PROJECT MANUAL

Volume Three

Renovate Mechanical/Electrical/Life Safety

Jefferson State Office Building

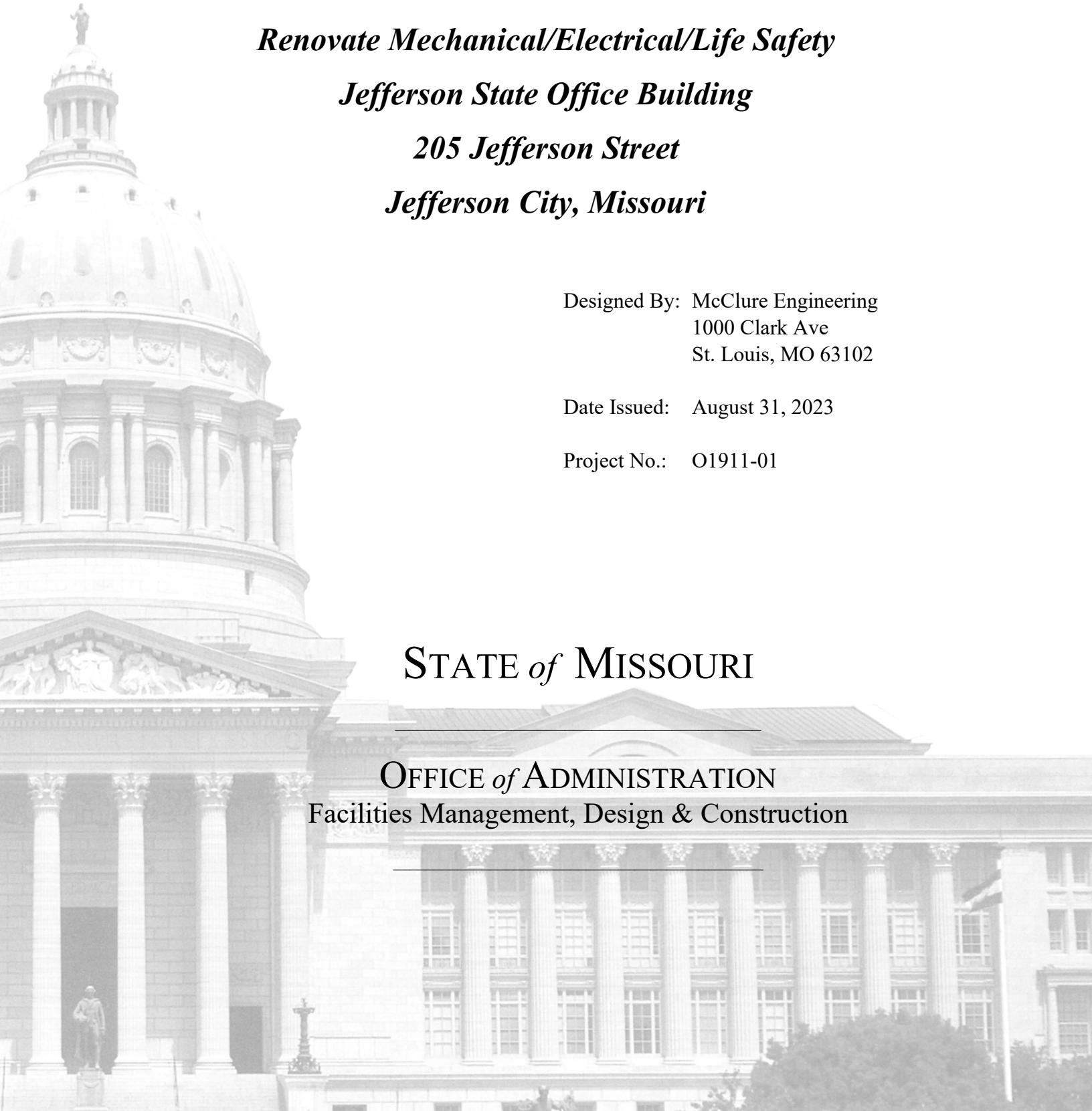
205 Jefferson Street

Jefferson City, Missouri

Designed By: McClure Engineering
1000 Clark Ave
St. Louis, MO 63102

Date Issued: August 31, 2023

Project No.: O1911-01



STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION
Facilities Management, Design & Construction

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1.2 SUMMARY

A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

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3.1 LIST OF DRAWINGS

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SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cables.
2. Connectors.
3. Solid terminations.
4. Separable insulated connectors.
5. Splice kits.
6. Medium-voltage tapes.
7. Arc-proofing materials.
8. Fault indicators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Material Certificates: For each type of cable and accessory.

C. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

PART 2 - PRODUCTS

2.1 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 IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Prysmian
   2. Southwire
   3. Okonite
   4. Superior Essex
   5. General Cable Co, or equivalent

B. Cable Type: Type MV 105.

C. Conductor Insulation: Ethylene-propylene rubber.

   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.

D. Conductor: Copper

E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682

F. Conductor Stranding Compact round, concentric lay, Class B

G. Shielding: Copper tape, helically applied over semiconducting insulation shield.

H. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

2.3 SPLICES AND TERMINATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M
   2. Cooper Power Systems
   3. Elastimold
   4. Hubbell
   5. Raychem

B. Connectors for splices and lugs for terminations shall be compatible with the cable and terminal, compression type rated for 15000volts, and installed per manufacturer’s requirements.
   1. Separable multiway splice system with all components for the required splice configuration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

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

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration,

I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

J. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 260513

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Metal-clad cable, Type MC.
3. Fire-alarm wire and cable.
4. Connectors and splices.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
2. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Metal-clad cable, Type MC.
3. Connectors and splices.

B. Product Schedule: Indicate type, use, location, and termination locations.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

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

1. Cerro Wire
2. Southwire
3. United Wire & Cable

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:
1. Type THHN and Type THWN-2. Comply with UL 83.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atkore
2. Encore Wire
3. Southwire

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multi-circuit with color-coded conductors. Multi-circuit to provide separate neutrals.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2. Comply with UL 83.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M
   2. ABB
   3. Hubbell
   4. ILSCO

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

   1. Material: Copper
   2. Type: One hole with standard barrels.
   3. Termination: Compression

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

   1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

   1. 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. Service Entrance: Type THHN/THWN-2, single conductors in raceway

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

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

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC. Type MC cable is permitted for wiring the final portion of light fixture branch circuits from fixture to fixture within a room or area. The MC cable may be supported by the light fixture bracing wires but shall not be supported by

the ceiling grid support wires. Type MC cable is permitted for wiring from local distribution junction boxes to devices or equipment in nearby walls or ceiling space. The local distribution junction boxes should be located within 20 feet of the device or equipment served. Conduit and wiring shall be used for branch circuiting between the local distribution junction boxes and for the "homeruns" from the panels. Type MC cable is permitted to route from receptacle to receptacle through walls and through the ceiling space for the final portion of branch circuit wiring between receptacles in adjacent walls of the same room or area. Type MC cable shall not be installed where exposed

3.3 INSTALLATION, GENERAL

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

B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits 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."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

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 12 inches 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."

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire-alarm wire and cable.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Fire-alarm wire and cable.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

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.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

   1. Flame Travel Distance: 60 inch (1520 mm) or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 FIRE-ALARM WIRE AND CABLE

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

B. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. 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. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.3 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

B. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.
1. Outlet boxes for cables must be no smaller than 4 inch square by 2-1/8 inch deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
2. Flexible metal conduit must not be used.

C. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows if possible.

E. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inch above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 IDENTIFICATION

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

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product indicated.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

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

a. Anderson; brand of Hubbell.

b. ERICO; brand of nVent Electrical plc.
c. Harger Lightning & Grounding; business of Harger Inc.

2. Referenced Standards: Complying with one or more of the following:

a. Soft or Annealed Copper Wire: ASTM B3
b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications; see Section 270526 "Grounding and Bonding for Communications Systems," for selection and installation guidelines.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Cooper B-Line; brand of Eaton, Electrical Sector
b. Crouse-Hinds; brand of Eaton, Electrical Sector
c. ERICO; brand of nVent Electrical plc
d. Harger Lightning & Grounding; business of Harger Inc.
e. ILSCO
f. O-Z/Gednev; brand of Emerson Electric Co., Automation Solutions, Appleton Group

2. General Characteristics:

a. Two pieces with zinc-plated bolts.
b. Clamp Material: Silicon bronze**.**
c. Listed for outdoor use.

E. UL KDER - Exothermically Welded Connection
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Burndy; brand of Hubbell Electrical Solutions, Hubbell Incorporated
      b. Crouse-Hinds; brand of Eaton, Electrical Sector
      c. ERICO; brand of nVent Electrical plc
      d. Harger Lightning & Grounding; business of Harger Inc.

   2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

   1. Regulatory Requirements:

      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

   2. Listing Criteria:

      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Bonding Bushing
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Crouse-Hinds; brand of Eaton, Electrical Sector
      b. Killark; brand of Hubbell Electrical Solutions; Hubbell Incoporated
      c. O-Z/Gednev; brand of Emerson Electric Co., Automation Solutions, Appleton Group
   2. General Characteristics: Threaded bushing with insulated throat.

E. UL KDER - Grounding Bushing
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Crouse-Hinds; brand of Eaton, Electrical Sector
      b. Killark; brand of Hubbell Electrical Solutions; Hubbell Incoporated

c. O-Z/Gednev; brand of Emerson Electric Co., Automation Solutions, Appleton Group

2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING ELECTRODES

A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Rod Electrode:

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

a. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
b. ERICO; brand of nVent Electrical plc.
c. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Copper-clad steel; 3/4 inch by 10 ft

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING CONDUCTORS

A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.

B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.

C. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.

3.3 SELECTION OF CONNECTORS

A. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

3.4 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Conductors:

   a. 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.

2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

   a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   b. Make connections with clean, bare metal at points of contact.

c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

    1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
    2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
    3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. Grounding and Bonding for Piping:

    1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
    3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

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

3. Electrodes:

    a. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

        1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
        2) Use exothermic welds for below-grade connections.

4. Grounding at Service:

    a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.

b. Generator: Install grounding electrode(s) at generator location. Electrode must be connected to equipment grounding conductor and to frame of generator.

5. Equipment Grounding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1) Feeders and branch circuits.
2) Lighting circuits.
3) Receptacle circuits.
4) Single-phase motor and appliance branch circuits.
5) Three-phase motor and appliance branch circuits.
6) Flexible raceway runs.
7) Metal-clad cable runs.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
e. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

3.5 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Fasteners.
e. Anchors.
f. .

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

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

a. CADDY; brand of nVent Electrical plc.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Unistrut; Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

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

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

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

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

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

1) Cooper B-line; brand of Eaton, Electrical Sector.
2) Empire Industries, Inc.
3) Hilti, Inc.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
5. Toggle Bolts: All steel springhead type.
6. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

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

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

PART 3 - EXECUTION

3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Provide seismic controls with hangers and supports in accordance with requirements specified in "Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.

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

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

3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT may be supported by openings through structure members, in accordance with 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 must be weight of supported components plus 200 lb

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 Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

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

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

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

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

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

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE duct raceways and fittings.
4. Type ERMC-S duct raceways, elbows, couplings, and nipples.
5. Type FMC-S duct raceways.
6. Type FMT duct raceways.
7. Type LFNC duct raceways.
8. Type PVC duct raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Electrically conductive corrosion-resistant compounds for threaded conduit.
11. Solvent cements.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:
1. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.3 ACTION SUBMITTALS

A. Product Data:
1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC-S duct raceways, elbows, couplings, and nipples.

5. Type FMC-S duct raceways.
6. Type FMT duct raceways.
7. Type LFNC duct raceways.
8. Type PVC duct raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Electrically conductive corrosion-resistant compounds for threaded conduit.
11. Solvent cements.

PART 2 - PRODUCTS

2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:
1. Material: Steel.
2. Options:

a. Exterior Coating: Zinc
b. Interior Coating: Zinc
c. Minimum Trade Size: trade size 3/4.

2.2 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN FKHU; including UL 1653.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:
1. Options:

a. Minimum Trade Size: trade size 3/4".
b. Fittings:

1) Mechanically Attached Fittings: UL 1653.
2) Solvent-Attached Fittings: UL 651.

2.3 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN EAZX; including UL 651A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):
1. Dimensional Specifications: Schedule 40.
2. Options:

a. Minimum Trade Size: trade size 3/4".

D. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):
1. Dimensional Specifications: Schedule 80.
2. Options:

a. Minimum Trade Size: trade size 3/4".

2.4 TYPE ERMC-S DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DYIX; including UL 6.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. Exterior Coating: Zinc.
2. Options:

a. Interior Coating Zinc
b. Minimum Trade Size: trade size 3/4".

D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
1. Options:

a. Exterior Coating: PVC complying with NEMA RN 1.
b. Interior Coating: Zinc
c. Minimum Trade Size: trade size 3/4".
d. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
e. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.5 TYPE FMC-S DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. operating instructions for product.

C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):
1. Material: Steel.
2. Options:

a. Minimum Trade Size: trade size 3/4".

2.6 TYPE FMT DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN ILJW; including UL Subject 1652.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL ILJW - Steel Flexible Metallic Tubing (FMT):
1. Options:

a. Minimum Trade Size: trade size 3/4".

2.7 TYPE LFNC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DXOQ; including UL 1660.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):
1. Additional Criteria: Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
2. Options:

a. Minimum Trade Size: trade size 3/4".

D. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):
1. Additional Criteria: Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
2. Options:

a. Minimum Trade Size: trade size 3/4".

E. UL DXOQ - Corrugated (Type C) Liquidtight Flexible Nonmetallic Conduit (LFNC-C):
1. Additional Criteria: Type C conduit with corrugated internal and external surfaces without integral reinforcement within conduit wall.
2. Options:

a. Minimum Trade Size: trade size 3/4".

2.8 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DZYR; including UL 651.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
1. Dimensional Specifications: Schedule 40.
2. Options:

a. Minimum Trade Size: trade size 3/4".

D. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
1. Dimensional Specifications: Schedule 80.
2. Options:

a. Minimum Trade Size: trade size 3/4".

2.9 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Fittings for Type ERMC, Type PVC, Type HDPE, Duct Raceways:
1. Listing Criteria: UL CCN DWTT; including UL 514B.
2. Options:

a. Material: Steel or Die cast.
b. Coupling Method: Compression coupling, Raintight compression coupling with distinctive color gland nut or Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable

c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL FKAV - Fittings for Type EMT Duct Raceways:
1. Listing Criteria: UL CCN FKAV; including UL 514B.
2. Options:

a. Material: Steel or Die cast.
b. Coupling Method: Compression coupling, Raintight compression coupling with distinctive color gland nut or Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

E. UL ILNR - Fittings for Type FMC Duct Raceways:
1. Listing Criteria: UL CCN ILNR; including UL 514B.

F. UL DXAS - Fittings for Type LFNC Duct Raceways:
1. Listing Criteria: UL CCN DXAS; including UL 514B.

2.10 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

2.11 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DWTT; including UL 514B.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE underground conduits are not permitted to be used aboveground on Project.

C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERMC.
2. Exposed and Subject to Physical Damage: ERMC.
    a. Locations less than 2.5 m (8 ft) above finished floor.
3. Exposed and Not Subject to Physical Damage: ERMC, PVC-80.
4. Concealed Aboveground**:** ERMC, EMT, PVC-80, PVC-40
5. Direct Buried: PVC-80, PVC-40, HDPE-80, HDPE-40
6. Concrete Encased Not in Trench: PVC-80, PVC-40
7. Concrete Encased in Trench: PVC-80, PVC-40, HDPE-80, HDPE-40
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC, LFNC-A, LFNC-B.

