoto lens
   b. One 20 degree wide angle lens
   c. One 40 degree extra-wide angle lens

4. Record output of camera during testing onto a DVD or store digital images of each piece of equipment inspected onto a CD as a record of the temperature variations. Record either by order or by digital imprinting the actual equipment being scanned. Turn off recordings during inactive periods or edit DVD to eliminate dead periods.
5. Display data on a monitor capable of providing both a gray step mode and color monitor. These capabilities allow distinct temperature levels to be shown in black and white and color on the thermogram.
6. Submit three copies of report and two copies of the DVD or CD.
7. Include DVD or CD of thermographs of the defective equipment and installations. Also include in report.
8. Submit both copies of the report to the Engineer who will make the determination of corrective measurements.

E. Medium Voltage Switch/Switchgear Tests:
1. Visually and mechanically inspect and electrically test all medium voltage switchgear, in accordance with NETA ATS-2017.
2. Acceptable values are as stated in NETA ATS-2017.
3. Test all components as specified in this Section.

F. Liquid Filled Transformer Tests:
   1. Visually and mechanically inspect and electrically test liquid filled transformers in accordance with NETA ATS-2017.
   2. Acceptable values are as stated in NETA ATS-2017.

G. Low Voltage Molded Case Circuit Breaker Tests:
   1. Visually and mechanically inspect and electrically test all low voltage circuit breakers in frame sizes rated 100-amperes or more in accordance with NETA ATS-2017.
   2. Acceptable values are as stated in NETA ATS-2017.

H. Low Voltage Switchboard Tests:
   1. Visually and mechanically inspect and electrically test all low voltage switchboards in accordance with NETA ATS-2017.
   2. Acceptable values are as stated in NETA ATS-2017.
   3. Test all switchboard components as specified in this Section.

I. Low Voltage Panelboard Tests:
   1. Visually and mechanically inspect and electrically test all low voltage panelboards furnished under this Project in accordance with NETA ATS-2017.
   2. Acceptable values are as stated in NETA ATS-2017.
   3. Test all components as specified in this Section.

J. Dry Type Transformer Tests:
   1. Visually and mechanically inspect and electrically test low voltage dry-type transformers in accordance with NETA ATS-2017.
   2. Acceptable test values are as stated in NETA ATS-2017.

K. Low Voltage Motor Starter Tests:
   1. Visually and mechanically inspect and electrically test all low voltage motor starters, furnished under this Project and rated 10-horsepower or more, in accordance with NETA ATS-2017.
   2. Acceptable values are as stated in NETA ATS-2017.

L. AC Motor Testing:
   1. Visually and mechanically inspect and electrically test all AC motors rated 10-horsepower or more in accordance with NETA ATS-2017.
   2. Acceptable test values are as stated in NETA ATS-2017.
   3. Immediately report all motors, which fail inspection to the Engineer for correction.

M. Voltage Adjustment:
   1. Measure the voltage at both no load and at nominal load at the following locations.
      a. Main Distribution Switchboard.
   2. Adjust the transformer taps to bring the no-load voltage above nominal, but in no case, higher than 105.8% of nominal.
   3. Adjust the operated loaded voltage to a value above 91.7%, (ANSI Range A), with only momentary excursions to a maximum of 105.8% and a minimum of 88.3% for all loads and 86.7% for motor loads. (ANSI Range B).
   4. After all adjustments have been made, re-measure all voltages.
   5. For record purposes, measure and record on all 3-phases the actual load at the switchboard.
      a. Measure minimum/maximum/average voltage, current and kVA load at the Main Distribution Switchboard over a 24 hour period with a recording meter.

3.04 CORRECTION OF DEFICIENCIES

A. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
   1. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

3.05 RETESTING

A. After equipment has been in service for a period of nine months repeat the following tests:
   1. Thermographic testing. Correct all causes of readings above the nominal expected reading for the load encountered.

END OF SECTION 26 0563



Addendum 01

# SECTION 26 2416

# PANELBOARDS

## PART 1 GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes the following:
   1. Lighting and appliance branch-circuit panelboards.

### 1.03 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1
      b. Bus configuration, current, and voltage ratings
      c. Short-circuit current rating of panelboards and overcurrent protective devices
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

   2. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used
   2. Test results that comply with requirements
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section “Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Section "Products."

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
1. Ambient Temperature: Not exceeding 122 deg F (50 deg C)
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Outages shall be scheduled to occur over the summer months when school is not in session; outages during the normal school year shall not be permitted.
2. Notify Construction Manager/Owner no fewer than fourteen (14) days in advance of proposed interruption of electrical service
3. Do not proceed with interruption of electrical service without Construction Manager's/Owner's written permission.

1.06 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Four (4) spares for each type of panelboard cabinet lock
a. All panelboards furnished under this Project shall be keyed alike, using Corbin lock as basis of design as specified hereinafter.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
      a. Eaton Corporation; Cutler-Hammer Products
      b. General Electric Co.; Electrical Distribution & Protection Division
      c. Siemens Energy & Automation, Inc.
      d. Square D Company.

### 2.02 MANUFACTURED UNITS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces.

B. Enclosures: Flush- and surface-mounted cabinets; NEMA PB 1, Type 12 or as otherwise required.
   1. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover
   3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat
   4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

C. Phase and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material.
   1. Main and Neutral Lugs: Compression type
   2. Ground Lugs and Bus Configured Terminators: Compression type.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

### 2.03 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

### 2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Main Overcurrent Protective Devices (where required): Circuit breaker, thermal-magnetic type or as indicated on the Drawings.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, thermal-magnetic type; replaceable without disturbing adjacent units.

C. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike using Corbin lock as basis of design.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with series-connected rating to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.06 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches above finished floor, unless otherwise indicated or required.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices.
   1. Set field-adjustable circuit-breaker trip ranges, as applicable.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.02 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 053.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 0526.

B. Connect wiring according to Section 26 0519.

3.04 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.05 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 2416

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# SECTION 26 2726

# WIRING DEVICES

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes the following:
   1. Duplex receptacles.
   2. Ground-fault circuit interrupter duplex receptacles.
   3. Light switches.
   4. Device wall plates.

