#95 Joseph M. Pettit Microelectronics Research

Fire Alarm Upgrades

Issued for Construction

TECHNICAL SPECIFICATIONS

October 14, 2016

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SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

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

1.2 SUMMARY
   
   A. This Section includes control equipment for HVAC systems and components.
   
   B. The DDC Controls System shall be manufactured and installed by Johnson Controls under State of Georgia DOAS RFP #9020017203 / Georgia Institute of Technology. The contractor is directed to contract with Johnson Controls. Base bids and change orders, as they relate to the building controls, shall be priced as per the RFP/P.O. pricing. Timothy Lucas is the Johnson Controls representative at (770) 870-3931 timothy.b.lucas@jci.com
   
   C. In addition to devices and materials indicated under PART 2, provide all devices and materials required to provide the sequences of operation.
   
   D. Controls work shall include updated graphics of existing DDC control systems including:
      1. Floor plans (with room numbers as assigned by the Owner) developed using the architectural AutoCAD floor plans with sensor locations.
      2. Air-conditioning unit control points information and command buttons.
   
   E. Controls shall be fully integrated into the controls of existing Campuswide DDC.

1.3 DEFINITIONS
   
   A. DDC: Direct digital control.
   
   B. I/O: Input/output.
   
   C. PID: Proportional plus integral plus derivative.

1.4 SYSTEM PERFORMANCE
   
   A. Comply with the following performance requirements:
      
      1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
      2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

### 1.5 SEQUENCE OF OPERATION

1. Unless modified by the sequences below, the existing sequences of operation shall remain in place. Documentation of the original controls requirements are provided on Sheet E4.1.

2. Upon detection of products of combustion at smoke detectors located in supply air ducts and at return air openings:
   a. The associated air handling unit fan(s) shall be disabled via a hard-wired shutdown circuit.
   b. Where applicable, (units S-1 through S-5) existing smoke dampers at air handling units shall close.
   c. A supervisory alert shall be initiated at the Fire Alarm Control Panel (FACP).

3. Upon detection of products of combustion at Air Sampling Smoke Detection (ASSD) system detectors:
   a. The associated fan (with designation TF) shall be disabled via a hardwired shutdown circuit.
   b. A supervisory alert shall be initiated at the fire alarm control panel.
   c. Refer to Sheet FA101 for additional information.

4. Upon a signal that the General Building Evacuation alarm has been activated
   a. Fans listed in schedules below that are not associated with a Clean Room shall be de-activated.
   b. Only fans associated with a Clean Room shall be de-activated upon alarm for Clean Room Level.

5. Upon a signal that the smoke alarm (and/or General Building Evacuation alarm) has been cleared, the fan(s) shall be automatically re-started. The automatic reset shall be provided through:
   a. OFF-ON-RESET features in the smoke detectors.
   b. Verification of reset settings in the existing variable frequency drives.

6. The above sequences shall apply to the following existing air handling units and supply fan systems. See drawings for locations of detection devices and associated equipment to be de-activated.
<table>
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<tr>
<th>Unit I.D.</th>
<th>Type</th>
<th>Serves</th>
<th>Supply Air Location</th>
<th>Return Air Location</th>
<th>Existing Smoke Dampers</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>Built-up AHU</td>
<td>Clean Room Makeup</td>
<td>Supply duct in Mech Rm</td>
<td>Return air duct in Mech Rm</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td>Built-up AHU</td>
<td>Clean Rm Circulating</td>
<td>Supply duct in Mech Rm</td>
<td>(2) Locations: 1st Fl RA wall opening 2nd Fl RA wall opening</td>
<td>Yes</td>
</tr>
<tr>
<td>S-3</td>
<td>Built-up AHU</td>
<td>1st and 2nd Fl</td>
<td>Supply duct in Mech Rm</td>
<td>(2) Locations: 1st Fl RA wall opening 2nd Fl RA wall opening</td>
<td>Yes</td>
</tr>
<tr>
<td>S-4</td>
<td>Built-up AHU</td>
<td>1st and 2nd Fl</td>
<td>Supply duct in Mech Rm</td>
<td>(2) Locations: 1st Fl RA wall opening 2nd Fl RA wall opening</td>
<td>Yes</td>
</tr>
<tr>
<td>S-5</td>
<td>Built-up AHU</td>
<td>1st and 2nd Fl</td>
<td>Supply duct in Mech Rm</td>
<td>N/A: 100% outside air</td>
<td>Yes</td>
</tr>
<tr>
<td>S-6</td>
<td>Fan Only</td>
<td>Clean Rm Level and Bsmt Level</td>
<td>Supply duct in Mech Rm</td>
<td>N/A: 100% outside air</td>
<td>N/A</td>
</tr>
<tr>
<td>CAC</td>
<td>Liebert</td>
<td>1st Floor</td>
<td>At unit</td>
<td>N/A: less than 15,000 cfm.</td>
<td>N/A</td>
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<tr>
<td>Unit I.D.</td>
<td>Type</td>
<td>Serves</td>
<td>Supply Air Smoke Detector</td>
<td>Return Air</td>
<td>Existing Smoke Dampers</td>
</tr>
<tr>
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<td>------------------------</td>
</tr>
<tr>
<td>TF-1A</td>
<td>Fan Only</td>
<td>Clean Room 18</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>TF-2A</td>
<td>Fan Only</td>
<td>Clean Room 17</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<tr>
<td>TF-3A</td>
<td>Fan Only</td>
<td>Clean Room 22</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<tr>
<td>TF-4A</td>
<td>Fan Only</td>
<td>Clean Room 21</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<td>TF-5A</td>
<td>Fan Only</td>
<td>Clean Room 28</td>
<td>Existing duct- mtd</td>
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<td>TF-5B</td>
<td>Fan Only</td>
<td>Clean Room 28</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<td>TF-6A</td>
<td>Fan Only</td>
<td>Clean Room 27</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>TF-6B</td>
<td>Fan Only</td>
<td>Clean Room 27</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>TF-7A</td>
<td>Fan Only</td>
<td>Clean Rooms 23, 24, 31A, 31B, &amp; 40 (Mask)</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>TF-7B</td>
<td>Fan Only</td>
<td>Clean Rooms 23, 24 31, 40 (Mask)</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>TF-8</td>
<td>Fan Only</td>
<td>Clean Rooms 15, 16, 23, 34</td>
<td>Existing duct- mtd</td>
<td>New ASSD</td>
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<tr>
<td>Unit I.D.</td>
<td>Type</td>
<td>Serves</td>
<td>Supply Air Location</td>
<td>Return Air Location</td>
<td>Existing Smoke Dampers</td>
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<td>----------</td>
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<tr>
<td>Focus</td>
<td></td>
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<td>F-1</td>
<td>Fan Only</td>
<td>Clean Rooms</td>
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<td>Clean Rooms</td>
<td>Existing duct-mtd</td>
<td>New ASSD</td>
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<td>F-3</td>
<td>Fan Only</td>
<td>Clean Rooms</td>
<td>Existing duct-mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<td>F-4</td>
<td>Fan Only</td>
<td>Clean Rooms</td>
<td>Existing duct-mtd</td>
<td>New ASSD</td>
<td>N/A</td>
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<tr>
<td>MAU-1</td>
<td>100% OA AHU</td>
<td>Makeup air for F-1, F-2, F-3, &amp; F-4</td>
<td>Existing duct-mtd</td>
<td>New ASSD</td>
<td>N/A</td>
</tr>
<tr>
<td>Column</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>RCU2-10</td>
<td>AHU</td>
<td>Clean Room 38</td>
<td>Existing duct-mtd</td>
<td>Existing Unit-mounted &amp; existing ASSD</td>
<td>N/A</td>
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<tr>
<td>BF2-7</td>
<td>Fan Only</td>
<td>Feeds makeup air into RA of TF-7A, TF-7B, &amp; TF-7C</td>
<td>New</td>
<td>---</td>
<td>N/A</td>
</tr>
<tr>
<td>BF2-10</td>
<td>Fan Only</td>
<td>Feeds makeup air into RA of RCU2-10 Column Area</td>
<td>New</td>
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<td>N/A</td>
</tr>
<tr>
<td>TF-7C</td>
<td>Fan Only</td>
<td>Clean Room 31C</td>
<td>Existing Unit-Mtd</td>
<td>ASSD</td>
<td>N/A</td>
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1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for transducers/transmitters, sensors and operator interface equipment.