D. Indoors:

1. Hazardous Classified Locations**:** ERMC
2. Exposed and Subject to Severe Physical Damage: ERMC. Locations include the following:
    a. Loading docks.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
3. Exposed and Subject to Physical Damage: ERMC, EMT. Locations include the following:
    a. Locations less than 2.5 m (8 ft) above finished floor.
    b. Stub-ups to above suspended ceilings.
4. Exposed and Not Subject to Physical Damage: ERMC, EMT, PVC-80.
5. Concealed in Ceilings and Interior Walls and Partitions: ERMC, EMT, PVC-80, PVC-40.
6. Damp or Wet Locations: ERMC.
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC, FMC, LFNC-A, LFNC-B.

E. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
1. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
2. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
3. Type HDPE: Article 353 of NFPA 70 and NECA NEIS 111.
4. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
5. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
6. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
7. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
8. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
9. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
10. Expansion Fittings: NEMA FB 2.40.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.
b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft (0.6 m) above finished floor.
c. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inch of changes in direction.
d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within 12 inches of enclosures to which attached.
g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct 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 duct raceway enters a building or structure.
3) Conduit extending from interior to exterior of building.
4) Conduit extending into pressurized duct raceway and equipment.
5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
j. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
k. Keep duct raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

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

2. Types ERMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

3. Types FMC, LFMC, and LFNC:

a. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

4. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.

5. Duct Raceways Embedded in Slabs:
   a. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
   b. Arrange duct raceways to ensure that each is surrounded by minimum of 1 inch of concrete without voids.
   c. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

6. Stub-ups to Above Recessed Ceilings:

   a. Provide EMT or ERMC for duct raceways.
   b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

7. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

   a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.

8. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
   a. EMT: Provide setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
   b. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

9. Expansion-Joint Fittings:

   a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
   b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

      1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
      4) Attics: 135 deg F temperature change.

   c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F 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 of temperature change for metal conduits.
   d. Install expansion fittings at locations where conduits cross building or structure expansion joints.

e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

10. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
11. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

a. Provide warning signs.

D. Interfaces with Other Work:

1. Coordinate installation of new products for with existing conditions.

2. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
3. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

B. Shop Drawings:

1. Shop drawings for floor boxes.

PART 2 - PRODUCTS

2.1 BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCIT - Metallic Outlet Boxes and Covers:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Options:

    a. Material: Sheet steel.
    b. Sheet Metal Depth: Minimum 2.8 inch.

D. UL QCIT - Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

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

    a. Crouse-Hinds; brand of Eaton, Electrical Sector.
    b. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

E. UL QCIT - Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

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

    a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    d. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

3. Options:

    a. Material: Sheet steel
    b. Sheet Metal Depth: minimum 2.8 inch.

F. UL QCIT - Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

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

    a. Cooper B-line; brand of Eaton, Electrical Sector.

b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

G. UL QCIT - Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.

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

a. AFC Cable Systems; Atkore International.
b. Arlington Industries, Inc.
c. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
e. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
g. Wiremold; Legrand North America, LLC.

2.2 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

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

a. Cooper B-line; brand of Eaton, Electrical Sector.
b. FSR Inc.
c. Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
f. Square D; Schneider Electric USA.

D. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

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

a. Cooper B-line; brand of Eaton, Electrical Sector.
b. FSR Inc.
c. Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
f. Square D; Schneider Electric USA.

2.3 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

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

a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Wiremold; Legrand North America, LLC.

2. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
b. Wallplate Material: Galvanized steel or as indicated on architectural Drawings.

D. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:

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

    a. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    d. Wiremold; Legrand North America, LLC.

2. Options:

    a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
    b. Wallplate Material: High-impact thermoplastic (nylon) with smooth finish and color matching wiring device or as indicated on architectural Drawings.
    c. Color: Gray or as indicated on architectural Drawings.

2.4 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:

    a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
    b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

3. Mounts to box using fasteners different from wiring device.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL QCIT or QCMZ - Retractable or Re-attachable Hoods for Outlet Boxes:

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

    a. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Options:

    a. Provides clear, weatherproof, "while-in-use" cover.

D. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

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

    a. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
3. Options:

    a. Provides clear, weatherproof, "while-in-use" cover.
    b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

3.2 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

    a. Type 3R unless otherwise indicated.
    b. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.

2. Indoors:

    a. Type 1 unless otherwise indicated.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. Boxes with knockouts or unprotected openings are prohibited.
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. 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.
3. 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, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for wallplates and covers.

14. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each box with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Coordinate installation of new products for with existing conditions.

2. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
3. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard on input feeder.

3.4 CLEANING

A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.5 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Requirements:
1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:
1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:
1. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Round, Galvanized-Steel, Sheet Metal Sleeves:
1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:
   1. General Characteristics:

      a. Material: Galvanized sheet steel.
      b. Minimum Metal Thickness:

         1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch
         2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

B. Options:

   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating**,** of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

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

   1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
   2. Design Mix: 5000 psi , 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.6 POURABLE SEALANTS

A. Performance Criteria:

   1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.

a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.7 FOAM SEALANTS

A. Performance Criteria:

1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

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

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

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

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

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

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

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

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

END OF SECTION 260544

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Restraints - rigid type.
2. Restraints - cable type.
3. Restraint accessories.
4. Post-installed concrete anchors.
5. Concrete inserts.

B. Related Requirements:
1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Restraints - rigid type.
2. Restraints - cable type.
3. Restraint accessories.
4. Post-installed concrete anchors.
5. Concrete inserts.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic and wind-load bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.

c. Seismic Design Calculations: Submit input data and loading calculations prepared in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."

2. Seismic-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.

a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified structural professional engineer to design seismic and wind-load control system in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."

B. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

C. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

2.2 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINTS - CABLE TYPE

A. Seismic- and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.4 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.6 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

B. Comply with MSS SP-58.

2.7 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include rated load capacity for each seismic- and wind-load-restraint device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-load-restraint component used.
3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
4. Annotate to indicate application of each product submitted and compliance with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions and high wind events.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch
2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch
2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2

B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.

2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.

C. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

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

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 1000 V or Less:
1. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
2. Colors for 208Y/120 V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240 V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral: gray.
6. Color for Equipment Grounds: Green with yellow stripe.
7. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Raceways and Cables Carrying Circuits at More Than 1000 V:

1. Black letters on orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
3. Colors for Cables Carrying Circuits at More Than 1000V:
   a. Phase A: Brown
   b. Phase B: Orange
   c. Phase C: Yellow

D. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

E. Warning labels and signs must 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 3 FEET MINIMUM."

F. Equipment Identification Labels:

1. Black letters on white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted 3 mil (0.08 mm) thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
2. Marker for Labels:
   a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:

    a. 1-1/2 by 6 inches for raceway and conductors.
    b. 3-1/2 by 5 inches for equipment.
    c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.

C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.

D. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
    1. Tape:

        a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical utility lines.
        b. Printing on tape must be permanent and may not be damaged by burial operations.
        c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

    2. Color and Printing:

        a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
        b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW"

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 thick, color-coded for phase and voltage level, with factory screened or printed permanent designations; punched for use with self-locking cable tie fastener.
   1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
   2. Marker for Tags:
      a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4 inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inch.

B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4 inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inch.

C. Laminated Acrylic or Melamine Plastic Signs:
   1. Engraved legend.
   2. Thickness:
      a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
      b. For signs larger than 20 sq. inch , 1/8 inch thick.
      c. Engraved legend with black letters on white face

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch
   2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F
   4. Color: Black, except where used for color-coding.

B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch
   2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F
   5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

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

C. Verify identity of item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

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

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 1000 V: Identification must completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

N. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high label; where two lines of text are required, use labels 2 inch high.

Q. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in common trench exceeds 16 inch overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose or plenum-rated cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose or plenum-rated cable ties.

Z. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on minimum 1-1/2 inch high sign; where two lines of text are required, use signs minimum 2 inch high.

AA. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

BB. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch high, black letters on 20 inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30 ft maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: Vinyl wraparound labels

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 120 V to Ground: Identify with self-adhesive raceway labels

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

H. Power-Circuit Conductor Identification, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with conductor designation.

K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

L. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels

1. Apply to exterior of door, cover, or other access.
2. 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.

O. Arc Flash Warning Labeling: Self-adhesive labels.

P. Operating Instruction Signs: Self-adhesive labels.

Q. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

R. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign Stenciled legend 4 inch high].
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
    g. Emergency system boxes and enclosures.
    h. Enclosed switches.
    i. Enclosed circuit breakers.
    j. Variable-speed controllers.

END OF SECTION 260553

SECTION 260573.13 – SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.
2. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.
3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

F. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Short-Circuit Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

a. Short-circuit study input data.

b. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

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

1. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.

E. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.

F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by study.

D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.

3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain data necessary for conduct of study.

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

B. Gather and tabulate required input data to support short-circuit study. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.
2. Exclude equipment supplied by single transformer smaller than 75 kVA.

E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

G. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

H. Include in report identification of protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.16 – COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

Study results must be used to determine coordination of series-rated devices.

B. Related Requirements:
1. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
2. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when abnormal current flow exists and then removes the affected portion of the circuit from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

F. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Coordination Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and equipment evaluation reports.
    c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
    d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

1.4 QUALITY ASSURANCE

A. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.5 REGULATORY AGENCY APPROVALS

A. Submittals for coordination study requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

B. Submittals for coordination study require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

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

    1. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

E. Computer program must be designed to perform coordination studies or have function, component, or add-on module designed to perform coordination studies.

F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Revisions to electrical equipment required by study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.

3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying portion of system covered.
2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

a. Power utility's overcurrent protective device.
b. Medium-voltage equipment overcurrent relays.
c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. Largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain data necessary for conduct of overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers must be in accordance with NFPA 70E.

B. Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Begin analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.
2. Exclude equipment supplied by single transformer smaller than 75 kVA.

E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.

G. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

I. Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.

J. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

K. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
4. Include in report identification of protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified medium-voltage and low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:
1. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
2. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.

E. SCCR: Short-circuit current rating.

F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

G. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:

    a. Arc-flash study input data, including completed computer program input data sheets.
    b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
    c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.4 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.5 REGULATORY AGENCY APPROVALS

A. Approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Submittals for arc-flash hazard analysis require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

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

    1. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.

7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch self-adhesive equipment label for each work location included in analysis.

B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.
    a. Arc-flash boundary.
    b. Restricted approach boundary.
    c. Limited approach boundary.
4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies prior to starting Arc-Flash Hazard Analysis.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain data necessary for conduct of arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below not fed by single transformer smaller than 75 kVA must have arc-flash label applied to it:

1. Medium-voltage switchgear.
2. Medium-voltage switches.
3. Medium voltage transformers.
4. Low-voltage switchgear.
5. Switchboards.
6. Panelboards.
7. Motor-control centers.
8. Low voltage transformers.
9. Safety switches.
10. Control panels.

C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 260573.19

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Indoor occupancy and vacancy sensors.
   2. Emergency shunt relay.
   3. Conductors and cables.

B. Related Requirements:
   1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Indoor occupancy and vacancy sensors.
   2. Switchbox-mounted occupancy sensors.
   3. Room Controllers.
   4. Network Bridges.
   5. Network Routers.
   6. Network Controller
   7. Emergency shunt relay.
   8. Manufacturer specific floor plan layouts
   9. Manufacturer specific wiring diagrams.
   10. Conductors and cables.

B. Shop Drawings:

   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Control Stations.
      c. Room Controllers.
      d. Network Bridges.
      e. Network Routers.
      f. Network Controller
      g. Emergency shunt relay.
      h. Interconnection diagrams showing field-installed wiring.
      i. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period. 3 years.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology, PIR, or Ultrasonic as defined on floor plan.
3. Hardwired connection to switch.
4. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
5. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.

6. Mounting:

a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door. Remote control. Network based where applicable.

7. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
8. Bypass Switch: Override the "on" function in case of sensor failure.

B. Dual-Technology Type: Wall or ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6 inches minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1200 sq. ft. when mounted on a 96 inch high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inches above finished floor.

2.2 EMERGENCY SHUNT RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120-277 V.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF CONTACTORS

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting controllers.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label network devices with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Field tests must be witnessed by design engineer.

B. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections. Reference lighting control matrix for further direction on phasing and field visits needed.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

END OF SECTION 260923

SECTION 261216 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-type, medium-voltage transformers, with primary and secondary bushings within or without air-terminal enclosures.
2. Control network.
3. Warning labels and signs.

1.2 DEFINITIONS

A. VPE: Vacuum Pressure Encapsulation.

B. VPI: Vacuum Pressure Impregnation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. For dry-type, medium-voltage transformers.

a. Include plans and elevations showing major components and features.

1) Include plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits. Concrete bases to be a minimum 3” high, unless noted otherwise and project not less than 1-1/2” beyond the equipment and not less than 3” beyond anchor bolts on all sides.

b. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
c. Include single-line diagram.
d. Include list of materials.
e. Include nameplate legends.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton/Cooper Industries; Cooper Power Systems Division
   2. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
   3. ABB/GE Electrical Distribution and Control
   4. Hammond Manufacturing, Transformer Group
   5. Schneider Electric
   6. MGM Transformer Co.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.01.

2.3 PERFORMANCE REQUIREMENTS

A. Windings Material: Aluminum or Copper.

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.

   1. Self-Cooled Rating, Class AA.

D. Winding Connections: Connection of windings and terminal markings must comply with IEEE C57.12.70.

E. Efficiency: Comply with 10 CFR 431, Subpart K.

F. Bushings must comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.

G. Tap Changer: External, for de-energized operation.

   1. Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

H. Enclosure:

1. Provide with provisions for lifting and anchoring frame to concrete pad.
2. With integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
3. Enclosure Finish:
    a. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over rust-inhibiting primer on treated metal surface.

I. Sound level must comply with requirements of NEMA TR 1.

J. Capacities and Characteristics:

1. Enclosure: Ventilated power transformer, NEMA 250 Type 1 enclosure.

2. Transformer Ratings.
    a. Temperature Rise: 150 deg C
    b. Coils Connection:

        1) Line-Side Winding: Delta
        2) Load-Side Winding: Wye.

    c. Voltage and BIL Ratings:

        1) Nominal primary phase-to-phase voltage and BIL:15kV, 60kV.
        2) Nominal secondary voltage and BIL: 480Y/277 V, 10 kV

3. Taps: Two 2-1/2 percent, full-capacity taps above and two 2-1/2 percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
4. Transformer Accessories:

    a. Dial-type analog thermometer with alarm contacts.
    b. At least four stainless steel ground connection pads.
    c. Provisions for jacking, lifting, and towing.
    d. Machine-engraved nameplate made of anodized aluminum or stainless steel.

2.4 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. Warning signs must be made of baked enamel.
2. Equipment Identification Labels: Engraved, laminated-acrylic or -melamine label

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine dry-type, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload transformers carefully, observing packing label warnings and handling instructions.
6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use lifting lugs when lifting transformers.
6. Use jacks only at corners of base plate of transformer case.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with crane.
8. Use spreaders or lifting beam to obtain vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.

5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions. Visually check for rust spots.

D. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders may cross section barriers to reach load or line lugs.

F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Ground resistance at transformer location may not be greater than 5 Ω.

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

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Concrete pads and bases shall be furnished and installed by the Contractor furnishing the equipment. This Contractor shall establish sizes and location of the various concrete bases required and shall provide all necessary anchor bolts together with templates for holding these bolts in position. Anchor bolts shall be placed in steel pipe sleeves to allow for adjustment, with a suitable plate at bottom end of sleeve to hold the bolt. Each concrete base shall be not less than 3” high, unless noted otherwise, which shall project not less than 1-1/2” beyond the equipment and not less than 3” beyond anchor bolts on all sides.

B. Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

1. At Interior Locations: For grounding to grounding electrodes, provide bare copper cable not smaller than 3/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
2. At Exterior Locations:

    a. For counterpoise, provide tinned bare copper cable not smaller than 3/0 AWG, buried not less than 30 inches below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
    b. Fence and equipment connections may not be smaller than 4 AWG. Ground fence at gate posts and corner posts and at intervals not exceeding 10 ft. Bond gate sections to fence posts using 1/8 by 1 inch tinned flexible braided copper strap and clamps.
    c. Make joints in grounding conductors and loops by exothermic weld or compression connector.

3. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
4. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of substations in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Testing Preparation:

1. Field tests and inspections must be witnessed authorities having jurisdiction.

B. Tests and Inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

2. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, grounding, and clearances.
3) Verify arresters are clean.
4) Verify that ground leads on devices are individually attached to ground bus or ground electrode.
5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

b. Electrical Test:

1) Perform insulation-resistance test on arresters, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in that table.
2) Perform watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Test dew point of tank gases if applicable.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify bushings are clean.
5) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
6) Verify that cooling fans operate correctly and have appropriate overcurrent protection.
7) Perform specific inspections and mechanical tests recommended by manufacturer.
8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; value of index may not be less than 1.0.
2) Perform power-factor or dissipation-factor tests on windings in accordance with test equipment manufacturer's published data.

C. Nonconforming Work:

1. Equipment and devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest.

D. Assemble and submit test and inspection reports. Record as-left set points of adjustable devices.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at outgoing section of transformers. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.

b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

a. Prepare written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:

a. Description of equipment to be tested.
b. Discrepancies.
c. Temperature difference between area of concern and reference area.
d. Probable cause of temperature difference.
e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
f. Identify load conditions at time of inspection.
g. Provide photographs and thermograms of deficient area.

4. Act on inspection results in accordance with recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 261216

SECTION 261323 - MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchgear enclosure.
2. Fusible load interrupter switchgear.
3. Load interrupter switchgear with circuit breakers.
4. Circuit breaker switchgear.
5. Power transfer configurations.
6. Instruments.
7. Protective relays.
8. AC control power supply.
9. DC control power supply.
10. Warning labels and signs.

B. Related Requirements:

1.2 DEFINITIONS

A. ASYM: Asymmetrical.

B. SYM: Symmetrical.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For medium-voltage, metal-enclosed switchgear.

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations must show major components, features, and mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits. Show location of anchor bolts. Concrete bases to be a minimum 3” high, unless noted otherwise and project not less than 1-1/2” beyond the equipment and not less than 3” beyond anchor bolts on all sides.

4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Locate accessory and spare equipment storage.
6. Include single-line diagram.
7. Include control power wiring diagrams.
8. Include copy of nameplate.
9. Ratings of the assembled switchgear:

    a. Voltage.
    b. Continuous current.
    c. Short-circuit rating.
    d. BIL.

10. Utility company's metering provisions with indication of approval by utility company.
11. Wiring Diagrams: For each switchgear assembly include the following:

    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices .

1.4 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace the switchgear control system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F

    a. For discharge rate not faster than 8 hours, discharge duration not longer than 8 hours, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 6 discharge cycles.
    b. For discharge rate not faster than 30 minutes, discharge duration not longer than 30 minutes, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 20 discharge cycles.
    c. For discharge rate not faster than 15 minutes, discharge duration not longer than 45 seconds, and voltage at end of discharge not less than 1.67 V, warranted life must be not fewer than 120 discharge cycles.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Manufactured Unit: Metal-enclosed switchgear, designed for application in solidly grounded neutral system.

B. Switchgear Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

C. Comply with IEEE C37.20.3.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton/Cooper Industries; Cooper Power Systems Division
2. ABB/GE Electrical Distribution and Control
3. Schneider Electric

2.3 SWITCHGEAR ENCLOSURE

A. Indoor Enclosure: Steel.

B. Enclosure Finish:
1. Indoor Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.4 LOAD INTERRUPTER SWITCHGEAR WITH CIRCUIT BREAKERS

A. Construction:

1. Deadfront, metal-enclosed, fixed-mount, switchgear assembly of vertical sections, each with non-fused load interrupter switch in series with a vacuum circuit breaker. Additional vertical sections must be provided to house accessories related to the switchboard functions.

a. Comply with IEEE C37.20.7,
b. Front and rear access switchgear.
c. Viewing window to show view of the position of the three poles of the interrupter.
d. Mechanical interlocks preventing the door from opening when the switch is open and requiring the door to be closed before the switch can be closed for vertical sections that house interrupter switches that do not have a vacuum circuit breaker.
e. Padlocking and tagging the switch in the opened or closed position.
f. Switch position indicator.

g. Front and rear vertical section covers must have full-length hinges. The front cover must be a flanged door with latching hardware. The rear cover may be bolted.

2. Bus: Silver-plated copper.

a. Ground Bus: Sized to carry the rated short-time withstand current and connected to the metal enclosures of each vertical section.

3. Auxiliary Vertical Sections and Compartments:

a. Utility metering compartment that complies with utility company requirements.

B. Surge Arresters: Comply with IEEE C62.11, distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

C. Switch: Load interrupter in series with vacuum circuit breaker:

1. Switch Construction:

a. Grounded, metal shield to cover live components and terminals.
b. Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
c. Phase barriers, full-length of switchblades for each pole; readily removable and replaceable; designed to allow visual inspection of switch components when barrier is in place.

2. Circuit Breaker: Operated by a motor-charged stored-energy mechanism and having manual means of charging the mechanism.

a. Electrically Operated:

1) 120 V(ac) close, ac capacitor trip. Powered from external power source

b. Equip with switch control device and indicator lights to show breaker contact position.
c. Equip the vacuum circuit breakers with contact wear indicators.

D. Protective Relays: Microprocessor based multifunction overcurrent relay.

1. Device Functions:

a. 51/50, 51/50N, or 51/50G, and 86 in accordance with IEEE C37.2.

E. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.

2.5 CIRCUIT BREAKER SWITCHGEAR

A. Construction:

1. Deadfront, metal-enclosed, drawout, switchgear assembly of vertical sections, each with vacuum circuit breakers. Additional vertical sections must be provided to house accessories related to the switchboard functions.

    a. Comply with IEEE C37.20.7
    b. Front and rear access switchgear.
    c. Front and rear vertical section covers must have full-length hinges. The front cover must be a flanged door with latching hardware. The rear cover may be bolted.

2. Bus: Silver-plated copper.

    a. Ground Bus: Sized to carry the rated short-time withstand current, and connected to the metal enclosures of each vertical section.

3. Auxiliary Vertical Sections and Compartments:

    a. Utility metering compartment that complies with utility company requirements.

B. Surge Arresters: Comply with IEEE C62.11, distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

C. Vacuum Circuit Breakers:

1. Operated by a motor-charged, stored-energy mechanism and having manual means of charging the mechanism.
2. Electrically Operated:

    a. 120 V(ac) close, ac capacitor trip. Powered from external power source

D. Protective Relays

1. Microprocessor-based, multifunction, overcurrent relay with the following IEEE C37.2 device functions:

    a. 50, 51, 51N, 50N, 51G, 50G, and 86.
    b. 50G, 51G, 50N, 51N, 50P, 51P, 27, 47, 59, 67, and 81.
    c. 50G, 51G, 50P, 51P, 50N, 51N, 25, 27, 32, 47, 59, 67, and 81.

E. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.

F. Capacities and Characteristics:

1. Switchgear Assembly:

    a. Rated Maximum Voltage and BIL: 15 kV, 95 kV.
    b. Rated Continuous Current: 1200 A.
    c. Rated Momentary Withstand Current (600 A and 1200 A Continuous Current Ratings): 40 kA SYM RMS for 10 cycles
    d. Rated Short-Time Withstand Current (600 A and 1200 A Continuous Current Ratings): 25 kA SYM RMS for 2 s.

2.6 INSTRUMENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital Meter and Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1. Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display with the following features:

    a. Phase Currents, Each Phase: Plus or minus 1 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    d. Three-Phase Real Power: Plus or minus 2 percent.
    e. Three-Phase Reactive Power: Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.
    g. Frequency: Plus or minus 0.5 percent.
    h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.

3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring and Control."
4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

2.7 AC CONTROL POWER SUPPLY

A. Description:

1. Control power transformer must supply 120 V control circuits through secondary disconnect and overcurrent protective devices.

    a. Dry-type transformer, in separate compartment, with primary and secondary fuses to provide current-limiting and overload protection.

2.8 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. Warning signs must be baked enamel signs.

2. Equipment Identification Labels: Laminated acrylic or melamine label, minimum 4 inch (100 mm) high.

2.9 SOURCE QUALITY CONTROL

A. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.20.3:

1. Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
2. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
3. Perform the control wiring dielectric test at 1500 V for one minute.

B. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.20.4.

1. Perform mechanical operation tests to ensure proper functioning of the switch.
2. Verify the contact gap. Perform terminal-to-terminal resistance test.
3. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
4. Perform the control wiring dielectric test at 1500 V for one minute.

C. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and shop drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear in accordance with manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against the entrance of dust, rain, and snow.
3. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

C. Storage:

1. Store switchgear in a location that is clean and protected from weather. Protect switchgear from dirt, water, contamination, and physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
2. Store switchgear with compartment doors closed.
3. Regularly inspect switchgear while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 ohms at switchgear location.

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

3.2 INSTALLATION OF SWITCHGEAR

A. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s). Concrete pads and bases shall be furnished and installed by the Contractor furnishing the equipment. This Contractor shall establish sizes and location of the various concrete bases required and shall provide all necessary anchor bolts together with templates for holding these bolts in position. Anchor bolts shall be placed in steel pipe sleeves to allow for adjustment, with a suitable plate at bottom end of sleeve to hold the bolt. Each concrete base shall be not less than 3” high, unless noted otherwise, which shall project not less than 1-1/2” beyond the equipment and not less than 3” beyond anchor bolts on all sides. Comply with

requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

2. Comply with requirements for vibration isolation devices specified in Section 260529 "Hangers and Supports for Electrical Systems."

B. Switchgear must be installed level and plumb. Switchgear must tilt less than 1.5 degrees while energized.

C. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's written instructions and NFPA 70.

D. Comply with NECA 430.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Interior Locations:

1. Install bare copper cable not smaller than No. 3/0 AWG for grounding to grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors.
3. Keep leads as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.

C. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.

D. Complete switchgear grounding and lightning arrester connections prior to making any other electrical connections.

E. Terminate medium-voltage cables in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA in 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods."
2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

B. Medium-Voltage Switchgear Assembly Field Tests:

1. Visual and Mechanical Inspection:

    a. Verify that fuse and circuit breaker sizes and types correspond to Drawings and coordination study.
    b. Verify that current and voltage transformer ratios correspond to Drawings.
    c. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
        2) Make key exchange with devices operated in off-normal positions.

    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Inspect insulators for evidence of physical damage or contaminated surfaces.
    g. Verify correct barrier and shutter installation and operation.
    h. Exercise active components.
    i. Inspect mechanical indicating devices for correct operation.
    j. Verify that filters are in place and vents are clear.
    k. Perform visual and mechanical inspection of instrument transformers in accordance with Article "Instrument Transformer Field Tests."
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.
        3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

    a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Perform dc voltage insulation-resistance tests on each bus section, phase to phase and phase to ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

   1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
   2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

   1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

   1) Minimum insulation-resistance values of control wiring must not be less than two megohms.

e. Control Power Transformers:

   1) Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground. Insulation-resistance values of winding insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
   2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
   3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
   4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

f. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

g. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

h. Perform system function tests in accordance with "System Function Tests" Article.
i. Verify operation of space heaters.
j. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

C. Medium-Voltage Vacuum Circuit Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required clearances.
c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism must be in accordance with manufacturer's published data.
g. Verify cell fit and element alignment.
h. Verify racking mechanism operation.
i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal

range in accordance with manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.

d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer's published data.

e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.

f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.

g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

i. Verify operation of heaters.

D. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data complies with Contract Documents.

b. Inspect physical and mechanical condition.

c. Verify correct connection of transformers with system requirements.

d. Verify that adequate clearances exist between primary and secondary circuit wiring.

e. Verify the unit is clean.

f. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

g. Verify that required grounding and shorting connections provide contact.

h. Verify correct operation of transformer withdrawal mechanism and grounding operation.

i. Verify correct primary and secondary fuse sizes for voltage transformers.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
c. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1. Polarity results must agree with transformer markings.

3. Electrical Tests of Voltage Transformers:

a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests winding-to-winding and each winding to ground. Test voltages must be applied for one minute in accordance with Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
c. Perform a polarity test on each transformer to verify the polarity marks or H1- X1 relationship as applicable. Polarity results must agree with transformer markings.
d. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
e. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3. Test results must indicate that the circuits are grounded at only one point.

E. Ground Resistance Test:

1. Visual and Mechanical Inspection:

a. Verify ground system complies with the Contract Documents and NFPA 70 Article 250, "Grounding and Bonding."
b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.
c. Inspect bolted electrical connections using a calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
d. Inspect anchorage.

2. Electrical Tests:

a. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than 5 ohms.
b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with Contract Documents.
c. Inspect physical and mechanical condition.
d. Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

F. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
d. Verify the unit is clean.
e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Verify accuracy of meters at all cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
c. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
d. Verify all instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
e. Verify that current transformer and voltage transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.

G. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data complies with Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify the arresters are clean.

e. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
f. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.

2. Electrical Test:

a. Perform an insulation-resistance test on each arrester, phase terminal to ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
c. Test grounding connections. Resistance between the arrester ground terminal and the ground system must be less than 0.5 ohm.

H. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme as follows:

1) Timing Relay:

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) Volts/Hertz Relay:

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at a second voltage level.

c) Determine time delay.

3) Sync Check Relay:

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine live line, live bus, dead line, and dead bus set points.
d) Determine time delay.
e) Verify dead bus/live line, dead line/live bus, and dead bus/dead line control functions.

4) Undervoltage Relay:

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at a second point on the timing curve for inverse time relays.

5) Directional Power Relay:

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at a second point on the timing curve for inverse time relays.

6) Current Balance Relay:

a) Determine pickup of each unit.
b) Determine percent slope.
c) Determine time delay.

7) Negative Sequence Current Relay:

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on the I-two-squared-t curve.

8) Phase Sequence or Phase Balance Voltage Relay:

a) Determine positive sequence voltage to close the NO contact.
b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the NC contact upon removal of voltage when previously set to rated system voltage.

9) Instantaneous Overcurrent Relay:

a) Determine pickup.
b) Determine dropout.

10) Time Overcurrent:

a) Determine minimum pickup.
b) Determine time delay at two points on the time current curve.

11) Ground Detector Relay:

a) Determine maximum impedance to ground causing relay pickup.

12) Directional Overcurrent Relay:

a) Determine directional unit minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine overcurrent unit pickup.
d) Determine overcurrent unit time delay at two points on the time current curve.

d. Control Verification:

1) Functional Tests:

a) Check operation of all active digital inputs.
b) Check output contacts or silicone-controlled rectifiers (SCRs), preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

3. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and that alarms comply with system manufacturer's recommendations.
c. Measure negative post temperature. Negative post temperature must comply with manufacturer's published data or IEEE 1188.
d. Measure charger float and equalizing voltage levels. Charger float and equalizing voltage levels must be in accordance with the battery manufacturer's published data.

e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.
f. Measure intercell connection resistances.
g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
h. Perform a load test in accordance with manufacturer's published data or IEEE 1188. Replace units that fail to pass the test.
i. Measure the battery system voltage from positive to ground and negative to ground. Voltage measured from positive to ground must be equal in magnitude to the voltage measured from negative to ground.