### 1.03 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

### 1.04 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

### 1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

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

C. Comply with NFPA 70.

### 1.06 COORDINATION

A. Receptacles and/or Cord and Plug Sets for Equipment Connections: Match requirements of the actual equipment installed, regardless of type indicated on project Bid Documents.
   1. Obtain copies of final or “Approved” equipment Shop Drawings from equipment suppliers.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Wiring Devices:
      a. Hubbell / Bryant Electric
      b. Hubbell Wiring Device-Kellems
      c. Legrand / Pass & Seymour
      d. Or Approved Equal

### 2.02 RECEPTACLES

A. Straight-Blade Receptacles: Provide heavy-duty duplex receptacles, 2-pole, 3-wire grounding type, 20-amperes,125-volts, with metal plaster ears, back wiring, NEMA configuration 5-20R, unless otherwise indicated or required.

B. GFCI Receptacles: Provide 20-amperes, 125-volt, 2-pole, 3-wire grounding type, Hospital grade, with integral straight-blade NEMA configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a standard 2-1/2-inch- deep outlet box without an adapter.

### 2.03 LIGHT SWITCHES

A. Snap Switches: Provide heavy-duty grade, quiet type, flush single or double pole, three-way or four-way switches as indicated on the drawings; 20 amperes, 125 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handle, and side wired screw terminals.

### 2.04 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Material: 0.035-inch- thick, satin-finished stainless steel.
   2. Provide red faceplates for emergency shutoff switches or devices.

### 2.05 FINISHES

A. Color:
   1. Wiring Devices Connected to Normal Power System: Brown or other color as selected by Architect, unless otherwise indicated or required by NFPA 70.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

C. Remove wall plates and protect devices and assemblies during painting.

3.02 IDENTIFICATION

A. Comply with requirements of Section 26 0553.
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate; and durable wire markers or tags inside outlet boxes.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 0526.

B. Connect wiring according to Section 26 0519.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 2726

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# SECTION 26 2816

# ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

### 1.02 SUMMARY

A. This Section includes the following individually mounted, enclosed switches:
   1. Fusible switches
   2. Non-fusible switches
   3. Enclosures

### 1.03 DEFINITIONS

A. HD: Heavy duty.

B. SPDT: Single pole, double throw.

### 1.04 SUBMITTALS

A. Product Data: For each type of enclosed switch, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1
   2. Current and voltage ratings
   3. Short-circuit current rating
   4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used
   2. Test results that comply with requirements
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements

E. Operation and Maintenance Data: For enclosed switches to include in emergency, operation, and maintenance manuals. In addition to items specified in Section "Closeout Procedures," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches
   2. Time-current curves, including selectable ranges for each type fuse

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not exceeding 122 deg F (50 deg C).
   2. Altitude: Not exceeding 6600 feet.

1.07 COORDINATION

A. Coordinate layout and installation of switches, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses:
      a. Control-Power Fuses: 3 of each type installed
      b. Fuses for Fusible Switches: 3 of each type installed

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Available Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products
2. General Electric Co.; Electrical Distribution & Control Division
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider

B. Fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Where indicated on the Drawings, furnish switches with an auxiliary set of contacts, arranged to mimic or follow the position of the main switch and open before the switch blades open.

2.03 ENCLOSURES

A. Provide enclosures sized to contain the safety switches, fuses, and all other required items.
1. Provide an interlock that prevents opening the enclosure door when the switch is in the “ON” position.
a. Provide an interlock defeater, which requires a common hand-tool to operate.

2. Provide a copper ground-bus or ground stud rated for 100 percent of capacity.

B. Provide each enclosure with an external operator that positively indicates the “ON”, “OFF”, and “TRIPPED” positions of the switch.

C. Provide the capability to pad-lock the switch in the “ON” and the “OFF” positions by using three padlocks.

D. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
1. Indoor, Dry Locations: NEMA 250, Type 12
2. Outdoor Locations: NEMA 250, Type 3R
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches.

B. Mount individual wall-mounting switches with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections
2. Verify switch and relay type and labeling verification
3. Verify rating of installed fuses
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Infrared Scanning:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch. Open or remove doors or panels so connections are accessible to portable scanner.
   b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
   c. Instruments, Equipment and Reports:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      2) Prepare a certified report that identifies enclosed switches included and describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.05 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 2816

# SECTION 28 31 00

# FIRE DETECTION AND ALARM

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Fire alarm system; complete, including all wiring, raceways, terminal cabinets, pull boxes, outlet and mounting boxes, initiating devices, alarm indicating devices, annunciator(s), control equipment, tests, and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.

B. Verify requirements with Jurisdictional authorities, i.e.: Insurance authority or Underwriter, Fire Department or Marshal, or Building Department. Provide system complete, functional and acceptable to Jurisdictions without penalty of any type to the insurance premium rate. This Contractor shall be completely responsible for all aspects of coordination with other sections of these specifications and drawings. No change will be issued for lack of coordination or lack of verification of requirements of Jurisdictional Authorities.

C. Related Sections
   1. Section 26 05 00 – Common Work Results for Electrical
   2. Section 26 05 28 – Hangers and Supports for Electrical Systems
   3. Section 26 05 33 – Conduits for Electrical Systems
   4. Section 26 05 34 – Surface Raceways for Electrical Systems
   5. Section 26 05 35 – Boxes for Electrical Systems

### 1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI/ASME A117.1, A117.3 Standard for Accessible and Usable Building and Facilities.

B. National Electrical Manufacturer's Association (NEMA)

C. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code
   2. NFPA 72 – National Fire Alarm Code
   3. NFPA 90A – Standard for the Installation of Air conditioning and Ventilating Systems
   4. NFPA 101 – Life Safety Code

D. Underwriters Laboratory, Inc. (UL):
   1. UL-864 – Control Units and Accessories for Fire Alarm Systems
   2. UL-1076 – Proprietary Burglar Alarm Units and Systems

E. International Fire Code (IFC)

F. The Americans with Disabilities Act (ADA)
   1. Public Law 101 - 336.

G. Underwriters Laboratories (UL) or Factory Mutual (FM) Approval.

H. Philadelphia Electrical Code.

I. Philadelphia Fire Alarm Code.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the FACP manufacturer for both installation and maintenance of units required for this Project. Installer shall be able to produce, upon request, references and proof of five (5) years minimum experience in the installation of systems of comparable size and performance to that specified.