2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
1.7 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Include the following:

1. Maintenance instructions and lists of spare parts for each type of control.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.9 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 ASHRAE 135 for DDC system components.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers:
1. Johnson Controls, Inc.; Controls Group.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.2 DDC SENSORS

A. Provide sensors, controls, instruments, and control interfaces to meet the performance specified herein. Sensors shall be high quality precision electronic type, selected to be compatible with the DDC controllers and appropriate for the service specified herein. Accuracy values specified herein include sensor, wiring, signal conditioning and display accuracies for overall end-to-end performance.

B. Photoelectric Sensors for Smoke Detectors: Refer to Division 28.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect and configure equipment and software to achieve sequence of operation specified.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable as follows:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 230900
SECTION 260010 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION AND DEFINITIONS

A. This division of the Specifications, Division 26, covers the complete electrical systems as indicated on the drawings or as specified herein. Provide all equipment, materials, labor, and supervision to install electrical systems. The requirements of this Section apply to all electrical work hereinafter described. The General and Special Conditions are considered a part of this Division of the Specifications and all provisions contained therein which affect this work are as binding as though incorporated herein.

B. The following words and phrases shall be interpreted as indicated:

1. "approved": approved or accepted by Governing Officials or Authorities Having jurisdiction
2. "materials": equipment and/or materials
3. "or equal/or equivalent": an equivalent with respect to appearance or function as determined by the Engineer/Engineer; submittal approval may be required - refer to individual specification sections
4. "provide": furnish, install, connect, and test the operation thereof
5. "work": materials provided - see above definitions
6. "wiring": conductors/cabling and raceway system, including fittings, boxes, connectors, supports, hardware, labeling, and related accessories
7. "replace": remove existing equipment, properly dispose of and “provide” new equipment

1.2 QUALITY ASSURANCE

A. Electrical work on this project must be performed by a contractor possessing a State of Georgia Unrestricted Electricians License.

B. All electrical work shall be in accordance with the following codes and agency standards:

8. Occupation Safety and Health Administration (OSHA).

C. Material Standards: All material shall conform to the standards where such standards have been established for the particular material indicated. Publications and standards of the organizations listed below are applicable to materials specified herein.

1. American National Standards Institute (ANSI)
2. Insulated Cable Engineers Association (ICEA)
3. Institute of Electrical and Electronic Engineers (IEEE)
4. National Electrical Manufacturers Association (NEMA)
5. National Fire Protection Association (NFPA)
6. Underwriters' Laboratories, Inc. (UL)

D. Listing and Labeling: Provide equipment assemblies that are listed and labeled.
   1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.3 MATERIALS

A. All materials shall comply with all applicable national standards. Materials shall be UL listed and labeled where UL listing is established for any specific product.

1.4 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.5 WARRANTY

A. The Contractor warrants to the Owner and Engineer that materials and equipment furnished under this Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Engineer, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. Refer to Division 1 for other warranty requirements.

1.6 PROJECT DOCUMENTS

A. Keep on hand at the project site a complete set of all project drawings and specifications. Refer to these documents as necessary; coordinate and install all work accordingly so that all electrical equipment will be properly located and accessible.

B. The drawings are diagrammatic and are intended to indicate the arrangements of electrical equipment. Do not scale drawings. Coordinate installation of electrical equipment with existing structural system and mechanical equipment and access thereto. Coordinate installation of electrical equipment with ductwork and piping, and wall thickness. Verify construction dimensions at the site and make changes necessary to
conform to the building as constructed. Work improperly installed due to lack of
construction verification shall be corrected at no additional cost to the Owner.

C. Bring all discrepancies shown on different drawings, between drawings and
specifications or between documents and field conditions to the immediate attention of
the Engineer.

1.7 SUBMITTALS

A. Shop Drawings and Product Data:
1. Submit for review by the Engineer data for materials and equipment to be used
on the project. Submittals shall be supported by descriptive material, catalog
cuts, diagrams, and performance charts published by the manufacturer to show
conformance to specification and drawing requirements. Model numbers alone
will not be acceptable. Provide documentation of complete electrical
characteristics for all equipment.
2. Refer to the individual sections for indication of equipment for which submittals
are required.

B. Record Documents: Provide record documents illustrating all field changes, as-built
drawings, and related submittals.

1.8 SITE INVESTIGATION

A. Prior to submitting bids for the project, visit the site of the work to become aware of
existing conditions which may affect the cost of the project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Furnish all materials specified herein or indicated on the drawings. All materials shall be
new, unless otherwise indicated.

B. Where Underwriters' Laboratories (UL) testing standards and listings exist for an item of
material or equipment, the listed material shall bear the UL label.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The physical execution of electrical work shall comply with applicable NECA National
Electrical Installation Standards.

3.2 TRAINING / DEMONSTRATION
A. Provide training by a manufacturer's authorized service technician for fire alarm system, engine-generator set and transfer switches. The contractor shall provide an orientation session for the Owner's personnel in which all aspects of the electrical system are addressed.

3.3 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at site and verify conformance with project requirements. Prevent unloading of unsatisfactory material. Handle materials in accordance with applicable standards and recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises and replaced.

B. All material, except items specifically designed to be installed outdoors, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided. Provide temperature and/or humidity control where necessary. All material for interior installation, including conductors, shall be stored in an enclosed weather tight structure and shall be protected from water, direct sunlight, cold or heat. Equipment stored other than as specified above shall be removed from the premises and replaced.

3.4 CLEANING, PAINTING, AND IDENTIFICATION

A. Remove oil, dirt, grease and foreign materials from all raceways, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touch-up scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, or other equipment enclosures with paint furnished by the equipment manufacturer specifically for that purpose.

B. Where painting of trim covers for flush mounted panelboards, communication equipment cabinets, pull boxes, junction boxes, and control cabinets is required under this or any other Division of these specifications, remove trim covers before painting. Do not paint locks, latches, hinges, or exposed trim clamps.

C. Identify electrical components where required in the individual specification sections.

3.5 OPERATION AND MAINTENANCE MANUALS AND INSTRUCTIONS

A. Provide printed material for binding in operation and maintenance manuals. Include electrical equipment shop drawings as a minimum, and other information as necessary. Refer to Division 1 for additional information on submittal requirements.

B. Instructions of Owner Personnel:
   1. Before final project review, as designated by the Engineer, provide a competent representative to instruct Owner's designated personnel in systems indicated.
   2. Use Operation and Maintenance Manuals as basis of instruction. Review contents with personnel in detail to explain all aspects of operation and maintenance.
   3. Prepare and insert additional data in Operation and Maintenance Manuals when the need for such data becomes apparent during instruction.
3.6 CONSTRUCTION OBSERVATION ASSISTANCE

A. Provide personnel to assist the Engineer or his representative during all construction observation visits. Provide tools and equipment as required to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.

B. Remove panelboard trims, motor controls covers, device plates, junction box covers, etc. as directed for inspection of internal wiring. Turn over to the Owner one set of keys for all lockable electrical equipment on the project. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.

C. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed.

D. Provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the Contract Documents at a time designated by the Engineer.

END OF SECTION 260010
SECTION 260113 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes procedural requirements for cutting and patching of interior walls and finishes.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.3 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Owner’s Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.
1.4 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operating elements include, but are not limited to, the following:
   1. Air or smoke barriers.
   2. Fire-suppression systems.
   3. Mechanical systems piping and ducts.
   4. Control systems.
   5. Communication systems.
   6. Conveying systems.
   7. Electrical wiring systems.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or those results in increased maintenance or decreased operational life or safety. Miscellaneous elements include, but are not limited to, the following:
   1. Water, moisture, or vapor barriers.
   2. Membranes and flashings.
   3. Exterior curtain-wall construction.
   4. Equipment supports.
   5. Piping, ductwork, vessels, and equipment.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with Owner and/or Engineer. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.
PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
3. Contact Utility Locator Services prior to any underground work. Utility Locator Services shall be complete before any work proceeds.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Concrete and or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Backfill material shall be compacted to 95 percent standard proctor to a level two feet below finished slab or surface and shall be compacted to 98 percent standard proctor from 2 feet below finished slab or surface to the underside of finished slab or surface.

5. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.

   b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

   a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alpha Wire.
   2. Belden Inc.
   4. General Cable Technologies Corporation.
   5. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2 and Type XHHW-2.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Gardner Bender.
   4. Ideal Industries, Inc.
   5. Ilsco; a branch of Bardes Corporation.
   6. NSi Industries LLC.
   7. O-Z/Gedney; a brand of the EGS Electrical Group.
   8. 3M; Electrical Markets Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

B. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway or Metal-clad cable, Type MC.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
3.4 CONNECTIONS

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

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes grounding and bonding systems and equipment.

1.2 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Burndy; Part of Hubbell Electrical Systems.
      2. Dossert; AFL Telecommunications LLC.
      3. ERICO International Corporation.
      4. Fushi Copperweld Inc.
      5. Galvan Industries, Inc.; Electrical Products Division, LLC.
      6. Harger Lightning and Grounding.
      7. ILSCO.
      9. Robbins Lightning, Inc.
      10. Siemens Power Transmission & Distribution, Inc.

2.2 SYSTEM DESCRIPTION
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. Comply with UL 467 for grounding and bonding materials and equipment.
2.3 CONDUCTORS

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

2.4 CONNECTORS

A. Listed and labeled by an NRTL 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.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

3.2 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. Flexible raceway runs.

3.3 INSTALLATION

A. 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.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Atkore International.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
5) **MKT Fastening, LLC.**

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.

### 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. **Description:** Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. **Materials:** Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. **Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:** Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. **Multiple Raceways or Cables:** Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

#### 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529
SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Surface raceways.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   4. Electri-Flex Company.
   5. O-Z/Gedney.
   6. Picoma Industries.
   7. Republic Conduit.
   8. Robroy Industries.
   10. Thomas & Betts Corporation.
   11. Western Tube and Conduit Corporation.
B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel or die cast.
      b. Type: Setscrew or compression.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
5. FSR Inc.
8. Kraloy.
10. Mono-Systems, Inc.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep)] unless otherwise indicated on drawings.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
B. Minimum Raceway Size: 1/2-inch (16-mm) trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
   1. Install surface raceways only where concealed raceways/cabling is not possible. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT or surface mounted raceway (similar to Legrand Wiremold Series 500/700 for finished spaces).

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35 mm) trade size and insulated throat metal bushings on 1-1/2-inch (41 mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch (53 mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS
   A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

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

3.5 PROTECTION
   A. Protect coatings, finishes, and cabinets from damage and deterioration.
      1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533
SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Grout.
   3. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have low VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

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

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

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

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

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

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

END OF SECTION 260544
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification for conductors.
3. Warning labels and signs.
4. Instruction signs.
5. Equipment identification labels.

1.2 QUALITY ASSURANCE


B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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

2.1 CONDUCTOR IDENTIFICATION MATERIALS
   A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.2 WARNING LABELS AND SIGNS
   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. Baked-Enamel Warning Signs:
      1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
      2. 1/4-inch (6.4-mm) grommets in corners for mounting.
      3. Nominal size, 7 by 10 inches (180 by 250 mm).
   D. Metal-Backed, Butyrate Warning Signs:
      1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
      2. 1/4-inch (6.4-mm) grommets in corners for mounting.
      3. Nominal size, 10 by 14 inches (250 by 360 mm).
   E. Warning label and sign shall include, but are not limited to, the following legends:
      1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
      2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.3 INSTRUCTION SIGNS
   A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) 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.
B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. 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 (10 mm).

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

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

3.1 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 signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding 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 (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

2. Power.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Conductor to Be Extended in the Future: Attach marker tape to conductors and list source.


1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

G. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) 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.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
d. Fire Alarm cabinets.

END OF SECTION 260553
SECTION 280513 - CONDUCTORS AND CABLES FOR FIRE ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire alarm wire and cable.
   2. Fire alarm speaker wiring for voice evacuation notification.
   3. Identification products.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.
B. IDC: Insulation displacement connector.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
E. RCDD: Registered Communications Distribution Designer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Wire & Cable, Inc.
   2. Superior Essex, Inc.
   3. West Penn Wire

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Riser cables for Signaling Line Circuits (SLCs) shall be 2-hour rated (Type CI cable).
D. Cables shall be plenum rated.

E. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

F. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.3 IDENTIFICATION PRODUCTS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

3.3 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72. Cables routed above ceilings shall be plenum rated.

B. Wiring Method: Installation of fire alarm conductors in raceway is not required when routed concealed above accessible ceilings.

C. When installing wiring in metal pathway to protect cables or when routed in an exposed manner, install according to Section 260533 "Raceways and Boxes for Electrical Systems."
   
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT or surface mounted raceway (similar to Legrand Wiremold Series 500/700 for finished spaces).

D. Wiring Method:
1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and Ci, is permitted.

3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or pathway as signaling line circuits.

E. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

F. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

G. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

A. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

A. For communication wiring, comply with J-STD-607-A and with BICSI TDMM's "Grounding, Bonding, and Electrical Protection" chapter.
3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 280513
SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit. Existing Notifier NFS2-3030 (circa 2016) fire alarm control panel. Existing to be retained and modified as described herein.
3. System smoke detectors (including duct detectors). Retain existing devices, provide new devices where shown on drawings.
4. Heat detectors. Retain existing devices, provide new devices where shown on drawings. Replace with smoke detector type where shown on drawings.
5. Optical Flame detectors.
7. Notification appliances. Replace existing audible horns with speaker type and provide new devices where shown on drawings.
8. Remote annunciator. Existing to remain.
9. Addressable interface device. Existing to remain.
10. Digital alarm communicator transmitter. Existing to remain.

Within this scope of work, the remaining Honeywell three (3) terminal cabinets will be removed. The cabinets are located in the Fire Alarm Control Room #033 located on the Cleanroom Floor level adjacent to the Fire Alarm Control Panel. With the removal of the cabinets, all existing fire alarm wiring will be replaced and new wiring configured as a Class A system.

Work shall be performed such that (2) spare SLC cards are available for future use.

Fire alarm work (including device installation, wiring and programming) shall be performed by a Notifier Premier Engineered Distributor (ESD) company with corporate offices located within a 50 mile radius of the Project.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Fire Alarm" for cables and conductors for fire-alarm systems.
2. Section 283145 "Aspirating Smoke Detection Systems (ASSD)" for Cleanrooms and clerestory area smoke detection fire alarm systems.

1.2 DEFINITIONS

A. DGMS: Dangerous Gas Monitoring System.
1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
   1. Riser diagram showing all components with wiring designations/descriptions.
   2. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   3. Include plans, elevations, sections, details, and attachments to other work.
   4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   5. Detail assembly and support requirements.
   6. Include voltage drop calculations for notification-appliance circuits.
   7. Include battery-size calculations.
   8. Include input/output matrix.
   9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
   10. Include performance parameters and installation details for each detector.
   11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   12. Include floor plans to indicate final outlet locations showing address of each addressable device.

C. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Engineer.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified, fire-alarm technician; Level III minimum.
      c. Licensed or certified by authorities having jurisdiction.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
   d. Riser diagram.
   e. Device addresses.
   f. Record copy of site-specific software.
   g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.
   h. Manufacturer's required maintenance related to system warranty requirements.
   i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 PROJECT CONDITIONS

A. Replacement of Existing Fire-Alarm Service: The existing fire alarm system must remain functional throughout the course of construction. Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Owner no fewer than three weeks in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
B. Automatic sensitivity control of certain smoke detectors.