I. DC System Vented NiCd Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify electrolyte level. Measure pilot-cell electrolyte temperature and correct as recommended by manufacturer's maintenance procedures to bring the temperature and electrolyte level to within normal limits.
h. Verify the units are clean.
i. Inspect spill containment installation.
j. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and that alarms comply with system manufacturer's recommendations.
c. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation. Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published data.
d. Measure intercell connection resistances.
e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
f. Perform a load test in accordance with manufacturer's published data or IEEE 1106. Replace units that fail to pass the test.
g. Measure the battery system voltage from positive to ground and negative to ground. Voltage measured from positive to ground must be equal in magnitude to the voltage measured from negative to ground.

J. Nonconforming Work:

1. Switchgear will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

K. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.6 SYSTEM FUNCTION TESTS

A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, if requested by Owner, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust switchgear taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:

    a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.

2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1deg C at 86 deg F
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and lists the results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between the area of concern and the reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 261323

SECTION 261326 - MEDIUM-VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchgear enclosure.
2. Switchgear construction.
3. Surge arresters.
4. Instruments.
5. Protective relays.
6. Control power supply.
7. Battery system control power supply.
8. Control network.
9. Warning labels and signs.

B. Related Requirements:

1.2 DEFINITIONS

A. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For each medium-voltage, metal-clad switchgear.

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of assembled section. Elevations must show major components, features, and mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits. Show location of anchor bolts. Concrete bases to be a minimum 3” high, unless noted otherwise and project not less than 1-1/2” beyond the equipment and not less than 3” beyond anchor bolts on all sides.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of field connection.
5. Locate accessory and spare equipment storage.
6. Include single-line diagram.

7. Include control power wiring diagrams.
8. Include copy of nameplate.
9. Test results of enclosure corrosion resistant finish.
10. Ratings the switchgear assembly:

    a. Voltage.
    b. Continuous current.
    c. Short-circuit current.
    d. Lightning impulse full-wave withstand voltage.

11. Utility company's metering provisions with indication of approval by utility company.
12. Design Calculations: Signed and sealed by a qualified professional structural engineer. Calculate requirements for selecting seismic restraints.
13. Relay settings.
14. Interface data with monitoring or control network.
15. Wiring Diagrams: For each switchgear assembly include the following:

    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For switchgear, signed by product manufacturer.

B. Source quality-control reports.

1.5 WARRANTY

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Manufactured Unit: Indoor, metal-clad switchgear, designed for application in solidly grounded neutral system.

B. Comply with IEEE ANSI C37.20.2.

C. The switchgear ratings must comply with IEEE ANSI C37.04 and must be the preferred ratings of IEEE ANSI C37.06.

D. Switchgear Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton/Cooper Industries; Cooper Power Systems Division
   2. ABB/GE Electrical Distribution and Control
   3. Schneider Electric

2.3 SWITCHGEAR ENCLOSURE

A. Indoor Enclosure: Steel.

B. Enclosure Finish:
   1. Indoor Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.4 SWITCHGEAR CONSTRUCTION

A. Deadfront, metal-clad, drawout, switchgear assembly of vertical sections, with vacuum circuit breakers. Provide additional vertical sections to house accessories related to the switchgear functions.

   1. Front and rear access switchgear.
   2. Front and rear vertical section covers with full-length hinges. The front cover must be a flanged door with latching hardware. The rear cover may be bolted.

B. Bus: Silver-plated copper.

   1. Ground Bus: Sized to carry the rated short-time withstand current, extended full length of the switchgear assembly, and connected to the metal enclosures of each vertical section.

C. Circuit Breaker Compartments: Include a racking mechanism, circuit breaker operated automatic shutters covering the high-voltage bus connections, safety interlocks.

D. Auxiliary Vertical Sections and Compartments:

   1. Utility metering compartment that complies with utility company requirements.

E. Circuit Breakers: Horizontally mounted, drawout, vacuum circuit breakers, operated by a motor-charged stored-energy mechanism, and having manual means of charging the mechanism.

   1. Electrically Operated:

      a. 120 V(ac) close, ac capacitor trip. Powered from external power source.

F. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.

1. One of each size handling device to remove the circuit breaker from metal-clad switchgear and to move the breaker about on the floor.
2. Test cabinet with accessories to connect to the secondary contacts on an electrically operated removable element, permitting operation and testing of the removable element when it is removed from the housing.

G. Capacities and Characteristics:

1. Comply with IEEE ANSI C37.06.
2. Switchgear Assembly:

    a. Rated Maximum Design Voltage and BIL (Dielectric Test): 15 kV, 95 kV.
    b. Rated Continuous Current: 1200 A.
    c. Rated Short-Circuit Current and Short-Time Current: 40 kA RMS

3. Circuit Breakers:

    a. Same capacities and characteristics as the switchgear assembly, and as follows:

        1) Rated Continuous Current and Load Switching Current: 1200 A.
        2) Rated Closing and Latching Current: 104 kA, peak.
        3) Rated Interrupting Time: 50 ms.

2.5 SURGE ARRESTERS

A. Comply with IEEE ANSI C62.11, distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

2.6 INSTRUMENTS

A. Instrument Transformers: Comply with IEEE ANSI C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital Meter and Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1. Inputs from sensors or 5 A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display with the following features:

    a. Phase Currents, Each Phase: Plus or minus 1 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    d. Three-Phase Real Power: Plus or minus 2 percent.
    e. Three-Phase Reactive Power: Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.
h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.

3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements in accordance with Section 260913 "Electrical Power Monitoring."
4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

5. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
6. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase voltages.
7. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
8. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
9. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
10. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
11. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a. Operation: Counts and records a succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.

2.7 PROTECTIVE RELAYS

A. Multifunctional, solid-state microprocessor-based relay systems, complying with IEEE ANSI C37.90.

B. Relay Mounting:

1. Each relay must be mounted in a drawout case with a two-stage quick-release operation.
2. Removal of the relay from the case must disconnect the trip circuits and short the current-transformer secondaries before the unit control power is disconnected.
3. When the relay is inserted into the case, control power connections must be made before the trip circuits are activated.
4. Include a self-shorting contact on the case terminal block for alarm indication and tripping of circuit breaker upon removal of the relay from the case.

C. Equip each relay system with a communications module to transmit the following data in accordance with Section 260913 "Electrical Power Monitoring."

1. Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.
2. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is configured in remote open-close mode.

D. Overcurrent and Ground-Fault Protective Relays:

1. IEEE ANSI C37.2 device functions 51/50 and 51/50N.
2. Field-Selectable Relay Settings: Required by the overcurrent protective device coordination study and arc-flash study.
3. Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.
4. Phase and Ground Protection: Field-selectable curves from IEEE moderately inverse, very inverse, or extremely inverse.
5. Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when the breaker is being closed and must be deactivated after approximately eight cycles.
6. Contacts:

    a. Two Form-A contacts.
    b. Field selectable into contact pairs as follows and as required by the overcurrent protective device coordination study and arc-flash study:

        1) One contact assigned function 51 phase and function 51 ground, and the other contact assigned function 50 phase and function 50 ground.
        2) One contact assigned function 51/50 phase, and the other contact assigned function 51/50 ground.

7. Alphanumeric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:

    a. Individual phase currents.
    b. Ground current.
    c. Cause of trip.
    d. Magnitude and phase of current-causing trip.
    e. Phase or ground indication.
    f. Peak current demand for each phase and ground since last reset.
    g. Current-transformer primary rating.
    h. Programmed phase and ground set points.

8. Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. A "protection off" alarm must be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay must be de-energized, providing a fail-safe protection off alarm.

2.8 AC CONTROL POWER SUPPLY

A. Description:

1. Control power transformer must supply 120 V(ac) control circuits through secondary disconnect and overcurrent protective devices.

a. Dry-type transformer, in separate compartment, with primary and secondary fuses to provide current-limiting and overload protection.

2.9 WARNING LABELS AND SIGNS

A. Install appropriate precautionary labels to warn about potential hazards that are inherent to the equipment. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. Warning signs must be baked enamel signs.
2. Equipment Identification Labels: Laminated acrylic or melamine plastic signs

2.10 SOURCE QUALITY CONTROL

A. Perform production tests on each circuit breaker housing for this Project, complying with IEEE ANSI C37.09.

1. Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
2. Conduct an alignment test with master circuit breaker to verify interfaces.
3. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
4. Perform the control wiring dielectric test at 1500 V for one minute.
5. Perform the dielectric test on primary and secondary circuits.

B. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE ANSI C37.09.

1. Perform mechanical operation tests to ensure proper functioning of the switch.
2. Conduct an alignment test with master cell to verify interfaces and interchangeability.
3. Verify the contact gap. Perform terminal-to-terminal resistance test.
4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.
5. Perform the control wiring dielectric test at 1500 V for one minute.
6. Set the contact gap.

C. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and shop drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear in accordance with manufacturer's recommendations, avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against the entrance of dust, rain, and snow.
3. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

C. Storage:

1. Store switchgear in a location that is clean and protected from weather. Protect switchgear from dirt, water, contamination, and physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
2. Store switchgear with compartment doors closed.
3. Regularly inspect switchgear while in storage and maintain documentation of storage conditions, noting discrepancies or adverse conditions.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

1. Verify removal of shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 ohms at switchgear location.

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

3.2 INSTALLATION OF SWITCHGEAR

A. Comply with the provisions of IEEE ANSI C37.20.2 subclause titled "Guide for Handling, Storage, and Installation."

B. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s) in accordance with Section 260529 "Hangers and Supports for Electrical Systems."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Switchgear must be installed level and plumb. Switchgear must tilt less than 1.5 degrees while energized.

D. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's written instructions and NFPA 70.

E. Comply with NECA 430.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Connections at Interior Locations:

1. Install bare copper cable not smaller than No. 3/0 AWG for grounding to grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors.
3. Keep leads as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.

C. Grounding at Exterior Locations:

1. Install tinned bare copper cable not smaller than No. 3/0 AWG, for counterpoise buried not less than 30 inch below grade interconnecting the grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Fence and equipment connections must not be smaller than No. 4 AWG.
5. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft.
6. Bond each gate section to the fence post using 1/8 by 1 inch flexible braided copper strap and clamps.

7. Make joints in grounding conductors and loops by exothermic weld or compression connector.

D. Terminate grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.

E. Complete switchgear grounding and lightning arrester connections prior to making other electrical connections.

F. Terminate medium-voltage cables in accordance with Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction

B. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods."
2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

C. Medium-Voltage Switchgear Assembly Field Tests:

1. Visual and Mechanical Inspection:

a. Verify that fuse and circuit breaker sizes and types correspond to Drawings and coordination study**.**
b. Verify that current and voltage transformer ratios correspond to Drawings.
c. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

2) Make key exchange with devices operated in off-normal positions.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Inspect insulators for evidence of physical damage or contaminated surfaces.
g. Verify correct barrier and shutter installation and operation.
h. Exercise active components.
i. Inspect mechanical indicating devices for correct operation.
j. Verify that filters are in place and vents are clear.
k. Perform visual and mechanical inspection of instrument transformers in accordance with "Instrument Transformer Field Tests" Paragraph.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Perform dc voltage insulation-resistance tests on each bus section, phase to phase and phase to ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.

c. Perform a dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it must be conducted in accordance with NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for

600 V rated cable. Test duration must be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring must not be less than 2 megohms.

e. Control Power Transformers:

1) Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground. Insulation-resistance values of winding insulation must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at devices.
3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

f. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

g. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

h. Perform system function tests in accordance with "System Function Tests" Article.
i. Verify operation of space heaters.
j. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Medium-Voltage Vacuum Circuit Breaker Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and required clearances.
c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.

d. Verify the unit is clean.
e. Perform mechanical operation tests on operating mechanism in accordance with manufacturer's published data.
f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism must be in accordance with manufacturer's published data.
g. Verify cell fit and element alignment.
h. Verify racking mechanism operation.
i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.
b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.
d. Verify correct operation of auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate in accordance with manufacturer's published data.
e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.
g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.
h. Perform a dielectric-withstand-voltage test in accordance with manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
i. Verify operation of heaters.

E. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

   a. Verify that equipment nameplate data complies with Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Verify correct connection of transformers with system requirements.
   d. Verify that adequate clearances exist between primary and secondary circuit wiring.
   e. Verify the unit is clean.
   f. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   g. Verify that required grounding and shorting connections provide contact.
   h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
   i. Verify correct primary and secondary fuse sizes for voltage transformers.
   j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

   a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V(dc) for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's written recommendations or NETA ATS, Table 100.5.
   c. Perform a polarity test of each current transformer in accordance with IEEE ANSI C57.13.1. Polarity results must agree with transformer markings.
   d. Perform an excitation test on transformers used for relaying applications in accordance with IEEE ANSI C57.13.1. Excitation results must match the curve supplied by the manufacturer or be in accordance with IEEE ANSI C57.13.1.
   e. Measure current circuit burdens at transformer terminals in accordance with IEEE ANSI C57.13.1. Measured burdens must be compared with and must match instrument transformer ratings.
   f. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
   g. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE ANSI C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.

3. Electrical Tests of Voltage Transformers:

   a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that

deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests winding-to-winding and each winding to ground. Test voltages must be applied for one minute in accordance with Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.

c. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results must agree with transformer markings.

d. Measure voltage circuit burdens at transformer terminals. Measured burdens must be compared with and must match instrument transformer ratings.

e. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data. Power-factor or dissipation-factor values must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with IEEE ANSI C57.13.3. Test results must indicate that the circuits are grounded at only one point.

F. Ground Resistance Test:

1. Visual and Mechanical Inspection:

a. Verify ground system complies with Contract Documents and NFPA 70 Article 250, "Grounding and Bonding."

b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections must be free of corrosion.

c. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

d. Inspect anchorage.

2. Electrical Tests:

a. Perform fall-of-potential or alternative test in accordance with IEEE Std 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground must be no more than 5 ohms.

b. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohm. Compare equipment nameplate data with Contract Documents.

c. Inspect physical and mechanical condition.

d. Inspect bolted electrical connections for high resistance using a low resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

G. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect bolted electrical connections using calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels must be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
    c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
    d. Verify the unit is clean.
    e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:

    a. Inspect bolted electrical connections using a low resistance ohmmeter to compare bolted resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Verify accuracy of meters at cardinal points. Meter accuracy must be in accordance with manufacturer's published data.
    c. Calibrate meters in accordance with manufacturer's published data. Calibration results must be within manufacturer's published tolerances.
    d. Verify instrument multipliers. Instrument multipliers must be in accordance with system design specifications.
    e. Verify that current transformer and voltage transformer secondary circuits are intact. Test results must confirm the integrity of the secondary circuits of current and voltage transformers.

H. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:

    a. Verify that equipment nameplate data complies with Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and clearances.
    d. Verify the arresters are clean.
    e. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
    f. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.

2. Electrical Test:

    a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
    b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

c. Test grounding connections. Resistance between the arrester ground terminal and the ground system must be less than 0.5 ohm.

I. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:

a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
b. Verify operation of light-emitting diodes, display, and targets.
c. Record passwords for each access level.
d. Clean the front panel and remove foreign material from the case.
e. Check tightness of connections.
f. Verify that the frame is grounded in accordance with manufacturer's instructions.
g. Set the relay in accordance with results in Section 260573.16 "Coordination Studies" and in Section 260573.19 "Arc-Flash Hazard Analysis."
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:

a. Perform insulation-resistance tests from each circuit to the grounded frame in accordance with manufacturer's published data.
b. Apply voltage or current to analog inputs and verify correct registration of the relay meter functions.
c. Functional Operation: Check functional operation of each element used in the protection scheme as follows:

1) Timing Relay:

a) Determine time delay.
b) Verify operation of instantaneous contacts.