B. Manufacturer's Representative: The system shall be provided and commissioned by the authorized Manufacturer's Local Representative. This representative shall provide documentation that the organization is factory certified on the system. This organization must maintain a qualified technical and engineering staff to program and service the system. This distributor shall fully stock and show evidence that they maintain a complete inventory of spare parts to properly and promptly service the system. Before commencing work, submit data showing the commissioned fire alarm systems of the same type and design as specified. He shall include the names and locations of at least five such installations within one hundred miles of the project. Specify type and design for each system and furnish documentation that the system has performed satisfactorily for the preceding 48 months.

1.04 SYSTEM DESIGN REQUIREMENTS

A. Verify requirements with jurisdictional authorities (i.e. Insurance Carrier or Underwriter, Fire Department or Marshall, or local Building Code Department). This contractor shall be responsible for providing a complete and functional system, acceptable to the jurisdictions involved.

B. Qualification of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared by or under the supervision of an individual who is experienced with the type of work specified herein and is currently certified by the National Institute of Certification in Engineering Technologies (NICET) as an engineering technician with minimum Level III certification in the fire alarm and detection system program. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings. All submittals shall be stamped by a Registered Fire Protection Engineer.

C. Notification circuits shall be designed with 20 percent spare capacity for future visual notification devices.

1.05 SUBMITTALS

A. Contractor shall submit shop drawings, product data and calculations to the Authority Having Jurisdiction, Fire Department/Marshall, Owner's Insurance Underwriter and/or other regulatory agency, and obtain approvals prior to submission to Engineer for review. Include approval documentation with submission to Engineer.

B. Provide complete submittals, which shall include schematic wiring drawings of the control panel showing internal and external control panel wiring and all devices. Floor plans/device layout drawings, sequence of operation, annunciator wiring schematics, battery calculations, and specification sheets for all equipment, all devices shall be provided. Drawings shall be done on full size sheets and to scale (1/8"=1'-0" minimum). Partial submittals will not be accepted.

C. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

1.06 OPERATION AND MAINTENANCE DATA

Submit to Engineer the following operation and maintenance information in accordance with the requirements of this section and General Conditions of Contract:

1. Instruction books and/or leaflets
2. Recommended renewal parts list
3. Final as-built drawings
4. Complete Wiring diagrams
5. NFPA 72 Test Report/Certificate

1.07 DEFINITIONS

A. Alarm-Initiating Device: A system component that originates transmission of a change-of-state condition, such as a manual pull station, smoke detector, heat detector, supervisory switch, etc.

B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station, the operation of a sprinkler system flow switch, etc.

C. Class A Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the fire alarm control panel (FACP) and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.

D. Class B Wiring: Circuits electrically supervised such that a single break or a single ground fault condition will be indicated by a trouble signal at the FACP no matter where the break or ground fault condition occurs.

E. Hard-Wired System: Alarm, supervisory, and initiating devices directly connected, through individual dedicated conductors, to a central control panel without the use of multiplexing circuits or devices.

F. Multiplex System: One using a signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal (also referred to as an Addressable System).

G. Supervisory Signal: Indicates abnormal status or need for action regarding fire suppression or other protective system.

H. Trouble Signal: Indicates that a fault, such as an open circuit, ground, etc. has occurred in the system.

I. Zone: A building area that has all initiating devices located within it programmed to initiate an alarm and to give a common location indication on the system FACP and annunciator.

1.08 SYSTEM DESCRIPTION

A. General: UL and FM listed. Complete, zoned, non-coded, addressable, microprocessor-based fire detection and alarm system with manual and automatic alarm initiation, intelligent analog

addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detectors as indicated.

B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.

C. Voice evacuation and Visual Alarm Indication: By sounding of audible notification devices and visual alarms.

D. System connections for alarm-initiation and alarm-indicating circuits: Class B (Style 4) wiring.

E. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building. Building owner shall be notified 48 hours in advance if normal building operations are to be interrupted - building interruptions shall occur only at the convenience of the owner.

1.09 RECORD DOCUMENTS

A. The As-Built drawings shall include three (3) complete sets of 30" x 42" contract base sheet drawings with any and all changes included and noted. The approved contract panel drawings and annunciator panel drawings shall also be provided on 30" x 42" reproducible. The Conduit Plan shall show the device address for all intelligent/analog-initiating devices. The As-Built drawings shall be kept up to date continuously by the electrician in charge of the system installation. These drawings shall be reviewed on a weekly basis for accuracy and completeness.

B. The Operation and Maintenance Manual shall include a complete set of equipment, component and device specification and data sheets as well as a reduced size paper copy (half-size or 11” x 17”) of the complete set of system drawings described in paragraph 1.4. A copy of the NFPA 72 Test Report/Certificate, a printed record of all test activity including the sensitivity readings for all intelligent/analog smoke detectors, the required system and component warrantee papers, and the name and address of the installer shall be included. The manual shall be bound in a black three ring loose leaf binder with dividers and a table of contents. Three (3) duplicate sets are required.

C. Five (5) sets of keys to all locks shall be provided in a proper key box or binder with each set of keys properly and legibly marked and tagged. Loose keys will not be accepted.

D. All locks and keys for fire alarm panel and power booster panel shall be keyed alike and keyed to the master key system of the School District of Philadelphia. Locks and pulls for doors of cabinets shall be Corbin #15767. The master key shall be #CAT60.

E. All documents and items described above shall be submitted for approval and turnover prior to the final testing and system certification with the exception of the NFPA 72 Test Report/Certificate which shall be delivered by hand to the owner within two (2) days of the actual test and acceptance. One copy of the Test Report/Certificate shall be submitted to the Engineer.

F. THE PHILADELPHIA SCHOOL DISTRICT SHALL RETAIN COMPLETE RIGHTS AND OWNERSHIP TO ALL SOFTWARE RUNNING IN THE SYSTEM. This fire alarm equipment vendor shall provide useable hard and soft copies of the software database to the Philadelphia School District at the end of the warranty period. The database provided shall be useable by an authorized and certified distributor of the product line, and shall include all applicable

passwords necessary for the total and unrestricted use and modification of the database. The database shall contain all information relevant to the installed system.