C. All components provided shall be listed for use with the selected system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Fire alarm system shall support speaker /strobe notification devices. This can accomplished as follows:
   1. For Notifier NFS2-3030. To support voice evacuation, provide Digital Voice Control (DVC), amplifier(s) and NCA-2 (Network Control Annunciator) to supervise the DVC.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   2. Heat detectors.
   3. Optical Flame detectors.
   4. Smoke detectors.
   5. Linear beam smoke detectAspirating Smoke Detection Systems (ASSD) detectors.
   6. Automatic sprinkler system water flow.
   7. Fire-extinguishing system operation.
   8. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances, including voice evacuation notices.
   2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   6. Recall elevators to primary or alternate recall floors.
   7. Record events in the system memory.
   8. Indicate device in alarm on the annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Duct smoke detectors.
   3. Independent fire-detection and -suppression systems.
   4. User disabling of zones or individual devices.
   5. Loss of communication with any panel on the network.
   6. Generator running, trouble/fault or low fuel.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Knox Box tamper switch activation.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.

F. In accordance with ANSI CGAG-13 *Storage and Handling of Silane and Silane Mixtures* and NFPA 318 *Standard for the Protection of Semiconductor Fabrication Facilities*, activation of the optical flame detection system (in the presence of Silane or Dichlorosilane) will:

1. Close the nearest isolation valve:
   a. At the local gas box near the tool or in the tool gas jungle.
   b. At the valve manifold box (VMB), shut down individual sticks.
   c. At the gas cylinder source.

2. Detectors will be appropriate for the application:
   a. In exterior Silane gas storage cabinets that lack a gas monitoring control panel.
   b. In interior Silane gas storage cabinets that possess a gas monitoring control panel.
   c. In the Cleanroom level utility chases where Silane gas piping occurs.
   d. In the valve manifold boxes.
   e. In the Cleanrooms where the process equipment occurs.

3. Continuously operate alarm notification appliances, including voice evacuation notices, with a signal that is distinctive from the building fire alarm evacuation or any process equipment alarm signals.

4. Integration with the existing Drager Dangerous Gas Monitoring System is required.

2.3 FIRE-ALARM CONTROL UNIT

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

B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
   
a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
   
b. Include a real-time clock for time annotation of events on the event recorder and printer.
   
c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
   
d. The FACP shall be listed for connection to a central-station signaling system service.
   
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.

3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations for Initiating Device Circuits (IDCs), Signaling Line Circuits (SLCs) and Notification Appliance Circuits (NACs) shall be both: NFPA 72, Class A.
3. Install no more than 256 addressable devices on each signaling-line circuit.
4. SLC and NAC circuits shall be designed such that spare capacity is provided. No circuit should be loaded to more than 75% of its capacity. NAC circuit voltage drop as installed shall not exceed 75% of the maximum allowed by the manufacturer at the last appliance on each circuit.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:

1. Coordinate work with Premier Elevators Co., Inc. Elevator controller is existing.
2. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
3. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
   a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.


M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

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

1. Notifier Flashscan® series addressable devices.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. Where required to be surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Provide where indicated on the drawings.

2.5 SYSTEM SMOKE DETECTORS

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

1. Notifier Flashscan® series addressable devices.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Multiple levels of detection sensitivity for each sensor.

C. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).
   3. Each sensor shall have multiple levels of detection sensitivity.
   4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. Notifier Flashscan® series addressable devices.

B. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 OPTICAL FLAME DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. Honeywell Analytics SS4-AS addressable devices.

B. General Requirements for Optical Flame Detectors: Capable of detecting a Silane flame signature.
   1. Hazardous area certified flame detector for the detection of hydrocarbon (SS4-A2) and non-hydrocarbon fires (SS4-AS2). The multispectrum detector senses radiant energy in the ultraviolet (UV), visible and wideband infrared (IR) spectrum. The radiant energy from all types of flaming fires will alert the detector to their presence. The field of view is a 120 degree cone of vision with a range of 60 feet.
      b. Built-in test for optical “through the lens” testing.
      c. False alarm immunity.
      d. Detects hydrocarbon and non-hydrocarbon based fires.
      e. Wide field-of-view and solar-blind.
      f. Adjustable detector sensitivity.
      g. Microprocessor based algorithms: FirePic™, Snapshot™ and Tri-Mode Plot™.
      h. Wide temperature range of operation.
      i. Compatible with standard approved fire alarm panels.
      j. Explosion-proof housing.
      k. Time programmable alarm verification.
      l. mA output option.
      m. Meets or exceeds MIL Spec 810 C Method 514.2, Curve AW.

2.8 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. Notifier.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
7. Weatherproof strobe (clear lens) shall be provided and installed on the exterior of the building. Refer to drawings. Provide surge suppression device.

D. Voice/Tone Notification Appliances:
   1. Comply with UL 1480.
   2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
   3. High-Range Units: Rated 2 to 15 W.
   4. Low-Range Units: Rated 1 to 2 W.
   5. Mounting: Flush, semi-recessed or surface mounted and bidirectional.
   6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.9 REMOTE ANNUNCIATOR- Existing.

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.
3. Operate fire shutters.
4. Operate atrium smoke purge system including exhaust fan, motorized louver through roof and louvers/dampers which allow entrance of outside air to the space,

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER- Existing

A. Digital alarm communicator transmitter (DACT) shall be acceptable to the remote central station and shall comply with UL 632. Support Silent Knight format 4/2. Program DACTs and establish proper reporting to the campus monitoring system. DACT reporting codes shall be programmed to match those of other campus DACTs

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet (9 m).
2. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
3. HVAC: Locate detectors not closer than 60 inches ((1520 mm) from air-supply diffuser or return-air opening.
4. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Elevator Shafts: Coordinate temperature rating and location.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm speaker and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT or surface mounted raceway (similar to Legrand Wiremold Series 500/700 for finished spaces).

3.4 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Magnetically held-open doors.
2. Electronically locked doors and access gates. Provisions only.
3. Alarm-initiating connection to elevator recall system and components.
4. Supervisory connections at valve supervisory switches.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.
3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Submit copy of test results in duplicate after signed by Owner's Representative to Architect, Owner, Owner's Insurance Company and local Fire Protection Authority. Mount copy of inspection record in Lexan enclosed frame assembly on control panel.

E. Complete forms included with this specification regarding:
   2. Fire Alarm System Record of Completion.

F. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

   3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   4. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

G. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

H. Fire-alarm system will be considered defective if it does not pass tests and inspections.
I. Prepare test and inspection reports.

J. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

K. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, 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 the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

3.10 CLOSE-OUT

A. Contractor shall provide all software programs and tools for use by Georgia Tech technicians to service the Fire Alarm system.

END OF SECTION 283111
Fire Alarm Testing Procedures

Building Name ___________________________ Bldg. # ______ Date: ________

GTFSO Representative: _________________________________________________

Fire Alarm Representative: _____________________________________________

Before the Test

— Prior to fire alarm test, fax NFPA 72 Record of Completion Form showing pretest has been completed to the Georgia Tech Fire Marshal at: (404) 385-7404.
— If system is monitored need verification that dialer is functioning properly (pre-test report). Fax to (404) 385-7404
— Do not have the system placed on test.
— A/C power to be turned off 24 hours prior to start of test.

Tasks

— Record carrier phone service. ___________________________________________
— List the verified phone numbers:
  o Primary ____________________________
  o Secondary __________________________
— Verify monitoring company is UL listed and contact # is on outside front cover of panel.
  o Company __________________________
  o Contact # (404-761-0694)
— Prime contractor contact phone number labeled on the outside front cover of FACP
  o Contractor __________________________
  o Contact # __________________________
— Verify that disconnection of both telco lines send a trouble signal to FACP or dialer within 4 minutes. (Audible and visual signal required at FACP.)
  o Primary _____________
  o Secondary ______________
— Reconnect batteries and then turn off 120vac. (Batteries should measure approximately 15v and have a difference of no more than 0.4v.)
  o Battery reading in volts: _________
  o Battery reading in volts: _________
— Assure a trouble signal for a/c loss is received at FACP within 200 sec.
  o Time: ______________
— While on battery power initiate alarm. (Batteries should remain at 12v each, but slowly dropping.)
— All booster panels supplying any other areas or floors shall also be operated under battery power.
— Verify the NAC circuit EOL voltage drop is no less than 3v. ______________
  o (This will verify the batteries are not overloaded).
— Reconnect a/c power and have a ground fault initiated on any appliance circuit. (FACP to receive trouble in 200 sec.)
— Test any NAC panels for ground fault verification.