2) Volts/Hertz Relay:

a) Determine pickup frequency at rated voltage.
b) Determine pickup frequency at a second voltage level.
c) Determine time delay.

3) Sync Check Relay:

a) Determine closing zone at rated voltage.
b) Determine maximum voltage differential that permits closing at zero degrees.
c) Determine live line, live bus, dead line, and dead bus set points.
d) Determine time delay.
e) Verify dead bus/live line, dead line/live bus, and dead bus/dead line control functions.

4) Undervoltage Relay:

a) Determine dropout voltage.
b) Determine time delay.
c) Determine time delay at a second point on the timing curve for inverse time relays.

5) Directional Power Relay:

a) Determine minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine maximum torque angle.
d) Determine time delay.
e) Verify time delay at a second point on the timing curve for inverse time relays.

6) Current Balance Relay:

a) Determine pickup of each unit.
b) Determine percent slope.
c) Determine time delay.

7) Negative Sequence Current Relay:

a) Determine negative sequence alarm level.
b) Determine negative sequence minimum trip level.
c) Determine maximum time delay.
d) Verify two points on the I-two-squared-t curve.

8) Phase Sequence or Phase Balance Voltage Relay:

a) Determine positive sequence voltage to close the NO contact.
b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
c) Verify negative sequence trip.
d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the NC contact upon removal of voltage when previously set to rated system voltage.

9) Instantaneous Overcurrent Relay:

a) Determine pickup.
b) Determine dropout.

10) Time Overcurrent:

a) Determine minimum pickup.
b) Determine time delay at two points on the time current curve.

11) Ground Detector Relay:

a) Determine maximum impedance to ground causing relay pickup.

12) Directional Overcurrent Relay:

a) Determine directional unit minimum pickup at maximum torque angle.
b) Determine closing zone.
c) Determine overcurrent unit pickup.
d) Determine overcurrent unit time delay at two points on the time current curve.

d. Control Verification:

1) Functional Tests:

a) Check operation of active digital inputs.
b) Check output contacts or silicone-controlled rectifiers (SCRs), preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
c) Check internal logic functions used in protection scheme.
d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

J. DC System VRLA Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify the units are clean.
h. Inspect spill containment installation.
i. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and that alarms comply with system manufacturer's recommendations.
c. Measure negative post temperature. Negative post temperature must comply with manufacturer's published data or IEEE Std 1188.
d. Measure charger float and equalizing voltage levels. Charger float and equalizing voltage levels must be in accordance with the battery manufacturer's published data.

e. Measure each monoblock/cell voltage and total battery voltage with charger energized and in float mode of operation. Monoblock/cell voltages must be in accordance with manufacturer's published data.
f. Measure intercell connection resistances.
g. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state. Monoblock/cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical monoblocks/cells in a fully charged state.
h. Perform a load test in accordance with manufacturer's published data or IEEE Std 1188. Replace units that fail to pass the test.
i. Measure the battery system voltage from positive to ground and negative to ground. Voltage measured from positive to ground must be equal in magnitude to the voltage measured from negative to ground.

K. DC System Vented NiCd Batteries Field Test:

1. Visual and Mechanical Inspection:

a. Verify that batteries are adequately located.
b. Verify that battery area ventilation system is operable.
c. Verify existence of suitable eyewash equipment.
d. Verify equipment nameplate data complies with Contract Documents.
e. Inspect physical and mechanical condition.
f. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
g. Verify electrolyte level. Measure pilot-cell electrolyte temperature and correct as recommended by manufacturer's maintenance procedures to bring the temperature and electrolyte level to within normal limits.
h. Verify the units are clean.
i. Inspect spill containment installation.
j. Verify application of an oxide inhibitor on battery terminal connections.

2. Electrical Tests:

a. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended levels.
b. Verify charger functions and that alarms comply with system manufacturer's recommendations.
c. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation. Cell voltages must be within 0.05 V of each other or in accordance with manufacturer's published data.
d. Measure intercell connection resistances.
e. Perform internal ohmic measurement tests. Cell internal ohmic values (resistance, impedance, or conductance) must not vary by more than 25 percent between identical cells that are in a fully charged state.
f. Perform a load test in accordance with manufacturer's published data or IEEE Std 1106. Replace units that fail to pass the test.
g. Measure the battery system voltage from positive to ground and negative to ground. Voltage measured from positive-to-ground must be equal in magnitude to the voltage measured from negative to ground.

L. Nonconforming Work:

1. Switchgear will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

M. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.6 SYSTEM FUNCTION TESTS

A. System function tests must prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, if requested by Owner, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust switchgear taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:

    a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.

2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 86 deg F.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and lists the results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between the area of concern and the reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of the deficient area.

4. Act on inspection results in accordance with the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION 261326

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D Company
2. General Electric by ABB
3. Eaton Cutler Hammer

B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings except for taps.

1. Coil Material: Aluminum or Copper.
2. Internal Coil Connections: Brazed or pressure type.

D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

a. Indoor: UL 50E, Type 2.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

F. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.

B. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

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

3.2 INSTALLATION

A. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

B. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base in accordance with manufacturer's published instructions.

D. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

D. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Assemble and submit test and inspection reports.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals.

Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Disconnecting and overcurrent protective devices.
3. Accessory components and features.

B. Related Requirements
1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Accessories.
4. Other components.
5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. GE by ABB
   2. Square D, Schneider Electric
   3. Eaton Cutler Hammer

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

   1. Main Devices: Panel mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:

   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Section Alignment: Front aligned.

J. Front- and Rear-Accessible Switchboards:

   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel and fixed, individually mounted.
   3. Sections front and rear aligned.

K. Nominal System Voltage: 480Y/277 V.

L. Main-Bus Continuous: 1600 A.

M. Indoor Enclosures: Steel, UL 50E, Type 1.

N. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.

O. Barriers: Between adjacent switchboard sections.

P. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

Q. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.

R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

S. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
2. Phase- and Neutral-Bus Material:

    a. Hard-drawn copper of 98 percent conductivity.

3. Copper feeder circuit-breaker line connections.
4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
5. Ground Bus: Minimum-size required by UL 89, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
7. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

8. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

T. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

B. Fuses are specified in Section 262813 "Fuses."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with NECA 400 and NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.

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

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 400 and NEMA PB 2.1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

    a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to switchboards.
    f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.

    a. Set field-adjustable switches and circuit-breaker trip ranges.

7. Install spare-fuse cabinet.

3.4 CONNECTIONS

A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

B. Support and secure conductors within switchboard in accordance with NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Disconnecting and overcurrent protective devices.

1.2 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. MCCB: Molded-case circuit breaker.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.
5. Disconnecting and overcurrent protective devices.
6. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: UL 50E, Type 1.

2. Height: 7 ft maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Same finish as panels and trim.

G. Incoming Mains:

1. Location: Top or Bottom.
2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

    a. Plating must run entire length of bus.
    b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
7. Do not mount neutral bus in gutter.
8. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

L. Panelboard Short-Circuit Current Rating:

1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by

authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.

a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. GE by ABB
2. Square D, Schneider Electric
3. Eaton Cutler Hammer

B. Listing Criteria: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inch high, provide two latches, keyed alike.

D. Mains: Circuit breaker or main lugs.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens
2. GE by ABB
3. Square D, Schneider Electric

4. Eaton Cutler Hammer

B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or main lugs.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens
2. GE by ABB
3. Square D, Schneider Electric
4. Eaton Cutler Hammer

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407 and NEMA PB 1.1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

    a. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
    b. Attach panelboard to vertical finished or structural surface behind panelboard.
    c. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
4. Mount panelboard cabinet plumb and rigid without distortion of box.
5. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
6. Install overcurrent protective devices and controllers not already factory installed.

    a. Set field-adjustable, circuit-breaker trip ranges.
    b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

7. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
8. Install filler plates in unused spaces.
9. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.
10. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
11. Mount spare fuse cabinet in accessible location.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated**.**

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

END OF SECTION 262416

SECTION 262716 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4. Rack or frame systems.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for equipment labels.

1.2 DEFINITIONS

A. RBB: Rack bonding busbar, located in equipment cabinets and racks.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4. Rack or frame systems.
5. Enclosure-mounted relocatable power taps.

B. Shop Drawings:

1. Shop drawings for custom enclosures and cabinets.
2. Shop drawings for racks or frames.

PART 2 - PRODUCTS

2.1 CABINETS AND CUTOUT BOXES

A. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL CYIV - Indoor Sheet Metal Cabinets:
1. General Characteristics: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Options:

a. Degree of Protection: Type 1

D. UL CYIV - Indoor Sheet Metal Cutout Boxes:
1. General Characteristics: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
2. Options:

a. Degree of Protection: Type 1

E. UL CYIV - Outdoor Sheet Metal Cabinets:
1. General Characteristics: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Options:

a. Degree of Protection: Type 3R

F. UL CYIV - Outdoor Sheet Metal Cutout Boxes :
1. General Characteristics: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
2. Options:

a. Degree of Protection: Type 3R

2.2 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. UL CCN XCKT; including UL 1773.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL XCKT - Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
1. Additional Characteristics: Listed and labeled for installation on line side of service equipment.
2. Options:

a. Indoor Degree of Protection: Type 1
b. Outdoor Degree of Protection: Type 3R

E. UL XCKT - Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
1. Additional Characteristics: Listed and labeled for installation on load side of service equipment.
2. Options:

a. Indoor Degree of Protection: Type 1
b. Outdoor Degree of Protection: Type 3R

2.3 MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. UL CCN XCKT; including UL 1773.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL XCKT - Indoor Sheet Metal Miscellaneous Enclosures:
1. Options:

a. Degree of Protection: Type 1.

D. UL XCKT - Outdoor Sheet Metal Miscellaneous Enclosures:
1. Options:

a. Degree of Protection: Type 3R

2.4 RACK OR FRAME SYSTEMS

A. Description: This category covers rack or frame systems that are not complete but include components and assemblies that are intended to power, protect, heat, cool, or otherwise support electrical or electronic equipment that will be installed at a later time.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. UL CCN NWIN; including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E or UL 2416.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Custom Enclosures and Cabinets: Include plans, elevations, sections, and attachment details.
2. Shop Drawings for Racks or Frames:

    a. Include plans, elevations, sections, details, and attachments to other work.
    b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Include workspace requirements and access for cable connections.
    d. Grounding: Indicate location of RBB and its mounting detail showing standoff insulators and wall-mounting brackets.

3.2 SELECTION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of electrical cabinets and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

    a. Type 3R unless otherwise indicated.

2. Indoors:

    a. Type 1 unless otherwise indicated.

3.3 INSTALLATION ELECTRICAL CABINETS AND ENCLOSURES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Cabinets and Cutout Boxes: Article 312 of NFPA 70.
2. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.

2. Coordinate with Section 078413 "Penetration Firestopping" for installation of sealants.
3. Grounding and Bonding:

    a. Cabinets, Enclosures, and Racks for Electrical Systems: Coordinate with Section 260526 "Grounding and Bonding for Electrical Systems" for grounding of RBBs.
    b. Cabinets, Enclosures, and Racks for Communications Systems and Electronic Safety and Security Systems: Coordinate with Section 270526 "Grounding and Bonding for Communications Systems" for grounding of RBBs.

4. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
5. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard on input feeder.

3.4 CLEANING

A. Remove construction dust and debris from cabinets, enclosures, and racks.

3.5 PROTECTION

A. Protect coatings and finishes of cabinets, enclosures, and racks from damage and deterioration.

END OF SECTION 262716

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches.
2. General-grade duplex straight-blade receptacles.
3. Receptacles with arc-fault and ground-fault protective devices.

1.2 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.3 DEFINITIONS

A. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

B. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Toggle switches.
2. Duplex straight-blade receptacles.
3. Receptacles with GFCI device.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES

A. Toggle Switch:

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

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Leviton Manufacturing Co., Inc.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

4. Options:

a. Device Color: White or as indicated on architectural Drawings.
b. Configuration:
1) General-duty, 120-277 V, 20 A, single pole, double pole, or three way as indicated on drawings.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

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

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Leviton Manufacturing Co., Inc.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: White or as indicated on architectural Drawings.
b. Configuration:

1) General-duty NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

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

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Leviton Manufacturing Co., Inc.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.

4. Options:

a. Device Color: white or as indicated on architectural drawings.
b. Configuration: Heavy-duty, NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using black-on-clear printed adhesive label.

D. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

    a. Mark cover or cover plate using black-on-clear printed adhesive label.

D. Interfaces with Other Work:

1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
2. Coordinate installation of new products with existing conditions.

3.4 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.
b. Panelboards.
c. Switchboards.
d. Enclosed controllers.
e. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
5. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals, include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Bussmann; Eaton, Electrical Sector.
2. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC.
2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC.
3. Type CD: 600-V, 31- to 60-A rating, 200 kAIC.

4. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSES

A. Contractor to turn over spare fuses to FMDC maintenance staff for storage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
1. Feeders: Class RK1, time delay.
2. Motor Branch Circuits: Class RK1, time delay.
3. Large Motor Branch (601-4000 A): Class L, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Molded-case switches.
4. Enclosures.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

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

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. GE by ABB
2. Square D, Schneider Electric
3. Eaton Cutler Hammer

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600 V(ac).
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

2.3 NONFUSIBLE SWITCHES

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

2. GE by ABB
3. Square D, Schneider Electric
4. Eaton Cutler Hammer

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens
2. GE by ABB
3. Square D, Schneider Electric
4. Eaton Cutler Hammer

B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker.

E. MCCBs must be equipped with device for locking in isolated position.

F. Lugs must be suitable for 75 deg C rated wire.

G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

N. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).

O. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.5 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Siemens
2. GE by ABB
3. Square D, Schneider Electric
4. Eaton Cutler Hammer

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs:

a. Mechanical type, suitable for number, size, trip ratings, and conductor material.

b. Lugs must be suitable for 75 deg C rated wire.

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12).

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: Circuit-breaker operating handle must be directly operable through front cover of enclosure (UL 50E Type 1) or directly operable through dead front trim of enclosure (UL 50E Type 3R). Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 3R.

C. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in fusible devices.

3.4 IDENTIFICATION

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

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges to values indicated on Drawings.

3.6 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. DDC: Direct digital control.

C. EMI: Electromagnetic interference.

D. LED: Light-emitting diode.

E. NC: Normally closed.

F. NO: Normally open.

G. OCPD: Overcurrent protective device.

H. PID: Control action, proportional plus integral plus derivative.

I. RFI: Radio-frequency interference.

J. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

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

B. Product Certificates: For each VFC from manufacturer.

C. Source quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1. Include the following:

a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Toshiba Q9
2. Yaskawa Z1000

3. Danfoss FC 102
4. ABB ACH 580

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

C. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

E. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
11. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
12. Speed Regulation: Plus or minus 5 percent.
13. Output Carrier Frequency: Selectable; 0.5 to 12 kHz.
14. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

F. Inverter Logic: Microprocessor based**,** 16 bit, isolated from all power circuits.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 1200 seconds.
4. Deceleration: 0.1 to 1200 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

I. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

K. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Integral Input Disconnecting Means and OCPD: circuit breaker or input fuses with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:
1. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

    a. 0- to 10-V dc.

b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

2. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc, which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

3. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

F. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status,
b. Control: On-off operation,

G. OPTIONAL FEATURES

H. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
1. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R
3. Other Wet or Damp Indoor Locations: Type 4
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2

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

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

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

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Comply with NECA 1.

3.3 IDENTIFICATION

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

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. VFCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable pressure switches.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 262923

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

A. RELATED DOCUMENTS

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

B. SUMMARY

1. Section Includes all LED Interior luminaries.

2. Related Requirements:

   a. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

   b. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

   c. Drawings for Luminaire Schedule.