1.10 ACCEPTANCE OF SYSTEM

A. Total acceptance of the system will only be made after the required tests, complete record document package and the instruction period have been provided.

1.11 GUARANTEE

A. Guarantee the labor, materials and equipment provided under this contract against system defects for a period of three (3) years after the date of final acceptance of this work by the Owner.

B. Provide service by the equipment supplier during the guarantee period, seven (7) days a week, including holidays, within four (4) hours after notification. Repairs shall be affected within twenty-four (24) hours of notification.

C. Should the Contractor fail to comply with the above requirements, the Owner will then have the option to make the necessary repairs and back charge the Contractor without any loss of warranty or guarantee as provided by the contract.

D. Any guarantee which is in conflict with the above will not be acceptable.

1.12 WARRANTY

A. The contractor shall warranty all materials, installation and workmanship for three (3) years from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

B. The system supplier shall maintain a service organization with adequate spare parts stock with 50 miles of the installation. Any defects that render the system inoperative shall be repaired with 24 hours of the owner notifying the contractor.

1.13 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning with Substantial Completion, maintenance service shall in three (3) years full maintenance by skilled employees of manufacturer's designated service organization. Included preventative maintenance, replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
    1. Include visual inspections according to "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection Testing and Maintenance" in chapter in NFPA 72
    3. Perform test per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    4. Test and recertify the fire alarm system at the end of the first year, at the end of second year, and at the end of third year, before expiration of the warranty.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Acceptable Manufacturers for the fire alarm system:
   1. Simplex-Grinnell
   2. Edwards System Technology (EST)
   3. Siemens Building Technologies

B. Manufacturers submitted by the bidder as equals or substitutions shall comply with specification Section 26 05 00.

### 2.02 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Control of System: By the FACP. Provide all programming required for a complete and operating fire alarm and detection system, to the complete satisfaction of the Owner and the Engineer. Backup of program shall be provided.

B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.

D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.

E. Transient voltage Protection: Provide protection on all circuits in accordance with manufacturer's recommendation.

F. System Reset: All zones are manually resettable from the FACP after initiating devices are restored to normal.

G. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and two (2) telephone lines.

H. Loss of primary power at the FACP initiates a trouble signal at the FACP and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.

I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a flame or heat detector, operation of a sprinkler flow device, or verified automatic alarm operation of a smoke detector initiates the following:
   1. Notification-appliance operation.
   2. Audible and visual annunciation of ‘alarm’ condition at the FACP and the remote annunciator(s).
   3. Identification, in plain-text English via alpha-numeric display, at the FACP and the remote annunciator(s) of the device originating the alarm.

4. Transmission of an alarm signal to the remote alarm receiving station.
5. Shutdown of fans and other air-handling equipment serving zone where alarm was initiated.
6. Closing of smoke dampers in air ducts of system serving zone where alarm was
7. Recording of the event in the system memory.
8. Alarm Silencing, System Reset and Indication: Controlled by switches on the FACP and the remote annunciator.
9. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
10. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
11. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

J. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the FACP.
2. Activation of a listed and approved "alarm verification" sequence at the FACP and the detector.
3. General alarm, once the alarm condition is verified. Activation of a second smoke detection device during the verification period shall automatically activate general alarm.
4. Cancellation of the FACP indication and system reset if the alarm is not verified.

K. Supplemental extinguishing systems (Kitchen hoods) initiates the following:
1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the FACP and the annunciator(s).
2. Identification, in plain-text English via alpha-numeric display, at the FACP and the remote annunciator(s) of the device that has operated.
3. Recording of the event by the system printer.
4. Transmission of trouble signal to remote central station.

L. Removal of an alarm-initiating device or a notification appliance initiates the following:
1. A "trouble" signal indication at the FACP and the annunciator(s).
2. Identification, in plain-text English via alpha-numeric display, at the FACP and the remote annunciator(s) of the device or zone involved.
3. Recording of the event by the system printer.
4. Transmission of trouble signal to remote alarm receiving station.

M. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACP is ten seconds.

N. Circuit Supervision: Indicate circuit faults by means of both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

O. FACP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

## 2.03 MANUAL PULL STATIONS

A. Description: Fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.
   1. Single-action mechanism, with positive visual indication of activation, initiates an alarm. Pull stations shall incorporate a key reset device.
   2. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
   3. Pull station body shall be red, with clearly visible operating instructions provided on the cover. The word "**FIRE**" shall appear on the front of the station in raised letters of contrasting color.
   4. Provide a sign adjacent to each manual pull station. The sign shall read "**IN CASE OF FIRE: SOUND ALARM AND CALL THE FIRE DEPARTMENT**". The sign is 12" wide x 6" high plastic laminate. The sign is white with red letters. Firmly affix the sign with a stainless-steel screw at each corner. The lettering is no less than 1" tall.
   5. Provide sample of sign to owner, construction manager, and engineer for review before purchasing final signs. Refer to Specification Section on Submittals before submitting sample.
   6. Sign layout:

**IN CASE OF FIRE:**
**SOUND THE ALARM AND**
**CALL THE FIRE DEPARTMENT**

## 2.04 SMOKE DETECTORS

A. General requirements:
   1. Operating Voltage: 24-V dc, nominal.
   2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
   4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
   5. Sensitivity: Can be tested and adjusted in-place after installation.
   6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
   7. Photoelectric Smoke Detectors include the following features:
      a. Sensor: LED or infrared light source with matching silicon-cell receiver.
      b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
      c. Where combination smoke/thermal detectors are noted to be utilized on the drawings, provide integral Thermal Detector: Fixed-temperature type with 135 degrees F setting.
   8. Beam-Type Smoke Detectors: Each detector consists of a separate transmitter and receiver with the following features:
      a. Adjustable Sensitivity: More than a six-level range, minimum.
      b. Linear Range of Coverage: 600 feet, minimum.
      c. Tamper Switch: Initiates trouble signal at the central FACP when either transmitter or receiver is disturbed.

d. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "trouble" signal.