Fire Alarm Acceptance Testing is performed to ensure that the fire alarm has been installed in accordance with accepted fire alarm plans and is functioning properly.
Quality Control

— All wiring has markers where landed in the FACP and terminal cabinets on multi-story buildings.
— Verify wire type and gauge was followed. (Compare wire in FACP and EOL to approved plans).
— Verify all components are in conditioned spaces.
— Phone numbers. (Must be separate carriers if long distance or wats).
— Verify proper phone jacks are installed (RJ 31x) and not installed inside FACP.
— Label for a/c feed to be on outside front cover of FACP:
  — Panel: ______ circuit breaker #: ______.
— Verify proper phone number is labeled on each jack.
— Verify FACP and all appliances are listed for the intended use (UL).
— FACP, remote annunciator, and NAC expanders maximum height of 6 feet aff (NEC 110-26) and readily accessible.
— Assure a/c feed has approved breaker lock out.
— Assure a/c circuit breaker is labeled in red.
— Verify smoke detector protection within 15 feet of FACP and any remote power supplies.
— FACP is in normal condition.
— All panel indicator lamps are functioning properly. (audible and visual for troubles and supervisory functions).
— Remote annunciators, if provided to be within 15 feet of fire department access and interfaced with FACP. Maximum height 60” a.f.f. required for new installations.
— Batteries to be labeled with manufacture date. ______________________
— EOL on all circuits to be labeled at all devices (initiating and notification).
— Label all devices with address, or circuit number. (verify with alarm plans)
— Verify wire type and gauge was followed. (Compare wire in FACP and EOL to approved plans).
— There shall be no splices in the system other than terminal blocks and junction boxes.
(Wire nuts and butt splices are not permitted.)

Documentation

— At the FACP have approved plans and as-built drawings and documents.
— NFPA 72 Record of Completion
— Fire alarm certification letter (Installer must have a GA license)
— Fire alarm certification for interconnection to auxiliary systems

Fire Alarm Acceptance Testing is performed to ensure that the fire alarm has been installed in accordance with accepted fire alarm plans and is functioning properly.
# FIRE ALARM SYSTEM RECORD OF COMPLETION

*To be completed by the system installation contractor at the time of system acceptance and approval.*

## 1. Protected Property Information

- **Name of property:**
- **Address:**
- **Description of property:**
- **Occupancy type:**
- **Name of property representative:**
- **Address:**
- **Phone:**
- **Fax:**
- **E-mail:**
- **Authority having jurisdiction over this property:**
- **Phone:**
- **Fax:**
- **E-mail:**

## 2. Fire Alarm System Installation, Service, and Testing Information

- **Installation contractor for this equipment:**
- **Address:**
- **Phone:**
- **Fax:**
- **E-mail:**
- **Service organization for this equipment:**
- **Address:**
- **Phone:**
- **Fax:**
- **E-mail:**
- **Location of as-built drawings:**
- **Location of Historical Test Reports:**
- **Location of system operation and maintenance manuals:**
- **Contract for test and inspection in accordance with NFPA standards is in effect as of**
- **Contracted testing company:**
- **Address:**
- **Phone:**
- **Fax:**
- **E-mail:**
- **Contract expires:**
- **Contract number:**
- **Frequency of routine inspections:**

## 3. Type of Fire Alarm System or Service

### NFPA 72®, Chapter Reference of System Type:

- **Name of organization receiving alarm signals with phone numbers (if applicable):**
  - **Alarm:**
  - **Supervisory:**
  - **Trouble:**
  - **Entity to which alarms are retransmitted:**
  - **Method of retransmission of alarms to that organization or location:**

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NFPA 72, Fig. 4.5.2.1 (p. 1 of 5)
If Chapter 8, note the means of transmission from the protected premises to the central station:

- Digital alarm communicator
- McCulloh
- Multiplex
- 2-way radio
- 1-way radio
- N/A

If Chapter 9, note the type of connection:
- Local energy
- Shunt
- N/A

### 3.1 System Software

Operating system (executive) software revision level: 

Site-specific software revision date: ____________________ Revision completed by: ____________________

### 4. Signaling Line Circuits

*Characteristics of signaling line circuits connected to this system (see NFPA 72®, Table 6.6.1):*

Quantity: ____________________ Style: ____________________ Class: ____________________

### 5. Alarm-Initiating Devices and Circuits

*Characteristics of initiating device circuits connected to this system (see NFPA 72®, Table 6.5):*

Quantity: ____________________ Style: ____________________ Class: ____________________

#### 5.1 Manual Initiating Devices

##### 5.1.1 Manual Pull Stations

Number of manual pull stations: ____________________

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A

#### 5.2 Automatic Initiating Devices

##### 5.2.1 Area Smoke Detectors

Number of smoke detectors: ____________________

Type of coverage:
- Complete area
- Partial area
- Nonrequired partial area
- N/A

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A

Type of smoke detector sensing technology:
- Ionization
- Photoelectric

##### 5.2.2 Duct Smoke Detectors

Number of duct smoke detectors: ____________________

Type of coverage:

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A

Type of smoke detector sensing technology:
- Ionization
- Photoelectric

##### 5.2.3 Heat Detectors

Number of heat detectors: ____________________

Type of coverage:
- Complete area
- Partial area
- Nonrequired partial area
- N/A

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A

##### 5.2.4 Sprinkler Waterflow Detectors

Number of waterflow detectors: ____________________

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A

##### 5.2.5 Alarm Verification

Number of devices subject to alarm verification: ____________________

Alarm verification on this system is:
- Enabled
- Disabled
- Set for ________ seconds

### 6. Supervisory Signal-Initiating Devices and Circuits

##### 6.1 Sprinkler System

Number of valve supervisory switches: ____________________

Type of devices:
- Addressable
- Conventional
- Coded
- Transmitter
- N/A
6.2 Fire Pump

Type of fire pump: □ Electric □ Diesel

Type of fire pump supervisory devices: □ Addressable □ Conventional □ Coded □ Transmitter □ N/A

Fire Pump Functions Supervised

□ Fire pump power □ Fire pump running □ Fire pump phase reversal □ Selector switch not in auto

□ Engine or control panel trouble □ Low fuel

Other: ____________________________

6.3 Engine-Driven Generator

Type of generator supervisory devices: □ Addressable □ Conventional □ Coded □ Transmitter □ N/A

□ Engine or control panel trouble □ Generator running □ Selector switch not in auto □ Low fuel

Other: ____________________________

7. Annunciators

7.1 Annunciator 1 □ Local □ Remote

Type: □ Addressable □ Directory □ Graphic □ N/A Location: ____________________________

7.2 Annunciator 2 □ Local □ Remote

Type: □ Addressable □ Directory □ Graphic □ N/A Location: ____________________________

7.3 Annunciator 3 □ Local □ Remote

Type: □ Addressable □ Directory □ Graphic □ N/A Location: ____________________________

8. Alarm Notification Devices and Circuits

8.1 Emergency Voice Alarm Service

Number of single voice alarm channels: ____________________________

Number of multiple voice alarm channels: ____________________________

Number of speakers: ____________________________

Number of speaker zones: ____________________________

8.2 Telephone Jacks

Number of telephone jacks installed: ____________________________

Number of telephone handsets stored on site: ____________________________

Type of telephone system installed: □ Electrically powered □ Sound powered □ N/A

8.3 Nonvoice Audible System

Characteristics of notification device circuits connected to this system (see NFPA 72®, Table 6.5): ____________________________

8.4 Types and Quantities of Nonvoice Notification Appliances Installed

Bells: ____________________________ With visual device: ____________________________

Horns: ____________________________ With visual device: ____________________________

Chimes: ____________________________ With visual device: ____________________________

Bells: ____________________________ With visual device: ____________________________

Visual devices without audible devices: ____________________________ Other (describe): ____________________________
9. Emergency Control Functions Activated

- [ ] Hold-open door releasing devices
- [ ] Smoke management or smoke control
- [ ] Door unlocking
- [ ] Elevator recall
- [ ] Other

10. System Power Supply

10.1 Primary Power

- Nominal voltage: 
- Amps: 
- Overcurrent protection: Type: Amps: 
- Location (of primary supply panelboard): 
- Disconnecting means location:

10.2 Secondary Power

- Location: Type: Nominal voltage: Current rating: 
- Number of standby batteries: Amp hour rating: 
- Location of emergency generator: 
- Location of fuel storage: 
- Calculated capacity of secondary power to drive the system
  - In standby mode: 
  - In alarm mode:

11. Record of System Installation

*Fill out after all installation is complete and wiring has been checked for opens, shorts, ground faults, and improper branching, but before conducting operational acceptance tests.*

The system has been installed in accordance with the following NFPA standards: (Note any or all that apply.)