C. DEFINITIONS

1. CCT: Correlated color temperature.

2. CRI: Color Rendering Index.

3. Fixture: See "Luminaire."

4. IP: International Protection or Ingress Protection Rating.

5. LED: Light-emitting diode.

6. Lumen: Measured output of lamp and luminaire, or both.

7. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

D. ACTION SUBMITTALS

1. Product Data: For each type of product.

   a. Arrange in order of luminaire designation.

   b. Include data on features, accessories, and finishes.

   c. Include physical description and dimensions of luminaires.

   d. Include emergency lighting units, including batteries and chargers.

   e. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

   f. Include sample warranty.

2. Shop Drawings: For nonstandard or custom luminaires.

a. Submit factory drawings with the following additional information included:

i. Plans, elevations, sections, and mounting and attachment details.

ii. Details of luminaire assemblies. Indicate dimensions of fixture including individual lens lengths, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

iii. Diagrams for power, signal, control wiring, and emergency lighting locations.

iv. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

v. Product Certificates: for each type of Luminaire.

vi. Product Test Reports: For each luminaire, for test performed by a qualified testing agency.

vii. Sample warranty.

E. PRODUCT SUBSTITUTIONS

1. Product Substitutions shall be submitted 10 days in advance of bid-day. All products included in bid shall be of equal or better quality to the basis of design.

F. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

a. Provide a list of all Lamps/LED Light Bars & Drivers/Transformers used on Project; use ANSI and manufacturers' codes.

G. MAINTENANCE MATERIAL SUBMITTALS

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

a. Lamps/LED Light Bars: One for every 100 of each type and rating installed. Furnish at least one of each type.

b. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

c. Drivers/Transformers: One for every 100 of each type and rating installed. Furnish at least one of each type.

H. QUALITY ASSURANCE

1. Luminaire Photometric Data Testing Laboratory Qualifications:

a. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

b. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

2. Provide luminaires from a single manufacturer for each luminaire type.

3. Each luminaire type shall be binned within a three-step MacAdam Ellipse or better to ensure color consistency among luminaires.

I. DELIVERY, STORAGE, AND HANDLING

1. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

J. WARRANTY

1. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

2. Warranty Period: From date of Substantial Completion.

a. Manufacturer: Five years minimum, unless otherwise noted.

b. Installer: One year minimum, unless otherwise noted.

PART 2 - PRODUCTS

A. PERFORMANCE REQUIREMENTS

1. Seismic Performance:

a. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

b. Luminaires and lamps shall be labeled vibration and shock resistant.

c. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified.

2. Ambient Temperature: 41 to 104 deg F.

a. Relative Humidity: Zero to 95 percent.

B. LUMINAIRE REQUIREMENTS

1. 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. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal

viewing angles when lamps are in place. Labels shall include but not limited to CCT, CRI and Lumens.

3. CRI of minimum 80. CCT of 3000K (decorative) CCT of 3500K (interior) 4000K (utility).
4. Related minimum luminaire life of 100,000 hrs to L70.
5. Luminaire dimmable from 100 percent to 10 percent of maximum light output unless otherwise specified on Luminaire Schedule.
6. All recessed fixtures less that 3” in diameter have accessibility to driver without reaching into ceiling cavity.
7. Lens:
    a. Acrylic diffusers: 100% virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    b. At least 0.125 inch minimum unless otherwise indicated on Luminaire schedule.
8. Housings: See luminaire schedule for exact requirements.
9. Recessed luminaires shall comply with NEMA LE 4.

C. MATERIALS

1. Metal Parts:
    a. Free of burrs and sharp corners and edges.
    b. Sheet metal components shall be steel unless otherwise indicated.
    c. Form and support to prevent warping and sagging.
2. Steel:
    a. ASTM A36/A36M for carbon structural steel.
    b. ASTM A568/A568M for sheet steel.
3. Stainless Steel:
    a. Manufacturer's standard grade.
    b. Manufacturer's standard type, ASTM A240/240M.
4. Galvanized Steel: ASTM A653/A653M.
5. Aluminum: ASTM B209.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions.
7. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidently during relamping and when secured in operating position

D. METAL FINISHES

1. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. EC shall receive approval from engineer/lighting designer prior to luminaire installation when there is a layout change due to unforeseen conditions.

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

B. TEMPORARY LIGHTING

1. If approved by the Architect, Engineer and Lighting Designer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

C. INSTALLATION

1. Comply with NECA 1.

2. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

3. Install per manufacturer’s installation instructions.

4. Supports:

   a. Sized and rated for luminaire weight.

   b. Able to maintain luminaire position after cleaning and relamping.

   c. Provide support for luminaire without causing deflection of ceiling or wall.

   d. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

5. Flush-Mounted Luminaires:

   a. Secured to outlet box.

   b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.

   c. Trim ring flush with finished surface.

6. Wall-Mounted Luminaires:

   a. Attached to structural members in walls

b. Do not attach luminaires directly to gypsum board.

7. Suspended Luminaires:

a. Ceiling Mount:

i. Aircraft cable size and support locations per manufacturer's requirements. See drawings for exact length.

ii. Aircraft cable supports and quantity per manufacturer's requirements. See drawings for exact length.

iii. Hook mount.

b. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

c. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

d. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod, or wire support for suspension for each unit length of luminaire chassis, including one at each end.

e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure. See seismic detail on drawings.

8. Ceiling-Grid-Mounted Luminaires:

a. Secure to any required outlet box.

b. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

c. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

9. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

D. FIELD QUALITY CONTROL

1. Perform the following tests and inspections:

a. After installing luminaires, lighting controls, and accessories, and after electrical circuitry has been energized, test luminaires with controls to confirm proper operation. Any defective component in the lighting systems shall be replaced and the system reprogrammed if necessary.

b. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

2. Luminaire will be considered defective if it does not pass operation tests and inspections.

E. STARTUP SERVICE

3. Comply with requirements for inspection and testing specified in Section 260923 "Lighting Control Devices"

F. ADJUSTING

1. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

    a. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

    b. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

    c. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency lighting.
2. Exit signs.
3. Materials.
4. Luminaire support components.

1.2 DEFINITIONS

A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.

B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of emergency lighting unit, exit sign, and emergency lighting support.

a. Include data on features, accessories, and finishes.
b. Include physical description of unit and dimensions.
c. Battery and charger for light units.
d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.

B. Shop Drawings:

1. For nonstandard or custom luminaires.

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

1. For emergency lighting units: Use same designations indicated on Drawings.
2. For exit signs: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of luminaire.

B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.

C. Sample Warranty: For manufacturer's warranty.

1.5 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. Luminaire-mounted, emergency battery pack: One for every 50 emergency lighting units. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.6 QUALITY ASSURANCE

A. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty for Batteries for Emergency and Exit Lighting: Manufacturer warrants that batteries for emergency luminaires and exit signs perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. Comply with NFPA 101.

C. Comply with NEMA LE 4 for recessed luminaires.

D. Comply with UL 1598 for fluorescent luminaires.

E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

F. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by emergency power unit manufacturer, whichever is less.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

A. General Characteristics: Self-contained units.

B. Emergency Luminaire See Lighting sheets for fixture locations:
1. Options:

a. Operating at nominal voltage of 277 V(ac).
b. Internal emergency power unit.

c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

2.3 EXIT SIGNS

A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Sign: See Lighting sheets for fixture locations.
1. Options:

a. Operating at nominal voltage of 277 V(ac)
b. Lamps for AC Operation:
1) LEDs; 50,000 hours minimum rated lamp life.

c. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components must be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Conduit: EMT, GRS, minimum metric designator 21 (trade size 3/4).

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

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

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

B. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

C. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls, Attached to a minimum 20-gauge backing plate attached to wall structural members
2. Do not attach luminaires directly to gypsum board.

D. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod, or wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Ceiling Grid Mounted Luminaires:

1. Secure to outlet box, if provided.

2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

C. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass operation tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

3.5 SYSTEM STARTUP

A. Perform startup service:

1. Charge emergency power units minimum of one hour and depress switch to conduct short-duration test.
2. Charge emergency power units minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

3.7 PROTECTION

A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION 265213

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.
3. Selection of signal reference grids.
4. Installation of grounding and bonding for towers and antennas.

B. Related Requirements:

1.2 DEFINITIONS

A. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.

B. RBB: Rack bonding busbar, located in equipment cabinets and racks.

C. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.

D. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.

E. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.

F. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.

G. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. For communications equipment room signal reference grid.
2. Include plans, elevations, sections, details, and attachments to other work.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Record Documentation: Project record documents in accordance with Section 017839 "Project Record Documents" must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of TBC connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF COMMUNICATIONS BUSBARS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. PBB:

1. Dimensions: 1/4 inch thick by 4 inch high.
2. Stand-Off Distance: 2 inch

C. SBB:

1. Dimensions: 1/4 inch thick by 4 inch high
2. Stand-Off Distance: 2 inch

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Communications Busbar Connections:

1. TBC: Not smaller than 1/0 AWG and no smaller than largest TBB.

2. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
5. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
6. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

3.4 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Busbars:

a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 12 inches above finished floor unless otherwise indicated.
b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

2. Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
d. Install without splices.
e. Support conductors at not more than 36 inch intervals.
f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Section 270528 "Pathways for Communications Systems," and bond both ends of raceway to SBB.

3.5 IDENTIFICATION

A. Comply with Section 270553 "Identification for Communications Systems."

B. Labels must be preprinted or computer-printed type.

1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

    a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

        1) If measured resistance from electrical service equipment to ground exceeds 5 Ω, notify Architect and include recommendations to reduce resistance to ground.

    b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

    a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB. Maximum acceptable AC current level is 1 A.

B. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

3.7 PROTECTION

A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Optical-fiber-cable pathways and fittings.
3. Metallic surface pathways.
4. Hooks.
5. Boxes, enclosures, and cabinets.

1.3 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Boxes, enclosures, and cabinets.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

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

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

E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum, riser or general**-use** installation unless otherwise indicated.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

2.3 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Finish: Manufacturer's standard enamel finish in color selected by Architect.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.4 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized steel.

E. Description: Enclosures for communications.

F. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep

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

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

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

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

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.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

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

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. >.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway, EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway, Plenum-type, communications-cable pathway, EMT.
9. Boxes and Enclosures: NEMA 250, Type 1

B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use set-screw or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.

3. TIA-569-D.
4. NECA 101

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

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

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

J. Support conduit within 12 inches of enclosures to which attached.

K. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

N. 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.

O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

Q. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

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

S. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

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

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

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

W. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

Y. Set metal floor boxes level and flush with finished floor surface.

3.3 FIRESTOPPING

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

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 270548 "Seismic Controls for Communications Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Anchors.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer**.** For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Equipment supports.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified."

1.6 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel
3. Channel Width: Selected for applicable load criteria
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

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

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

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. 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.

2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

1.7 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 2 - EXECUTION

2.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

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

2.2 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.

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

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
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.

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

2.3 INSTALLATION OF FABRICATED METAL SUPPORTS

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

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

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

END OF SECTION 270529

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Wall Sleeves, Cast Iron:

1. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Description:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.
2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches thickness must be 0.138 inch.

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT

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

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.6 FOAM SEALANTS

A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

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

A. Comply with NECA 1.

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

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

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor, so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.

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

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

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

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

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

END OF SECTION 270544

ECTION 270548 - VIBRATION AND SEISMIC CONTROLS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-installed concrete anchors.
6. Concrete inserts.

B. Related Requirements:

1. Section 270529 "Hangers and Supports for Communications Systems" for commonly used communications system supports and installation requirements.

1.3 DEFINITIONS

A. Designated Seismic System: A communications system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load capacity for each seismic-restraint device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic restraint component used.
3. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal for Each Seismic-Restraint Device:

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
c. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
d. Qualified Professional Engineer: All designated design submittals for seismic calculations are to be signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for communications components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7**,** Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active communications seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

1.6 QUALITY ASSURANCE

A. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic control system.

1. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7 or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.

a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.

C. Consequential Damage: Provide additional seismic restraints for suspended communications components or anchorage of floor-, roof-, or wall-mounted communications components as indicated in ASCE/SEI 7 so that failure of a non-essential or essential communications component will not cause failure of any other essential architectural, mechanical, or communications building component.

D. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7.

2.2 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINTS - CABLE TYPE

A. Seismic Restraint Cables: ASTM A1023 galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.4 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors which have been prequalified for use in seismic applications. Post-installed concrete anchors must conform to all requirements of ASCE/SEI 7 Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.6 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC RESTRAINT DEVICES

A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Communications Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install all equipment and devices to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
3. Comply with requirements in NFPA 70 and ASCE/SEI 7.

F. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Install cables so they do not bend across edges of adjacent equipment or building structure.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling.

Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION 270548

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Signs.
   2. Bands and tubes.
   3. Cable ties.
   4. Miscellaneous identification products.
   5. Labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Identification Schedule:

   1. Outlets: Scaled drawings indicating location and proposed designation.
   2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
   3. Racks: Scaled drawings indicating location and proposed designation.
   4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

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

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

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, polyester or vinyl flexible labels with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels:
a. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

2.5 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:
1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch) thick.
c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

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

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

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

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

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Snap-Around Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

K. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:

a. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:

1. Wiring closet designation.
2. Colon.
3. Faceplate number.

E. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels.

2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels.
3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:

    a. Room number being served.
    b. Colon.
    c. Faceplate number.

F. Backbone Cables: Label each cable with a vinyl-wraparound label, snap-around label, or self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a vinyl-wraparound label, snap-around label, or self-adhesive wraparound label indicating the following, in the order listed:

1. Room number.
2. Colon.
3. Faceplate number.

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.

1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label, Baked-enamel signs, Metal-backed butyrate signs, or Laminated-acrylic or melamine-plastic sign.
2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign
3. Equipment to Be Labeled:

    a. Communications cabinets.
    b. Uninterruptible power supplies.
    c. Computer room air conditioners.
    d. Fire-alarm and suppression equipment.
    e. Egress points.
    f. Power distribution components.

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Boxes, enclosures, and cabinets.
3. Power strips.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
3. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
4. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

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

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

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

E. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

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

G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

2.4 POWER STRIPS

A. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.2 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 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. Power strips.
3. Grounding.
4. Labeling.

B. Related Requirements:

1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
3. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
4. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Technician.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Technician to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

B. UL listed.

C. RoHS compliant.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.3 19-INCH EQUIPMENT RACKS

A. Description: Two and four post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Floor-Mounted Racks:

1. Overall Height: 72 inches.
2. Overall Depth: 23 inches.
3. Upright Depth: 3 inches.
4. Two-Post Load Rating: 200 lb
5. Number of Rack Units per Rack: 38.
6. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
7. Base shall have a minimum of four mounting holes for permanent attachment to floor.
8. Top shall have provisions for attaching to cable tray or ceiling.
9. Self-leveling.

D. Cable Management:

1. Metal, with integral wire retaining fingers.

2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Rocker-type on-off switch, illuminated when in on position.

2.5 GROUNDING

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

2.6 LABELING

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Labels shall be machine printed. Type shall be 1/8 inch in height.

END OF SECTION 271116

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type OFNR optical fiber cable.
2. Type OFCR optical fiber cable.
3. Type OFNP optical fiber cable.
4. Type OFCP optical fiber cable.
5. Optical fiber cable connecting hardware, patch panels, and cross-connects.

1.2 DEFINITIONS

A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.

D. Type OFCR: Conductive cable for use as riser in vertical shafts or from floor to floor.

E. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

F. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.

G. Types OFC and OFCG: Conductive cable for general purpose use.

H. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 COORDINATION

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

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates:

1. For each type of product.

D. Field Quality-Control Submittals:

1. Optical fiber cable testing plan.
2. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Submittals:

1. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors.