9. Duct Smoke Detectors: Photoelectric type with duct-mounted housing.
   a. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied. Sampling tube shall be sloped downward from the detector housing. Sampling tube holes shall be oriented toward the air stream in the duct.
   b. Smoke Detector: Shall be photoelectric type with UL listed air velocity range of 300-4,000 feet per minute.
   c. Relay Fan Shutdown: Isolated auxiliary contact, rated to interrupt fan motor-control circuit.
      i. Wiring between aux. contact and ATC system provided by Contractor.
   d. Locate duct detector remote test switch on adjacent wall at 5'-6" above floor.

## 2.05 HEAT DETECTORS

A. Heat Detector, Fixed-Temperature/Rate-of-Rise Type: Actuated by temperature that exceeds a fixed temperature of 135 degrees F. Rate-of-rise element shall be rated at 15 degrees F per minute.
   1. Mounting: Plug-in base, interchangeable with smoke detector bases.
   2. Provide and install remote test switches for all heat detectors that are more than 10 feet above finished floor.

B. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 degrees F.
   1. Mounting: Plug-in base, interchangeable with smoke detector bases.
   2. Provide and install remote test switches for all heat detectors that are more than 10 feet above finished floor.

C. Heat Detector, Fixed-Temperature/Rate-of-Rise Type: Actuated by temperature that exceeds a fixed temperature of 190 degrees F. Rate-of-rise element shall be rated at 15 degrees F per minute.
   1. Mounting: Plug-in base, interchangeable with smoke detector bases.
   2. Provide and install remote test switches for all heat detectors that are more than 10 feet above finished floor.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 degrees F.
   1. Mounting: Plug-in base, interchangeable with smoke detector bases.
   2. Provide and install remote test switches for all heat detectors that are more than 10 feet above finished floor.

E. Weatherproof Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 degrees F.
   1. Mounting: Plug-in base, interchangeable with smoke detector bases.
   2. Provide and install remote test switches for all heat detectors that are more than 10 feet above finished floor.
   3. System Sensor Model 885WP-B or approved equal.
   4. Provide and install remoted test switches for all weatherproof heat detectors.

## 2.06 NOTIFICATION DEVICES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.

B. Fire Alarm speaker shall be of the polarized 24-V dc operation. The speaker shall 70.7 VRMS inputs and be field selectable power taps from 0.25 to 2 watts. Speaker shall have frequency response of 400 to 4,000 Hz and be UL Listed for fire alarm voice evacuation use. Speakers shall be designed to be wall or ceiling mounted.

C. Fire Alarm speaker & strobe combination: shall be of the polarized 24-V dc operation. The speaker shall 70.7 VRMS inputs and be field selectable power taps from 0.25 to 2 watts. Speaker shall have frequency response of 400 to 4,000 Hz and be UL Listed for fire alarm voice evacuation use. The device shall also have a Xenon strobe light listed under UL 1971 with clear polycarbonate lens. Mount lens on aluminum faceplate. Housing shall be red in color, with the word “FIRE’ clearly printed in white. The strobe intensity output shall field selectable. Combination devices shall be designed to be wall or ceiling mounted.

D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear polycarbonate lens. Mount lens on an aluminum faceplate. Housing shall be red in color, with the word "FIRE" clearly printed in white.
   1. Strobe Leads: Factory connected to screw terminals.
   2. Minimum strobe intensity for devices is noted on drawings.
   3. All strobe lights visible within the same area shall be fully synchronized.
   4. Device shall have field selectable output for visual settings.
   5. Strobe light shall produce a minimum of 15 candelas at approximately one flash per second with continuously applied voltage.

## 2.07 CARBON MONOXIDE DETECTOR

A. Carbon monoxide detector shall be listed to UL 2075 for Gas and Vapor detectors and sensors. The detector shall be equipped with a trouble relay.

B. The detector shall provide dual-color LED indication which blinks to indicate normal standby, alarm or end-of-life. When the sensor supervision is a trouble condition, the detector shall send a signal to the control panel.

C. The detector shall provide a means to test CO gas entry into the CO sensing cell. The detector shall provide this with a test mode that accepts CO gas from a test agent and alarms immediately upon sensing CO entry.

D. The detector shall be operated at 24 volts DC.

E. The detector shall be mounted to a single gang back box.

F. End of life timer: When the detectors internal sensor has reached the end of its life, a trouble signal shall be sent to the control panel.

## 2.08 WATER FLOW DETECTOR (SWITCH)

A. Water flow switches shall be UL Listed for its intended purpose. Individual addressable modules shall be provided for each switch.

B. Vane-type waterflow detectors shall be installed on system piping as designated on the design drawings.

C. Install water flow detectors on any clear of the appropriate nominal size, either a vertical upflow or horizontal run, at least 6” from any fittings which may change water direction, flow rate, or pipe diameter; or no closer than 24” from a valve or drain.

D. Waterflow detectors shall have a sensitivity of in the range of 4 to 10 gallons per minute and a static pressure rating of 450 psi for 2” to 8” pipes.

E. The waterflow detector shall respond to waterflow in the specified direction after a preset time delay which is field adjustable. The delay mechanism shall be a sealed mechanical pneumatic unit with visual indication of actuation. The actuation mechanism shall include a polyethylene vane inserted through a hole in the pipe and connected by a mechanical linkage to the delay mechanism.

F. Outputs shall consist of dual SPDT (single pole, double throw) From C contacts.

G. Two conduit entrances for standards fittings of commonly used electrical metallic tubing shall be provided on the detectors.

H. All housing shall be NEMA 4 Listed by UL for indoor or outdoor use.

2.09 TAMPER SWITCH

A. Tamper switches shall be UL Listed for its intended purpose. Individual addressable modules shall be provided for each switch.

B. Outputs shall consist of dual SPDT (single pole, double throw) From C contacts.

C. The switch assembly shall include two switches each with a rated capacity of 2.5 amps at 24 VDC.

D. Two conduit entrances for standards fittings of commonly used electrical metallic tubing shall be provided on the detectors.