- [ ] NFPA 72®
- [ ] NFPA 70®, Article 760
- [ ] Manufacturer’s published instructions
- [ ] Other (please specify):

System deviations from referenced NFPA standards:

Signed: Printed name: Date:
Organization: Title: Phone:

12. Record of System Operation

All operational features and functions of this system were tested by or in the presence of the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements of:

- [ ] NFPA 72®
- [ ] NFPA 70®, Article 760
- [ ] Manufacturer’s published instructions
- [ ] Other (please specify):
- [ ] Documentation in accordance with Inspection and Testing Form (Figure 10.6.2.3 of NFPA 72®) is attached

Signed: Printed name: Date:
Organization: Title: Phone:
13. Certifications and Approvals

13.1 System Installation Contractor

This system as specified herein has been installed and tested according to all NFPA standards cited herein.

Signed: __________________________ Printed name: __________________________ Date: __________
Organization: __________________________ Title: __________________________ Phone: __________

13.2 System Service Contractor

This system as specified herein has been installed and tested according to all NFPA standards cited herein.

Signed: __________________________ Printed name: __________________________ Date: __________
Organization: __________________________ Title: __________________________ Phone: __________

13.3 Central Station

This system as specified herein will be monitored according to all NFPA standards cited herein.

Signed: __________________________ Printed name: __________________________ Date: __________
Organization: __________________________ Title: __________________________ Phone: __________

13.4 Property Representative

I accept this system as having been installed and tested to its specifications and all NFPA standards cited herein.

Signed: __________________________ Printed name: __________________________ Date: __________
Organization: __________________________ Title: __________________________ Phone: __________

13.5 Authority Having Jurisdiction

I have witnessed a satisfactory acceptance test of this system and find it to be installed and operating properly in accordance with its approved plans and specifications, its approved sequence of operations, and with all NFPA standards cited herein.

Signed: __________________________ Printed name: __________________________ Date: __________
Organization: __________________________ Title: __________________________ Phone: __________
SECTION 283145 - AIR SAMPLING SMOKE DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This specification contains performance and design requirements concerning air sampling smoke detection systems, which are to be installed within the facility.

B. The scope of work includes design and implementation of the systems in accordance with this specification and applicable codes; preparation of appropriate drawings and calculations; submittal of drawings, calculations, equipment data sheets, and bill of materials, complete system installation, completion of functional testing, operational/acceptance testing, and proper training of the Owner's key employees.

C. Air sampling detection installation shall include the piping distribution systems, detectors, and all components necessary to provide a complete interface between the detectors and the building fire alarm control unit (FACU).

D. The scope of work includes all necessary programming of the detector(s) and/or FACU. All revisions to these programs that are required by the approval authorities up to the point of final acceptance of the complete system by all approval authorities are to be carried out by the Contractor at no additional expense to the Owner.

E. The scope of work also includes provision of all necessary technical personnel required to complete interim system inspections and tests as well as thorough acceptance tests by the various approval authorities. Successful completion of all inspections, interim testing, and acceptance testing shall be subject to approval by the Engineer.

F. The Contractor is responsible for coordination of the installation of all system-related equipment with other subtrades. Where conflicts exist, the Contractor is responsible for making the Engineer aware of each situation so that the appropriate action may be determined and approved by the Engineer.

G. The Contractor is responsible for identifying and complying with all permitting requirements and jurisdiction specific requirements related to the Air sampling detection system installation.

1.2 RELATED DOCUMENTS

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

A. Equipment and materials shall be approved for their designed use and performance. The term "approved" shall mean Factory Mutual (FM) approved and/or Underwriters Laboratories (UL) listed and acceptable to the approval authorities.

B. Approval authorities shall include the Owner, authorized representative of Harrington Group, Inc. (Engineer), and the Authorities Having Jurisdiction (local building/fire/code official).

1.4 REFERENCES

A. National Fire Protection Association (NFPA)
   5. 2012 International Mechanical Code

B. Underwriters Laboratories, Inc. (UL)
   1. Fire Protection Equipment Directory (most current edition including supplements)

C. Factory Mutual System (FM)
   2. FM Approval Guide (most current edition including supplements)

1.5 SYSTEM DESCRIPTION

A. General
   1. The systems shall be designed and installed to detect low-energy fires before the fire conditions threaten technical equipment.
   2. The performance objectives of the air sampling detection systems include:
      a. Early detection of a fire condition in the protected spaces.
      b. Occupant notification of a fire condition in the protected spaces.
   3. All system design and installation shall be performed in strict compliance with the system manufacturer’s recommendations.
   4. The air sampling detection system(s) shall consist of sampling points located in the HVAC return air intakes in accordance with the design drawings and manufacturer’s requirements.
   5. All equipment shall be new and unused and shall be free from contamination, corrosion, or other physical damage.
   6. The Contractor shall coordinate all work carefully with that of other trades to ensure that the complete system is compatible and functions properly as a whole.

B. Detection
   1. The air sampling-type detectors shall have a sensitivity range as necessary to accomplish the performance objective as stated in this specification, and shall be programmable and adjustable across this sensitivity range.
The maximum transport time for the air sampling detection systems shall be 60 seconds.

C. Sequence of Operation
1. Activation of any air sampling detector or zone - Level 1 or 40% of the programmed sensitivity shall result in the following:
   a. Supervisory audible/visual indications and message at the FACU.
   b. Protected area alarm audible/visual device activation.
   
   Note: Level 1 alarm shall be the lowest sensitivity at which the detector transmits a signal. The typical setting for Level 1 alarm would be 40% of the chosen programmed detector sensitivity range, which will be determined based on field conditions.

2. Activation of any air sampling detector or zone - Level 2 alarm shall result in the following:
   a. Fire Alarm audible/visual indications and message at the FACU.
   b. Protected area alarm audible/visual device activation.
   c. Transmission of alarm signal to the main building FACU.

D. Power Supply Arrangement
1. Power to the air sampling detectors shall be supplied from dedicated A.C. power circuits that serve no other loads. Each circuit shall be equipped with a separate breaker that is properly sized and identified per NFPA 70 (NEC) and NFPA 72. Each circuit breaker shall be locked to prevent unauthorized operation.

2. All circuits supplying the air sampling detectors shall be arranged to be supplied from UPS- or generator-backed power circuits provided for the facility where applicable.

3. Use of centralized power supply should be provided for multiple detector installations.

1.6 SUBMITTALS

A. The Contractor shall prepare a shop submittal package covering the complete system. The shop submittal package shall be submitted to the approval authorities for review and approval. The shop submittal package shall be approved prior to ordering materials or starting construction. The complete submittal shall conform to all requirements of this section.