B. Maintenance Contracts:

1. Software service agreement.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining

ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNR OPTICAL FIBER CABLE

A. Description: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNR, Designation OM4, Multimode Optical Fiber Cable
1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

a. Configuration: 12 fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: **3**.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
c. Jacket Color: Aqua.

2.2 TYPE OFCR OPTICAL FIBER CABLE

A. Description: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFCR, Designation OM4, Multimode Optical Fiber Cable Retain "Source Limitations" Subparagraph below to limit sources for this product type.
1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

a. Configuration: 12 fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: **3**.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
c. Jacket Color: Aqua.
d. Armor: Steel.

2.3 TYPE OFNP OPTICAL FIBER CABLE

A. Description: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

    a. Performance: TIA-568.3.
    b. Inside Plant Mechanical Properties: ICEA S-83-596.
    c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
    d. Jacket:

        1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
        2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNP, Designation OM4, Multimode Optical Fiber Cable:
1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

    a. Configuration: 12 fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
    c. Jacket Color: Aqua.

2.4 TYPE OFCP OPTICAL FIBER CABLE

A. Description: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

    a. Performance: TIA-568.3.
    b. Inside Plant Mechanical Properties: ICEA S-83-596.
    c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
    d. Jacket:

        1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
        2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFCP, Designation OM4, Multimode Optical Fiber Cable:
1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

    a. Configuration: 12 fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
    c. Jacket Color: Aqua.
    d. Armor: Steel.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

D. Connector Type: Type LC complying with TIA-604-10 connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.

2.6 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

C. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. Type OFNR or Type OFNP.

2. Conductive:

a. Type OFCR or Type OFCP.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNP.
b. Type OFNR or Type OFNP in metallic conduit.

2. Conductive:

a. Type OFCP.
b. Type OFCR or Type OFCP in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNR or Type OFNP in metallic conduit.
2. Conductive: Type OFCR or Type OFCP in metallic conduit.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:
1. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

a. Install plenum cable in environmental airspaces, including plenum ceilings.
b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

2. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10 ft long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets,

backbone pathways and cables**,** terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

E. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

C. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

D. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Category 6 twisted pair cable.
   2. Twisted pair cable hardware, including plugs and jacks.
   3. Multiuser telecommunications outlet assembly.
   4. Cable management system.
   5. Cabling identification products.
   6. Grounding provisions for twisted pair cable.
   7. Source quality control requirements for twisted pair cable.

B. Related Requirements:

   1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

    a. Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Telecommunications conductor drop locations.
    f. Typical telecommunications details.
    g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

1.5 CLOSEOUT SUBMITTALS

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

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. Connecting Blocks: One of each type.
2. Cover Plates: One of each type.
3. Jacks: Ten of each type.
4. Multiuser Telecommunications Outlet Assemblies: One of each type.
5. Patch-Panel Units: One of each type.
6. Plugs: Ten of each type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:
a. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Homaco
2. Panduit
3. Hoffman

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

D. Connecting Blocks:
1. 110-style IDC for Category 6.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated

F. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

G. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.

H. Jacks and Jack Assemblies:

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

I. Cover Plate:

1. Four port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533 "Raceway and Boxes for Electrical Systems."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

J. Legend:

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

2.5 CABLE MANAGEMENT SYSTEM

A. Description: Computer-based cable management system, with integrated database capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.

2.6 IDENTIFICATION PRODUCTS

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

2.7 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

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

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.

5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

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

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
   1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet
   4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.

   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. Collect, assemble, and submit test and inspection reports.

END OF SECTION 271513

SECTION 27 41 00 AUDIO-VIDEO SYSTEMS

SECTION 274100 – AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

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 project is for the renovation of the Jefferson State Office Building. The design, defined by the Project Documents, provides for the installation, programming and testing, and owner training of the Audio-Visual Systems for the Board Room and Multi-Purpose Room.

Retain definition(s) remaining after this Section has been edited.

A. RGB: Red, Green, Blue

B. RGBS: Red, Green, Blue, Sync

C. RGBHV: Red, Green, Blue, Horizontal Sync, Vertical Sync

D. Y-C: Chrominance, Luminance

E. S-Video: Chrominance, Luminance

F. DVI = Digital Video Interface

G. HDMI = High Definition Media Interface

H. SDI = Serial Digital Interface

I. HDSDI = High Definition Serial Digital Interface

1.3 SYSTEM DESCRIPTIONS

A. Board Room and Multi-Purpose (dividable spaces

1. Loudspeakers and Audio Monitors

The sound reinforcement system for the spaces shall produce high-quality sound for speech for the entire seating area. The speakers will consist of both existing and new ceiling units. AV contractor shall install and test both new and existing speakers for proper operation.

2. Connectivity

Connectivity plates shall be distributed throughout the Board Room and Multi-Purpose spaces. Board Room floor boxes shall include power and telecommunications (by EC), along with feed-through sections for owner provided table-top microphones. HDMI and connections for keyboard and mouse also provided at presenter's location of Board Room table

Additional connections provided throughout Multi-Purpose space for "AV Data'. AV data connections shall be shielded, category 6A lines from floor boxes and wall plates to patch panel located inside AV rack, allowing the owner to patch AV signals to portable monitors on carts, along with any future requirements. Connection plate at presenter's location in Multi-Purpose room shall also have connections for HDMI, keyboard/mouse for rack mounted PC, and USB-C for additional presenter's AV source.

Wireless collaboration and presentation unit shall be provided and programmed to allow content to be presented (without cables) from computers and mobile devices over the network and shall

include additional features such as multi-participant content sharing. AV contractor shall include assist owner with installing application for wireless presentation system.

3. Audio Processing and Distribution

A flexible audio signal processor shall be provided with acoustic echo cancellation (AEC) and Dante network audio integrated into the processor and shall be programmed for loudspeaker management and signal processing requirements including crossovers, equalizers, compressor-limiting circuits to protect loudspeakers, signal routing and distribution, and integration with AV control processor. Dante integration shall allow the system to send and receive digital audio over the network and allow for easy expansion of additional inputs and outputs as required for future additions. Audio processor shall also include the ability to integrate with camera tracking system.

4. Microphones

Sixteen (16) existing wired microphones shall be reinstalled on the Board Room table and tested by AV contractor for proper operation. Four (4) wireless microphone systems including two (2) lapel/beltpack transmitters and two (2) handheld transmitters for presentations and conferencing events. Microphones shall be voiced to maximize performance and rang for feedback to improve stability and maximize gain. Ceiling array microphones included for conferencing and/or recording, as well as integration into camera tracking system. Dedicated AEC channel shall be provided for each microphone coverage lobe.

5. Video Displays, Transmission, and Switching

HDMI video encoders and decoders provided to allow for seamless, full matrix switching of AV inputs to fixed and portable monitor locations with HDMI decoders. HDMI matrix switcher provided that shall support AV inputs from HDMI and USB-C connections. Switched camera and mixed audio signals shall be input into switcher for far-side participants from USB-A connections via USB-C connection to presenting computer. Presets shall be provided to allow several room

configurations for portable carts with video decoders. Refer to “Touch Panel and AV Control System Programming” for configurations required.

6. Tracking Cameras for Presenter and Conferencing Participants

Auto-tracking camera with pan-tilt-zoom capability furnished and installed to capture presenter within pre-defined “presenter’s zone”. Additionally, two pairs of tracking cameras provided to capture conferencing participants. Camera system shall include the ability to cleanly cut to a person speaking without having to view camera movement or zoom. Camera system shall be integrated with audio processor and system microphones to identify conference participant locations. Note that only select audio processor and microphone systems capable of integrating with camera switching system.

In addition to auto-tracking, AV integrator shall program system to allow the end users to have a “manual” mode with several presets for all cameras.

7. Hearing Assistance System

Hearing assistance system included to meet federal ADA requirements. System shall include RF transmitter and antenna for broadcasting to receiver beltpacks. System shall also include a two-channel Wi-Fi server with Ethernet connection that routes hearing assistance signals over the owner’s WiFi network to personal devices that have free app installed. Ear speakers, inductive neck loops, charging stations, venue awareness and signage kits also provided with system.

8. AV System Integration

Upon initiation of the fire alarm voice EVAC system, the Auditorium sound system shall mute upon receiving control contacts from the fire alarm system. Fire alarm contractor shall furnish and install fire alarm control module and terminate output control signal on fire alarm system module. AV contractor shall install control cabling from AV rack to fire alarm control module and terminate

control conductors on AV/control processor, and coordinate testing the system with fire alarm contractor

9. Touch Panel and AV Control System Programming

AV system shall be programmed to include all functions listed above, along with the additional capabilities described below. Touch screen sheet layouts shall be submitted prior to or along with AV system shop drawings.

System power on/off that includes (rack-mounted) audio amplifiers and fixed video monitors. Note that video encoders/decoders, audio/video processing and distribution equipment, Ethernet switches, wireless microphone receivers and charging stations, AV control processors and ancillary control devices, control/touch panels, and assistive listening system transmitters/base station shall be unswitched and left on.

Camera control including “automatic” mode where cameras track when activated by person entering specific areas or speaking, along with “manual” mode with pan-tilt-zoom controls and several basic presets that can be modified and saved by system end users.

Video source selection and matrix switching for all system inputs and outputs. Video endpoints include all fixed and portable monitors with decoders. Input sources available shall include all HDMI, USB-C and wireless presentation system.

Room configuration presets shall be included on the touch screens with the functionality described below.

“Board Meeting Open”

Audio from AV inputs in Board Room floor box and system microphones broadcast to all system loudspeakers. (Room dividers all open.) Slight delay shall be added to Multi-Purpose speaker

circuits to pull image towards Board Room table microphones. AV inputs from Multi-Purpose room do not show up on touchscreen/not routed.

Camera systems shall not be used/disabled.

AV input sources selected shall route to all fixed (Board room table) monitors, along with select number of portable monitors with decoders. AV contractor shall field coordinate the exact number of portable monitors used for configuration.

Table microphones, along with wireless microphones capable of being routed to far-end via Zoom conference.

AV contractor shall coordinate with owner to integrate Zoom conferencing. Room PC shall host call and gather system peripherals including switched camera feed and system microphones and send to far-end participants.

Local HDMI input, along with wireless presentation sources available for basic presentations, but not included for integration into Zoom conference call.

“Multi-Purpose Open”

Board Room speakers and inputs not used or routed.

Audio from AV inputs in Multi-Purpose room and system microphones broadcast to all system loudspeakers except in the Board Room. Note that ceiling array microphones shall not be used for sound reinforcement and are only for the far-end during conference calls and for camera auto-tracking. Wireless microphones shall broadcast to local speakers, and to the far-end of conference call.

Camera systems programmed to auto-track presenter and conference participants, with the inclusion of manual mode as described above.

AV contractor shall coordinate with owner to integrate Zoom conferencing. Room PC shall host call (via USB extender)and gather system peripherals including switched camera feed and system microphones and send to far-end participants. Local data jack for output of portable USB-C

extender also included to allow guest computer to host Zoom call, including using system peripherals.

Local HDMI input, along with wireless presentation sources available for basic presentations, but not included for integration into Zoom conference call.

Video input source selected shall route to number of portable monitors with decoders. AV contractor shall field coordinate the exact number of portable monitors used for configuration.

“Multi-Purpose Closed”

System shall function identical to “Open” mode above except for muting loudspeakers in the western 102 section and disabling rear pair of cameras.

10. System Commissioning

AV contractor shall include time to support remote commissioning services provided by camera/camera switcher manufacturer (Crestron part # IV-PROSERVICE-1).

Retain first paragraph below if Contractor is required to assume responsibility for design.

1.4 SUBMITTALS

Submittals in first two paragraphs below are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."

A. Prior to shop drawing submittal, contractor will submit touch screen sheet layouts to the owner for review. Programming allowance shall be made to modify touch screen pages without additional compensation.

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

C. Shop Drawings: Shop drawings and submittal data shall contain sufficient information to describe the work to be performed. Prepare drawings at an appropriate scale and submit the required number of copies (see Division 1) of the submittal package neatly bound in sets. The required information shall include but not be limited to:

1. Detail equipment assemblies and indicate dimensions, weights, required clearances.

2. Written verification of the Audio-Visual Contractor’s qualifications as required in this section.

3. Wiring diagrams for each system including wire types.

4. Rack drawings showing proposed rack layout.

5. Speaker mounting details. (Note: It is the responsibility of the Audio-Visual Contractor to assure the structural integrity of the speaker hanging method and hardware only.)

6. All rough-in information including junction and back boxes.

7. Layout of all custom plates outlet plates/panels.

8. A material list of all equipment to be furnished.

9. Manufacturers specification sheets of all equipment to be provided. (bound in a neat and orderly fashion with an index listing the manufacturer's specification sheets in specification order).

Cabling diagram showing cable routing. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."

Retain first paragraph below if Drawings do not include detailed plans or if Project involves unusual coordination requirements.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special

moldings are shown and coordinated with each other, using input from installers of the items involved.

Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

E. Operation and Maintenance Data

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The Audio-Visual Systems Contractor shall be a contractor who has been continuously engaged in furnishing and installing commercial audio and video systems of the type specified for at least five (5) years.

B. The Audio-Visual Systems Contractor shall maintain a suitably staffed and equipped service organization and shall regularly offer maintenance services for systems of this type and size.

C. The Audio-Visual Systems Contractor shall be an authorized dealer of all equipment provided with this system. Given the inherent warrantee difficulties which occur when products are provided from contractors who participate in trans-shipping or two-stepped equipment sales, this dealership requirement will be strictly adhered to. At the owner's request, any contractor responding to this bid proposal must provide proof of dealership status for all listed system components or approved alternates. Failure to comply with this request will be grounds for bid rejection.

D. At the request of the Owner, Architect or Engineer, an inspection of the Audio-Visual Systems Contractor's place of business shall be scheduled to demonstrate that the contractor possesses adequate plant and equipment to complete the work properly and in a timely manner, adequate staff with sufficient technical experience, and suitable financial status to meet the obligations of the contract.

E. The Audio-Visual Systems Contractor shall supply technicians who have received training from a nationally recognized training organization in the last 5 years on "speaker rigging methods" and "rigging safety".

F. An Electrical Contractor who does not meet the requirements listed above who intends to bid on this work shall be required to employ the services of a qualified Audio-Visual Systems Sub-Contractor. The Audio-Visual Systems Contractor must be named in the shop drawing submittal

information along with written documentation verifying that the sub-contractor fulfills all requirements listed in 119690.

Select appropriate "Level" option from first subparagraph below, or insert other qualification requirements. NICET-technician certification requires testing (written and multiple choice) and documentation, including work history, recommendations, and, for most programs, a supervisor's verification of specific experience. Continuing education is required for renewal, which occurs at three-year intervals. The highest level obtainable is Level IV; currently, exams through Level III are available. For details related to educational and experiential requirements for the different levels, see http://nicet.org/certification/audio.cfm. Retain one of two subparagraphs below.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Refer to the Audio-Visual Drawings for all required equipment.

See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain paragraph and list of manufacturers below. See Division 01 Section "Product Requirements."

PART 3 - EXECUTION

3.1 WIRING METHODS

Retain one of first two paragraphs below and coordinate with Drawings. Delete both if wiring methods for system are indicated on Drawings. Coordinate selection with "Raceways" Article.

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board

partitions where unenclosed wiring method may be used]. Conceal raceway and cables except in unfinished spaces.

Retain first subparagraph below if retaining option in paragraph above.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements: All work shall be performed under the supervision of a Audio-Visual equipment supplier accredited by the factory of the system

manufacturer. Satisfactory performance of the equipment shall be the responsibility of the equipment supplier. The final connections and shall be by the Audio-Visual Systems Contractor.