2.10 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: LED indicating light near each smoke detector that may not be readily visible, and each sprinkler water-flow switch and valve-tamper switch. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located.

B. Mounting: Mounted at an accessible location in ceiling/wall in close proximity to smoke detector.

2.11 FIRE ALARM CONTROL PANEL (FACP)

A. Fire alarm audio control panel shall provide complete voice annunciation of the fire alarm system. Panel shall include ability to select paging zone by area or all call. The panel shall support both live paging and prerecorded digital messages. The fire alarm control panel shall include the following performance features:
   1. Audio Channels: one simultaneous 70.7 VRMS channel, minimum
   2. Audio Levels: As required by NFPA 72
   3. Digital Message: As recorded by Owner’s representative
   4. Preamp supervision and Automatic changeover.

5. Amplification: supports 3 distributed or central bank amplifiers.
6. Remote microphone for all-call paging.

B. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
   1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
   2. Mounting: As noted/shown on drawings.

C. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

D. Control Modules: Include types and capacities required to perform all functions of fire alarm systems.

E. Indications: Local, visible, and voice signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

F. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

G. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control.
   1. Display: Back-lit, 80-character minimum LCD display, utilizing plain-text English, for alarm, supervisory, and component status messages; and indication of control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

H. The fire alarm control panel shall be capable of operating remote displays and/or printers. The output shall be serial ASCII from an EIA RS-232-C connection with and adjustable baud rate of 300, 1200, 2400, 48000 or 9600 to allow use of compatible UL864 listed display, keyboard or printer.

I. The fire alarm control panel shall be provided with a coded one-man walk test feature and program the fire alarm control panel for this feature.

J. Provide signature device programming / service tool to allow programming of signature devices with using the PC and use for retrieving information from signature device history log and trouble codes. Also provide necessary accessories including communication and power cables.

K. Provide memory stick with complete copy of points list.

L. The FACP cannot have a map fault feature.

## 2.12 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, reset, and test.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

## 2.13 EMERGENCY POWER SUPPLY

A. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
   1. Battery Nominal Life Expectancy: 20 years, minimum.
   2. Battery Capacity: Comply with NFPA 72. Batteries shall be sufficient to operate the system for a minimum of 24 hours in 'Standby', followed by 5 minutes in 'Alarm.' If required, provide remote power panels with battery backup same as the main control panel. Extend 120 VAC source from the main control panel. Coordinate location of remote power supply panel(s) in the field with the Owner/Architect.

B. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

C. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

## 2.14 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for alarm-initiating devices (with normally open contacts).

B. Provide an Integral Addressable Interface (IAI) device or relay and associated circuitry, etc., for each fire protection alarm initiating device as required.
   1. Provide additional addressable relays/addressable monitors, and associated circuitry, to perform auxiliary functions indicated on the drawing or required by applicable codes.
   2. Coordinate exact quantities with Fire Protection Contractor.

C. Locate Addressable Interface Device in conditioned spaces. Do not locate Addressable Interface Device in Boiler Rooms, Fan Rooms, or Basement type areas.

## 2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled under UL 864 and NFPA 72.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Provide standalone digital alarm communicator transmitter (DACT) to transmit alarm signals to a Central Monitoring Station (CMS). The DACT shall be a manufactured by Silent Knight, model 5129 or an approved equal by the school district. Provide (2) CAT6 cables from the fire alarm control panel to the telephone demarcations station in the Main Mechanical Room to transmit alarm signal to the security officer at School District Main Office.

D. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity shall be adequate to comply with NFPA 72 requirements.

E. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

F. The digital alarm communicator transmitter (DACT) and the fire alarm control panel shall be arranged to transmit all zones to the central monitoring station. Zones to be transmitted shall be defined by the Owner. The system shall be capable of transmitting a distinct signal for each zone to the monitoring station's facilities, including spare zones. A trouble or low battery condition associated with the DACT shall be transmitted to the monitoring station.

G. The supplier of the DACT shall coordinate compatibility with the central monitoring station. All labor and hardware required to obtain compatibility with the monitoring station shall be the included. Forward a letter to the Architect/Engineer stating that this coordination has been done and that the proposed communicator system is completely compatible with the central monitoring station's equipment.

H. Provide two dedicated telephone lines for use by the DACT in the fire alarm control panel. Coordinate requirements with Owner's Representative.

## 2.16 INTERNET & 4G COMMERCIAL FIRE COMMUNICATOR

A. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically dials a preset number for remote central station. When contact is made with the central station, the signal is transmitted. The unit is capable of using either cellular or voice over internet protocol (VOIP). The unit is set up for VOIP primary and cellular backup. The unit transmits the signal to a central monitoring station (CMS).

B. Provide standalone internet and 4G commercial fire communicator as manufactured by Honeywell Security model iGSMCFP4G or approved equal by the school district. Provide (2) CAT6 cables from the communicator to the main telecommunications room in the building. Terminate the cable at both ends with RJ-45 jacks. Test the cabling per the TIA standards.

C. Primary power: Provide 120-volt to 12-volt transformer. Connect to adjacent branch circuit feeding fire alarm control panel. Secondary power: Integral rechargeable battery and battery charger. Battery capacity shall be adequate to comply with NFPA 72 requirements, but no less than 24 hours.

D. Encryption: Furnish a unit with 256-bit encryption.

E. Diagnostic LED: Furnish a unit diagnostic LED that show signal strength and status indications. The status indications include: power, VOIP available, cellular available.

F. The communicator and the fire alarm control panel shall be arranged to transmit all zones to the central monitoring station. Zones to be transmitted shall be defined by the Owner. The system shall be capable of transmitting a distinct signal for each zone to the monitoring station's facilities,

including spare zones. A trouble or low battery condition associated with the communicator or FACP shall be transmitted to the monitoring station.

G. The supplier of the communicator shall coordinate compatibility with the central monitoring station. All labor and hardware required to obtain compatibility with the monitoring station shall be the included. Forward a letter to the Architect/Engineer stating that this coordination has been done and that the proposed communicator system is completely compatible with the central monitoring station's equipment.

## 2.17 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Utilized on all devices in gymnasium and on other devices as noted on drawings.
   2. Factory fabricated and furnished by the manufacturer of the device.
   3. Finish: Paint of color to match the protected device.
   4. Provide guards for audio, visual and initiation devices in the gymnasium.