B. The submittal package shall include the following information:
1. Complete system shop drawings, drawn to scale and showing all system components, including location and type of detectors, arrangement and size of air sampling system piping, location of air sampling-type detectors, and location of spot-type detectors. Spot-type detectors must be shown on the shop drawings even if not in the scope of the Contractor’s work. Complete elementary wiring schematics shall also be provided. The drawing scale shall not be less than 1/8 in. = 1 ft. Drawings shall show piping in plan and isometric views. The isometric view shall show hydraulic reference points, pipe length, pipe diameters, pipe reduction methods, etc.
2. Drawings shall show the intended location of all pipe hangers and supports. Support/restraint spacing and sizing criteria shall be clearly indicated. Complete information on all hangers and supports to be used shall be provided.

3. Drawings shall provide details of the mounting methods of all detection devices. Wire size, wire counts, wire designations, and location and size of all conduit and junction/equipment boxes shall be shown.

4. The manufacturer’s original equipment data sheets on every system component that clearly identifies component part number to be used in each case. This requirement also includes such materials as pipe, fittings, couplings, supports, pipe straps and connecting hardware, auxiliary relays, panel modules, and wire/cable.

5. Complete computerized flow calculations using the manufacturer’s approved computer program for all new air sampling systems.

6. A complete bill of materials listing all system components, manufacturer, quantity and part number.

7. Complete details of manufacturers’ warranties on equipment and Contractor's warranties on installation.

8. Complete details concerning the proposed method of training for the Owner's employees regarding the operation and maintenance of the system.

9. Complete manual covering installation, operation, testing, and programming of the air sampling detector, and all other system components as well as system piping.

C. The Contractor shall prepare Record Documentation that reflects the “as-built” arrangement of the system(s). Three (3) copies of the Record Documentation shall be provided to the Owner in a spiral bound form or 3-ring binder. One (1) additional copy shall be submitted to the Engineer. All record documentation, drawings, programming, functional testing documentation, and similar documentation shall be submitted for approval by the Engineer prior to the start of the final operational/acceptance testing.

D. The system Record Documentation shall consist of the following:
1. All information included as part of the Shop Submittal package, but revised to reflect "as-built" status. "As-built" information is intended to include accurate pipe drawings and flow calculations and accurate electrical equipment location, wiring and conduit/junction box location information and schematics.
2. Operation and maintenance manuals for the system(s).
3. Copy of the initial operational/functional test reports and commissioning reports covering the air sampling detection system.

1.7 QUALITY ASSURANCE

A. Qualifications
1. Contractor shall be certified by the material/equipment manufacturer as trained in and as knowledgeable of, the manufacturer's standard practices and procedures relating to installation of the air sampling detection system(s). The Contractor shall be certified and licensed by the state and local jurisdictions, as applicable.
2. Contractor shall be a firm specializing in performing work of this Section with a minimum of three (3) years experience and must be regularly engaged in carrying out such installations.
3. Contractor shall have successfully installed air sampling detection systems of the same type used for the project. The Contractor shall provide evidence of such
qualifications. The data shall include names and locations of at least three (3) installations where the Contractor has installed such systems. The Contractor shall indicate the type and design of each system and certify each system has performed satisfactorily in the manner intended for a period of not less than 18 months. The Contractor shall submit a copy of a valid state certificate and license, as applicable.

4. Contractor shall provide workers normally employed in the field and as otherwise specified in NFPA 70 and NFPA 72, and local ordinances.

B. Equipment and components shall bear the UL or FM label or marking.

C. All material shall be new and in good condition, free of defects, scratches, corrosion, and contamination. Used equipment shall not be allowed.

D. Regulatory Requirements

1. The design, equipment, materials, installation, and workmanship shall be in strict accordance with the required and advisory provisions of NFPA 70 and NFPA 72; to all other applicable NFPA, local, state and federal codes; and to all other requirements specified herein. The advisory provisions (Annexes) of the NFPA publications referred to herein shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. If there are any conflicts between these specifications and the referenced standards and publications, the most stringent requirement shall apply, as determined by the Engineer.

2. Shop drawings, product data, and "flow" calculations shall bear the stamp of approval of Authorities Having Jurisdiction, including the Engineer and the Fire Marshal's office.

3. Deviations from the contract documents and the Contractor's approved submittal documents shall not be permitted without written consent from the Engineer prior to making the modifications.

4. Compliance with the contract documents shall not relieve the Contractor from any specification section including strict compliance with NFPA 70, NFPA 72, local, state or federal requirements, and the requirements of the Authorities Having Jurisdiction.

1.8 VERIFICATION

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Engineer of any discrepancy before performing the work.

1.9 PERMITS

The Contractor shall be responsible for obtaining, and paying for any and all permits required by federal, state and local regulations prior to beginning work at the direction of the General Contractor.

1.10 SEQUENCING

AIR SAMPLING SMOKE DETECTION SYSTEMS 283145 - 5
All work performed shall be carried out in accordance with the applicable sections under the General Requirements and shall adhere to the established completion schedule. Every effort shall be made to coordinate the installation of the air sampling detection systems with all other trades.

1.11 WARRANTY AND SERVICE AGREEMENT

A. The Contractor shall provide as part of the installed cost of this air sampling detection system a warranty and service agreement to cover the installation of the complete system for a period of at least three (3) years (unless noted otherwise) following final system acceptance by the Owner and Engineer.

This agreement shall include the following:

1. Equipment and labor for all components replaced under warranty.

2. Parts and labor to accomplish any manufacturer recommended upgrades or component replacements.

3. Complete system inspection, testing, and other verifications and maintenance requirements for one (1) year in accordance with NFPA 72 and the system manufacturer.

B. The Contractor shall guarantee provision of emergency service coverage for the system by properly trained, experienced, and knowledgeable service technicians 24 hours per day, 7 days per week, including all holidays. The Contractor shall also guarantee a maximum callback time of one hour and on-site response time of four hours from the initial call.

C. The Contractor shall guarantee that all factory issued notifications related to system equipment/programming upgrades and replacements will be carried out within 14 days of initial notification by the manufacturer.

PART 2 - PRODUCT

2.1 GENERAL

A. All system components shall be approved, compatible for interconnection, and shall be by a single manufacturer wherever possible. In cases where equipment from more than one manufacturer cannot be avoided, compatibility for interconnection shall be proven to the approval authorities.

B. Where specific model numbers for devices are indicated, it is intended that the latest manufacturer’s recommended compatible model be provided where newer or replacement versions have been introduced.

2.2 AIR SAMPLING-TYPE SMOKE DETECTORS
A. Air sampling-type smoke detectors shall be UL listed as a smoke-automatic fire detector for open area protection and special applications.

B. Air sampling-type smoke detectors shall utilize laser-based particle counting technology.

C. Air sampling-type smoke detectors shall be capable of providing a minimum of four (4) individual alarm output levels, and shall be fully adjustable across the full sensitivity range of the detector.

D. Air sampling-type smoke detector control units shall be equipped with a minimum of six (6) normally-open contacts.

2.3 AIR SAMPLING PIPING NETWORK

A. Each air sampling piping network shall be assembled using piping in accordance with the air sampling detector manufacturer’s recommendations. Material color of both pipe and fittings shall be consistent throughout all air sampling piping networks provided for the facility.

B. Where located in a return air plenum all piping and fittings shall be UL 1820 rated.

C. Each piping network shall be principally assembled using 0.75-in. diameter pipe and fittings.

2.4 WIRING, RACEWAYS AND RELATED MATERIALS

A. All wire and cable of the system shall be listed and shall fully conform to the requirements of the National Electrical Code (NEC) as well as the manufacturers’ requirements.

B. All conduit, junction boxes, device boxes, terminal cabinets and related hardware and equipment shall be listed and shall fully conform to the requirements of the NEC. All conduit shall be selected such that the maximum fill capacities indicated in the NEC are not exceeded. All device boxes and junction boxes shall similarly be selected such that the fill capacities of these components are within the limits indicated in the NEC.

C. All conductors shall be solid or stranded copper. All stranded copper conductors shall be provided with either ring or fork connectors. No stranded wires shall be landed directly on screw terminals.

2.5 SIGNS & LABELS

A. Instructional or informational signage shall be provided adjacent to all system devices. All signs shall be professionally manufactured using highly visible colors on durable material. Typesetting shall be consistent on all signs. White engraved lettering on a blue background is required for all signs other than those provided by the system manufacturer. All signs shall be permanently mounted where they will be most visible. Final sign locations shall be coordinated carefully with the Owner. All sign materials and arrangement shall be approved by the Engineer.
B. The air sampling smoke detection system related circuit breakers shall be provided with machine produced labels indicating the panel or equipment controlled by the breaker.

C. A typewritten sequence of operations shall be provided in a suitable frame at the FSCP and/or FACU. The sequence of operation, as well as the frame type and arrangement, shall be approved by the Engineer prior to installation.

D. The pipe shall be identified as Aspirating Smoke Detector Pipe, Smoke Detection Sampling Pipe, or similar wording along its entire length at regular intervals not exceeding the manufacturer’s recommendation or that of local codes and standards.

E. Each sample point shall be labeled. Sampling point labels shall be in accordance with the manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Equipment shall be located in accordance with the design drawings and this specification. Deviations in intended equipment locations shall be approved by the Engineer.

3.2 AIR SAMPLING-TYPE DETECTION SYSTEMS

A. All air sampling pipes for monitoring of return air grilles/vents shall be centered in front of, beneath, or over the return air grille/vent with sampling holes oriented in accordance with the manufacturer’s recommendations. The sampling pipe shall be located far enough away from the grille such that air velocity does not exceed the manufacturer’s recommendations.

B. All joints of CPVC air sampling piping shall be assembled using CPVC primer and CPVC cement which has been selected and applied in full conformance with the requirements of the pipe manufacturer and the listing of the components. As an alternate, a one-step cement fusion process may be used if approved by the pipe/fitting manufacturer.

C. Sampling points shall not be installed within 3 ft. of any supply air registers or within 1 ft. of any, duct, pipe, structural member, conduit, light fixture, or other building system device.

D. Pipes shall be suspended from, or attached to, the ceiling deck or walkways or shelving support elements using hangers or clamps at intervals of not more than 4 ft. 6 in. to ensure stability of the piping and reduce the possibility of cracks or breaks at the joints. A hanger shall be located within 1 ft. of each horizontal elbow and tee fitting.

E. All connections and joints shall be made with standard fittings, which are designed to be fully compatible with the pipe material. All joints shall be secured according to standard practices.
F. All joints shall be airtight to prevent air leakage or infiltration, which may adversely affect the desired venturi effect in the piping.

G. Following installation and prior to connection to the air sampling detector, each air sampling pipe network shall be internally cleaned by connecting a vacuum cleaner to the piping network at the detector connection point.

3.3 WIRING, RACEWAYS, AND ELECTRICAL BOXES

A. All electrical circuits shall be installed in electrical metallic tubing (EMT). Where necessary for servicing or movement of devices, the use of flexible metallic tubing shall be permitted in accordance with NFPA 70. The maximum length of any flexible conduit connections shall be 6 ft. Conduit fill limitations of NFPA 70 shall be complied with. Separate conduit runs shall be provided as required by the manufacturer.

B. All system junction boxes shall be rigidly mounted and shall be painted red, both inside and outside. All junction box covers shall be painted red on both sides. All painting shall be carried out off premises.

C. All connectors to junction boxes and device mounting boxes shall include insulated (plastic) throats. All flexible metallic conduit shall incorporate use of insulated (plastic) throats where appropriate.

D. All junction boxes mounted in gypsum walls shall be anchored using a minimum of two (2) appropriately sized screws driven directly into the stud. Where necessary to add system devices after wallboard has been installed, each box shall be anchored using a minimum of two (2) appropriately sized molly or toggle bolts. All devices mounted to masonry walls or structural elements shall be similarly anchored.

E. Conduit shall not be run directly over lighting fixtures or other suspended ceiling mounted devices requiring removal, or in a manner which would obstruct equipment servicing hatches, covers, etc.

F. All wiring shall be appropriately color-coded and permanent machine produced wire markers shall be used to identify the terminations at each air sampling-type detector and at the FACU and/or FSCP. Color coding shall be consistent through each circuit run. The number of splices on all circuits shall be held to an absolute minimum. All wiring terminations shall be completed with properly sized crimped connectors or pressure-type connectors except where devices are provided with stem plate-type terminals. End-of-line resistors shall be connected to devices using fork-type crimp connectors. Wire-to-wire connection shall be completed through the use of properly sized pressure connectors such as Thomas & Betts Sta-Kon connectors, or equivalent. Pressure connectors must be attached through the use of the manufacturer’s intended tool. Wire nuts shall not be used. Use of butt splice-type connectors is not acceptable. Wire-to-wire connections may also be made using plastic, completely shielded floating-type terminal blocks.

G. All wiring, with the exception of the communications loop if provided as a cable, shall have copper conductors which are 16 AWG in size or larger. The communications loop, when arranged as a cable, shall be 18 AWG in size or larger. Type of wire or cable shall be in strict accordance with the equipment manufacturer's recommendations and the
requirements of NFPA 70, Articles 725 and 760. All wiring shall be approved for its intended application. Conductors/cables shall be shielded and/or separated as required by the system/device manufacturer. For each device that incorporates wire pigtails, one wire nut may be used as a temporary circuit connection to facilitate system acceptance testing. These temporary connections shall be revised during the course of acceptance testing (following checking of circuit supervision) to utilize pressure type connectors.

H. All wire/cable sizes shall be selected and the associated circuits configured such that no circuits are loaded beyond 80 percent of full capacity, with proper consideration given to voltage drop and other required electrical performance parameters.

I. A minimum clearance of 3/4 in. shall be maintained between 120V circuits and all low voltage wiring.

J. All wiring shall be tested for proper connection, continuity and resistance to ground. Megger testing of all circuit conductors is required. A voltage generating-type insulation resistance tester shall be used. Records of these tests must be produced and maintained on a per-circuit basis.

CAUTION: Megger tests must be performed prior to termination of any system devices to avoid damage to the devices. The voltage/current generated is also sufficient to discharge any initiators connected to initiator circuits, potentially discharging gaseous extinguishing systems and/or causing bodily injury.

K. Separate properly sized equipment boxes shall be provided for all I/O modules, A/O modules, and system relays. In no case shall the air sampling detector be used to house auxiliary relays and modules that are not intended by the equipment manufacturer to be installed within the panel.

3.4 TRAINING SESSIONS

A. Prior to the start of the air sampling detection system burn-in period, the Contractor shall provide initial operational training to the Owner's key employees.

B. The Contractor shall arrange finalized training sessions at the convenience of the Owner. The sessions shall be completed as soon as possible following system acceptance. Each training session shall include details of the system interface and control.

C. Each training session shall include a complete demonstration of the operation of the air sampling detection system and as well as operation of audible and visual notification devices.

D. Training shall cover the step-by-step operation of the system from activation of each alarm level.

3.5 SYSTEM PERFORMANCE TESTING

A. A final operational/acceptance test of the system shall not be conducted until after the system has been thoroughly functionally tested and is considered to be fully operational by
the Contractor. The final operational/acceptance test shall not be carried out until the FACU and all associated system subpanels have been through a minimum 14-day “burn-in” period following completion of all electrical related work and system programming. This burn-in period shall be used to log ambient conditions and ultimately determine the programmed sensitivity range for the air sampling detectors. The Contractor shall document this burn-in period by obtaining hard copy printout of the air sampling detection system history buffer. All final operational/acceptance tests shall be conducted by the Contractor during normal working hours and at the direction, and in the presence of, the approval authorities. Provide a minimum of fifteen (15) working days notice to the Engineer before final testing. Operational tests that shall be conducted include:

1. Each air sampling detection system shall be tested by measuring the suction pressure at each sampling point of the system. All measurements shall be recorded on the appropriate system commissioning forms.

2. The sensitivity and transport time of the air sampling-type detection systems shall be tested by performing a wire burn test (if possible) in the protected space in accordance with BS6266 Test 1. The testing materials and methods shall be approved by the engineer.

3. Conditions discovered during this test that do not meet the requirements of the approval authorities, or which are not in accordance with this specification, shall be immediately corrected by the Contractor at no expense to the Owner.

END OF SECTION 283145