B. For each manual pull station provide and install a clear polycarbonate cover with local horn. The horn is powered by a 9-volt dc battery and produces a sound of no less than 95db.

## 2.18 EXTRA EQUIPMENT INSTALLED & WIRED

A. Fire alarm pull station– provide a total of one (1) manual pull station install, wired and programmed at locations determined by the owner in the field. If the owner chooses not to add an additional pull stations to the project, the pull station become the property of the School District of Philadelphia.

B. Fire alarm strobe – provide two (2) fire alarm strobe units installed, wired and programmed at locations determined by the owner in the field. If the owner chooses not to add any fire alarm strobes to the project, the fire alarm strobes become the property of the School District of Philadelphia.

C. Smoke detector - provide five (5) fire alarm smoke detector units installed, wired and programmed at locations determined by the owner in the field. If the owner chooses not to add any fire alarm smoke detectors to the project, the smoke detectors become the property of the School District of Philadelphia.

D. Fire alarm speaker/ strobe – one (1) fire alarm speaker/ strobe unit installed, wired and programmed at locations determined by the owner in the field. If the owner chooses not to install to add any additional fire alarm speaker/ strobes to the project, the fire alarm speaker/ strobe become the property of the School District of Philadelphia.

E. Heat detectors – two (2) fire alarm heat detectors units installed, wired and programmed at the locations determined by the owner in the field. These heat detectors are rated for 135 degrees F and 15 degrees F rate of rise. If the owner chooses not to install to add any additional heat detectors to the project, the heat detectors become the property of the School District of Philadelphia.

F. Heat detectors – one (1) fire alarm heat detectors units installed, wired and programmed at the locations determined by the owner in the field. These heat detectors are rated for 190 degrees F and 15 degrees F rate of rise. If the owner chooses not to install to add any additional heat

detectors to the project, the heat detectors become the property of the School District of Philadelphia.

G. Heat detectors –one (1) fire alarm heat detectors units installed, wired and programmed at the locations determined by the owner in the field. These heat detectors are rated for 135 degrees F fixed temperature. If the owner chooses not to install to add any additional heat detectors to the project, the heat detectors become the property of the School District of Philadelphia.

H. Heat detectors – one (1) fire alarm heat detectors units installed, wired and programmed at the locations determined by the owner in the field. These heat detectors are rated for 190 degrees F fixed temperature. If the owner chooses not to install to add any additional heat detectors to the project, the heat detectors become the property of the School District of Philadelphia.

I. Heat detectors – one (1) fire alarm heat detectors units installed, wired and programmed at the locations determined by the owner in the field. These heat detectors are rated for 135 degrees F fixed temperature, weatherproof. If the owner chooses not to install to add any additional heat detectors to the project, the heat detectors become the property of the School District of Philadelphia.

2.19 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 degrees C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

2.20 PULL BOXES AND TERMINAL CABINETS

A. Pull boxes shall be Pentair NEMA type 1 hinged cover cabinets only. Sizes as shown on the fire alarm system drawings. Paint all pull box doors red and label F/A PULL BOX. Pull boxes shall be rated for the environment they are placed in (i.e. NEMA 1, NEMA 3R, NEMA 4X, etc.)

B. Terminal cabinets shall be Pentair NEMA type 1 hinged cabinets with a painted steel removable subplate and 'T' handle latch. No locks are required. Each terminal cabinet shall have a factory painted red finish. Provide on the door of each terminal cabinet a red lamacoid nameplate with ¾ inch white letters to read Fire Alarm Terminal Cabinet #__. Flush cabinets shall be the same type except for factory supplied flush mounting trim. Provide one (1) IDEAL (389-061) terminal block per wire entering and leaving the terminal cabinet, plus 10% spare terminal blocks. Mount terminal blocks vertically and use the appropriate terminal block mounting channel and terminal block end plates (89-062) as recommended by the manufacturer. Each terminal shall be properly identified and the respective Terminal Cabinet Directory as shown in the drawings shall be attached to the inside cover with an adhesive backed vinyl envelope.

2.21 PRINTER

A. Provide and install a system printer in or adjacent to the fire alarm control panel. The printer shall print messages that appear on the fire alarm control panel screen.

B. The printer shall show all operator commands and shall be capable of providing a printer list of system conditions, such as: detector sensitivities, thresholds, analog voltages, device type, and custom messages. A *TROUBLE* condition shall be generated when the printer paper has run out. An internal buffer shall continue to store events when paper is out.

PART 3 EXECUTION

3.01 INSTALLATION

A. SCOPE

1. The system shall electrically supervise all wiring between the control panel and all initiating and indicating devices.
2. The system shall be capable of differentiating between a system trouble condition and the activation of a supervisory device.
3. A complete NFPA 72 test shall be done and a system status report issued prior to the start of any demolition of the existing functioning fire alarm systems.

B. EQUIPMENT INSTALLATION

1. All wiring shall be installed in conduit except as otherwise shown. Entire conduit system housing fire alarm cabling shall be red in color. Prepainted EMT conduit shall be as manufactured by Allied Tube and Conduit or approved equal.
2. All conduits, cabinets and device back boxes shall be recessed unless shown otherwise on the drawings and as directed by the Architect or Engineer.
3. Provide smoke detector above fire alarm control panel and each auxiliary power supply (if not shown on floor plans).
4. All spot type detectors shall be located on the suspended ceilings, except as noted. If suspended ceilings do not exist, the detectors shall be mounted on the slab.
5. All detectors shall be centered in the ceiling tiles and back boxes and conduits shall be recessed in areas with suspended ceilings. The back boxes and conduits for detectors on the slab shall be surface mounted with conduits run perpendicular/parallel to the walls.
6. All detectors shall be located at the highest point on the ceiling or slab except as specifically noted.
7. Exact location of all automatic detectors shall be as directed by the manufacturer's representative.
8. Smoke detectors shall not be located within three (3) feet of or in the direct air stream from supply air diffusers. Additionally, smoke detectors shall not be located within three (3) feet of return air grilles.
9. Automatic detectors shall not be mounted on or within three (3) feet of doorways, beams, columns or walls, except smoke detectors at doors with door holders shall be mounted between two (2) and four (4) feet from the doors.
10. The Electrical Contractor shall furnish and install duct smoke detectors utilizing workmen skilled in appropriate trades. The Electrical Contractor shall provide all fire alarm wiring and interconnections. All power and/or control wiring required for the operation of smoke dampers or for the shutdown of air handling units shall be provided by this Contractor.
11. All manual stations located at egress doors shall be located adjacent to and within five (5) feet of the respective egress doors.
12. All detectors mounted on suspended ceilings shall be connected to pull boxes mounted on the slab with flexible conduit that shall be long enough to move the detector five (5) feet in any direction.
13. Detector bases shall be mounted on ceiling outlets so that indicator lamps are visible from the floor below, or from the nearest equipment aisle, or from the doorway entering the room, as applicable.
14. The conduit, device back boxes, pull boxes, terminal cabinets, panels and wiring as shown on the Fire Alarm System drawings shall be installed as shown. The device back boxes and conduit wire fill shall be in compliance with the National Electrical Code.
15. Provide white lamacoid nameplates on the ceiling grid with ¼ inch red letters to identify all above ceiling devices.

16. The fire detection and alarm system shall be operational at all times, except that when work is being performed on the system during normal working hours only those portions actually undergoing modification shall be out of service. All detectors in the construction area shall be bagged with plastic bags during the working hours and de-bagged after working hours.
17. At the end of each workday, and before workmen leave the site, proper operation of the system shall be demonstrated to the designated Owner's representative.

C. WIRING INSTALLATION

1. All alarm initiating devices and supervisory initiating devices shall be connected on Class B (Style 4) OR Class A two (2) wire Signaling Line Circuits (SLC). Unsupervised wiring (point wires) shall not be permitted. T-tapping and parallel branch circuit wiring shall be permitted on the addressable SLCs, in accordance with the manufacturer's recommendations.
2. All alarm indicating devices shall be connected on Class B OR Class A two (2) wire electrically supervised circuits and on a minimum of two active circuits.
3. Wiring to initiating and supervisory devices and to fire alarm annunciators shall be with two- (2) conductor, twisted solid copper UL listed fire alarm system wire subject to manufacturer's recommendations (#16 AWG minimum).
4. Wiring to alarm indicating devices shall be with two- (2) conductor twisted solid copper UL listed jacketed fire alarm system wire subject to manufacturer's recommendations (#14 AWG minimum).
5. All other wiring shall be as recommended by the system manufacturer.
6. No splicing of wires is permitted except on terminal blocks in annunciators, control panels or properly labeled terminal cabinets as shown on the drawings. The use of wire nuts or similar type devices is not permitted. All devices shall have terminals for each wiring connection. No splicing of any type shall be permitted in pull boxes, to include crimp terminals.
7. All wires shall be labeled at both ends with ¾" x 1-3/9" ScotchCode SWD Write-On Tape and SMP Write-On Marking Pen only.
8. Use plastic wire ties and wire tie mounts to ensure a neat quality appearance.

3.02 TESTS

A. Prior to the acceptance test of the project by the Owner, a factory-trained technician from the equipment supplier shall inspect, test and adjust the complete Fire Alarm System according to NFPA-72, including, but not limited to, the following:

1. Visual inspection of all equipment.
2. Verification of alarm, supervisory and trouble signals at all receiving locations and circuits, including audible and visual alarms, annunciators, control panels, and central monitoring control panel.
3. Test each alarm initiation device for alarm and correct annunciation.
4. Test each alarm strobe light for proper operation.
5. Test the sensitivity of each smoke detector with a manufacturer's detector test set (the fire alarm control panel shall be UL listed for this purpose). Retain a printed recorded of all firing voltages. Correlate firing voltage records to the device addresses as shown on the as-built drawings.
6. Check all end of line devices for proper installation and polarity.

B. All smoke detector sensitivity adjustments and tests shall be performed:

1. From the Fire Alarm Control Panel with each detector in its exact operating location and not at some convenient place.
2. Only under normal, balanced and completed maximum air flow conditions, with supply air systems constant and not undergoing balancing or other alterations, and air conditioning refrigeration systems operating properly.

3. A complete printout showing all sensitivity readings shall submitted.

C. After the system has been installed, the DACT shall be completely tested by the equipment manufacturer's representative for proper operation. A letter shall be provided to the Owner by the manufacturer's representative confirming the test, indicating their approval and that all zones are capable of being transmitted to and satisfactorily received by the central monitoring station.

D. The Owner's acceptance test will only be made after the above tests are made and the copy of the NFPA 72 Test Report/Certificate results is turned over to the Owner for evaluation. The Owner's test will be the same as the above Contractor's tests. Demonstrate to the Owner that no wire nuts or similar devices have been used in the system. Perform these tests in the presence of the Owner or the Owner's representative.

E. Per NFPA 72, submit to the owner, construction manager, and engineer – FIRE ALARM SYSTEM RECORD OF COMPLETION.

F. Per NFPA 72, submit to the owner, construction manager, engineer, and Pennsylvania Department of Labor & Industry – FIRE ALARM SYSTEM INSPECTION & TESTING. This form must be accepted with no exceptions.

3.03 FIELD ADJUSTMENTS

A. Repair or replace at his expense any defective devices, equipment or wiring and perform additional testing required to demonstrate that the system is in full compliance with the drawings and specifications.

B. The cost of any re-testing as a result of the failure of the system to operate in accordance with these specifications and/or non-compliance with the drawings or applicable codes shall be paid by the Contractor to the Owner. A purchase order shall be delivered to the Owner before the re-testing is scheduled or started.

3.04 TRAINING

A. Upon the completion of all work and of all tests, furnish the necessary skilled labor for providing operating instructions of all systems and equipment for a period of one (1) day of eight (8) hours for each building or as otherwise directed. During this period, instruction will be given to the owner or his representative(s) in the full operation, adjustment and maintenance of all equipment furnished or provided.

B. The contractor will provide video taping of all the training, and 3 copies of the training on a DVD to the owner.

END OF SECTION