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

6. Precautions shall be taken to prevent electromagnetic and electrostatic hum pickup in the system wiring. For line level audio signals, float cable shields at the output of the source device.

Shields not connected are to be folded back over the cable jacket and covered with heat shrink tubing for future use. Do not cut off unused shields.

7. Furnish and install minimum (1) one cable penetration EZDP33FWS, as manufactured by Specified Technologies, Inc. or equivalent, through fire rated partitions and floors, as indicated on the drawings.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in equipment room spaces with terminating hardware and interconnection equipment.

2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker level, line-level, microphone-level, control, video and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate parallel audio-visual system conductors from power runs by at least 12 inches. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Bridged connections should be applied at microphone and line-level signal interfaces to maximize voltage transfer.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place, with extra safety cable used where possible. Design equipment supports with a minimum safety factor of five for any overhead loudspeakers. Provide speaker

mounting hardware with ±5° adjustability from the specified aiming angle and perform such adjustments upon request without claim for additional payment.

D. Metallic speaker back boxes will be required on all ceiling or wall mount flush speakers.

E. Each cable shall be properly identified at each end using suitable wrap-around or other permanent labeling method. All cable numbers shall be marked on the record drawings for future reference.

F. Equipment Cabinets and Racks:

1. Group items of same function together and arrange controls symmetrically.

2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.

3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

4. Provide engraved lamacoid or adhesive backed laminated labels on the front and rear of all active equipment mounted in the racks. Hand-written or embossed "ROTEX" or "DYMO" type

labels shall not be accepted. Mark controls for easy operation by an operator unfamiliar with the system.

G. Limiter/Compressor: Program digital signal processors serving each speaker output with a limiter/compressor to avoid damage to speakers from system overloads.

H. Wall-Mounted Outlets: Flush mounted.

I. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

J. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Terminate equipment racks and other audio-visual equipment with properly grounded receptacles (no isolated grounds).

Retain paragraph below for special applications only.

3.6 FIELD QUALITY CONTROL

Retain one of first three paragraphs below to identify who shall perform tests and inspections. If retaining second option in first paragraph, or if retaining second or third paragraph, retain "Field quality-control reports" Paragraph in "Submittals" Article.

Retain first paragraph below to require Contractor to perform tests and inspections.

Retain first paragraph below to describe tests and inspections to be performed.

A. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.

2. After installing the Audio-Visual systems, test for compliance with requirements.

3. Operational Test: Perform tests that include originating program at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

4. Acoustic Coverage Test: Measure system response to ensure variation of sound pressure levels in audience areas is plus or minus 2 dB.

B. Inspection: Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified

3.7 DEMONSTRATION

A. Owner's operating personnel in the proper set up, operating and maintenance procedures, installed under this contract, and shall include at least three (3) service calls of 4 hours minimum during the warranty period for service or instructions as required by the Owner, at a time mutually agreeable to the Owner and Contractor.

B. Provide minimum of two four-hour training sessions for system operation of the Board Room/Multi-Purpose Audio-Visual system.

END OF SECTION

SECTION 281400 - ACCESS CONTROL SYSTEM HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control system units.
2. Access control system power supplies and battery chargers.
3. Access control system supplementary computer equipment.

B. Related Requirements:

1. Section 281500 "Integrated Access Control Hardware Devices" for access control field devices controlled by hardware specified in this Section.

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. LAN: Local area network.

C. RAID: Redundant array of inexpensive disks; redundant array of independent disks.

D. RAM: Random-access memory.

E. WAN: Wide area network.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For access control system hardware. Conduct meeting(s) at Project site.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, Owner's security representatives, and administrants for field tests and inspections. Notify Owner of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Access control system units.
2. Access control system power supplies and battery chargers.
3. Access control system supplementary computer equipment.

B. Shop Drawings:

1. Project general notes.
2. Hardware and equipment locations.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. Hardware and equipment installation details.
6. Secondary power calculations.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installation instructions for access control system servers.
2. Installation instructions for access control system DGPs.
3. Installation instructions for access control system input/output interface.
4. Installation instructions for access control system door controllers.
5. Installation instructions for access control system workstation.
6. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
7. Installation instructions for access control system power supplies and battery chargers.
8. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
9. Installation instructions for access control system printers.
10. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SYSTEM UNITS

A. Description: This category covers head end units for access control systems, providing a means of regulating or controlling physical entry into an area, or access to or use of device by electrical, electronic, and/or mechanical means. Access control systems are investigated as complete configuration based upon manufacturer's specified system components. Access control systems are intended to comply with applicable life safety access and egress requirements.

B. Performance Criteria:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
    b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Network Controller

1. Johnson Controls CK721-A Network Controller

2. Source Limitations: Obtain products from single manufacturer.

3. Options:

    a. Input Voltage: 24V
    b. Operating Temperature: 32 to 120 deg F.
    c. Materials: ABS-polycarbonate
    d. Battery Backup: 24 V .

D. Access Control System Door Interface:

1. Johnson Controls RDR2SA 2 Door Interface

2. Johnson Controls RDR8S 8 Door Interface

3. Source Limitations: Obtain products from single manufacturer.
4. Additional Characteristics:

    a. Data ports for connection to LAN and downstream controllers.
    b. Integral terminal blocks for connection of inputs/outputs to field devices.
    c. Controller Inputs:

        1) Request to exit devices.
        2) Door contact.
        3) readers.

    d. Controller Outputs:
        1) Door strike.
        2) Shunt Alarm.

5. Options:

    a. Input Voltage 24 V(dc).
    b. Operating Temperature: 32 to 158 deg F.
    c. Controller Communication: TIA-485
    d. Mounting: surface, DIN rail, or enclosure

2.2 ACCESS CONTROL SYSTEM POWER SUPPLIES AND BATTERY CHARGERS

A. Description: This category covers power supplies and battery chargers for access control system units, controllers, input/output interfaces, workstations, printers, and encoders.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Power Supply and Battery Charger:

1. Johnson Controls

2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. Input Voltage: 120 V(ac).
b. Output Voltage: 12 to 24 V(dc).
c. Operating Temperature: 32 to 120 deg F
d. Network connection for remote supervision, management, and testing.
e. Enclosure lock with tamper switch and monitoring.

4. Accessories:

a. DIN rails for mounting.

2.3 INSTALLATION OF ACCESS CONTROL SYSTEM HARDWARE

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Installation of Access Control System Hardware and Wiring: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with requirements in guide information for UL CCN ALVY.
2. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:

1. Coordinate installation of new products for access control system hardware with existing conditions.

2. Coordinate with Section 281000 "Access Control" for physical and functional interfaces with access control system and for compliance with system-wide performance requirements.
3. Coordinate with Section 284621.11 "Addressable Fire-Alarm Systems" for interfacing security system inputs/outputs with fire-alarm system inputs/outputs.

2.4 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM HARDWARE

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

B. Nonconforming Work:

1. Hardware and components will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

2.5 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

2.6 ADJUSTING

A. Adjust printers and ribbons to function smoothly and lubricate as recommended in writing by manufacturer.

2.7 PROTECTION

A. After installation, protect access control system hardware from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 281400

SECTION 281500 - INTEGRATED ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Integrated credential readers and entry management.
2. Access control credentials.
3. Electrified locking devices and accessories.
4. Egress management devices.
5. Access control remote devices.
6. Electronic key management systems.

B. Related Requirements:

1. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 280010 "Supplemental Requirements for Electronic Safety and Security" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. NFC: Near Field Communications.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting(s): For integrated access control hardware devices. Conduct meeting(s) at Project site.

1. Attendees: Installers, fabricators, representatives of manufacturers, representatives from telecommunications, Owner's security representatives, and administrants for field tests and inspections. Notify Owner of scheduled meeting dates.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Integrated Credential Readers and Entry Management:

a. Credential readers.

b. Keypads.
c. Combination reader devices.

2. Access Control Credentials:

a. Access control cards.

3. Electrified Locking Devices and Accessories:

a. Electrically controlled single-point locks and latches.
b. Electrically controlled two- and three-point locks and latches.
c. High-security electronic locks.
d. Status monitoring and egress devices.

4. Egress Management Devices:

a. Panic hardware with special locking arrangement.
b. Fire-exit hardware with special locking arrangement.

5. Access Control Remote Devices:

a. NFC access control devices.

6. Electronic Key Management Systems:

a. Electronic key management system units.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
3. Printing, programming, and handling instructions for access control credentials.
4. Installation instructions for electrified locking devices and accessories.

5. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
6. Installation instructions for egress management devices.
7. Manufacturer's recommended tests and inspections for egress management devices.
8. Installation instructions for access control remote devices.
9. Manufacturer's recommended tests and inspections for access control remote devices.
10. Installation instructions for electronic key management systems.
11. Manufacturer's recommended tests and inspections for electronic key management systems.

B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreements.

B. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Include the following:

1. Integrated Credential Readers and Entry Management Devices: One of each type.
2. Electrified Locking Devices and Accessories: One of each type.

PART 2 - PRODUCTS

2.1 INTEGRATED CREDENTIAL READERS AND ENTRY MANAGEMENT

A. Swipe Card Reader :

1. HID RP40
2. Source Limitations: Obtain products from single manufacturer.
3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) UL CCN ALVY; including UL 294.
2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

c. General Characteristics: Visual LED indication of card read.

2.2 ACCESS CONTROL CREDENTIALS

A. Access Control Cards
1. Performance Criteria:

a. Reference Standards:
1) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
2) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
3) Material Durability: INCITS 322.

b. Format: Customizable, including artwork.

2.3 ELECTRIFIED LOCKING DEVICES AND ACCESSORIES

A. Electrically Controlled Single-Point Latch:

1. SDC Security CS321413

2. Source Limitations: Obtain products from single manufacturer.
3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria:

1) Special Locking Arrangements: UL CCN FWAX; including UL 294, NFPA 101, and ICC IBC.
2) Electrically Controlled Single-Point Locks and Latches: UL CCN GYQS, UL 10B, and UL 10C; designed to be used with Class 2 control-voltage circuits in accordance with Article 725 of NFPA 70.

4. Options:

a. Audible indication of door unlock.
b. Input Power: 12 V(ac/dc) or 24 V(ac/dc).
c. Operating Temperature: Minus 31 to plus 151 deg F.
d. Connectivity: Hardwired.
e. Failure Mode: Fail-safe.
f. Mechanical key override.
g. Latch bolt monitor.

B. Request-to-Exit (REX) Motion Sensor:

1. SDC Security 474U
2. Source Limitations: Obtain products from single manufacturer.
3. Performance Criteria:

a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Listing Criteria: UL CCN ALVY; including UL 294.

4. Options:

a. Input Power: 12-24 V(ac/dc).
b. Operating Temperature: Minus 13 to plus 140 deg F.
c. Sensing Technology: Active infrared (AIR).
d. Color: Black.
e. Mounting: Wall recessed.

PART 3 - EXECUTION

3.1 DEPLOYMENT OF CREDENTIALS

A. Comply with manufacturer's published instructions.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: 6 Conductor 18AWG

C. Interfaces with Other Work:

1. Coordinate installation of new products for access control hardware devices with existing conditions.

2. Coordinate access control credentials with integrated credential readers and access control system architecture.
3. Egress Management Interfaces:
a. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" for monitoring of egress management device alarms by BMS.
b. Coordinate with Section 284621.11 "Addressable Fire-Alarm Systems" for monitoring of egress management device alarms by fire-alarm system.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.4 PROTECTION

A. After installation, protect integrated access control hardware devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for two years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within two years from date of Substantial Completion.

a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 281500

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Addressable fire-alarm system.
2. Fire-alarm control unit (FACU).
3. Manual fire-alarm boxes.
4. System smoke detectors.
5. Duct smoke detectors.
6. Heat detectors.
7. Fire-alarm notification appliances.
8. Firefighters' smoke-control system.
9. Fire-alarm graphic annunciators.
10. Fire-alarm remote annunciators.
11. Fire-alarm addressable interface devices.
12. Digital alarm communicator transmitters (DACTs).
13. Fire-alarm radio transmitters.

B. Related Requirements:

1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. DACT: Digital alarm communicator transmitter.

B. EMT: Electrical metallic tubing.

C. FACU: Fire-alarm control unit.

D. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

E. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).

F. NICET: National Institute for Certification in Engineering Technologies.

G. PC: Personal computer.

H. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When 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 building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.5 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. 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.

C. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, and details, including details of attachments to other Work.
3. 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.
4. Annunciator panel details as required by authorities having jurisdiction.
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 written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section 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. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring and equipment required for HVAC unit shutdown on alarm system.
    c. Locate detectors in accordance with manufacturer's written instructions.

14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.6 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:

    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

B. Field quality-control reports.

C. Qualification Statements: For Installer.

D. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.7 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:

a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" in accordance with "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.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

1.8 FIELD CONDITIONS

A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.

1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event."

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:

1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice-and-strobe notification for evacuation.

B. Performance Criteria:

1. Regulatory Requirements:

a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

2. General Characteristics:

a. Automatic sensitivity control of certain smoke detectors.
b. Fire-alarm signal initiation must be by one or more of the following devices:

1) Manual stations.
2) Heat detectors.
3) Smoke detectors.
4) Duct smoke detectors.
5) Automatic sprinkler system water flow.
6) Fire-extinguishing system operation.
7) Fire standpipe system.
8) Fire pump running.

c. Fire-alarm signal must initiate the following actions:

1) Continuously operate alarm notification appliances, including voice evacuation notices.
2) Identify alarm and specific initiating device at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
3) Transmit alarm signal to remote alarm receiving station.
4) Unlock electric door locks in designated egress paths.
5) Release fire and smoke doors held open by magnetic door holders.
6) Activate voice/alarm communication system.
7) Switch HVAC equipment controls to fire-alarm mode.
8) Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9) Activate stairwell and elevator-shaft pressurization systems.
10) Close smoke dampers in air ducts of designated air-conditioning duct systems.
11) Recall elevators to primary or alternate recall floors.
12) Activate elevator power shunt trip.

13) Activate emergency lighting control.
14) Record events in system memory.
15) Record events by system printer.
16) Indicate device in alarm on graphic annunciator.

d. Supervisory signal initiation must be by one or more of the following devices and actions:

1) Valve supervisory switch.
2) Elevator shunt-trip supervision.
3) Independent fire-detection and -suppression systems.
4) Fire pump is running.
5) Fire pump has lost power.
6) Power to fire pump has phase reversal.
7) Zones or individual devices have been disabled.
8) FACU has lost communication with network.

e. System trouble signal initiation must 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 addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4) Loss of primary power at FACU.
5) Ground or single break in internal circuits of FACU.
6) Abnormal ac voltage at FACU.
7) Break in standby battery circuitry.
8) Failure of battery charging.
9) Abnormal position of switch at FACU or annunciator.
10) Voice signal amplifier failure.

f. System Supervisory Signal Actions:

1) Initiate notification appliances.
2) Identify specific device initiating event at FACU, connected network control panels, off-premises network control panels, and remote annunciators
3) Record event on system printer.
4) After time delay of 200 seconds transmit trouble or supervisory signal to remote alarm receiving station.
5) Transmit system status to building management system.
6) Display system status on graphic annunciator.

g. Network Communications:

1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.

3) Provide integration gateway using BACnet for connection to building automation system.

h. System Printer:

1) Printer must be listed and labeled as integral part of fire-alarm system.

i. Document Storage Box:

1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
3) Color: Red powder-coat epoxy finish.
4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.2 FIRE-ALARM CONTROL UNIT (FACU)

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

C. Performance Criteria:

1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:

a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
b. Include real-time clock for time annotation of events on event recorder and printer.
c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
d. FACU must be listed for connection to central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.

f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.

1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.

g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.

1) Annunciator and Display: LCD, 80 characters, minimum.
2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.

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

1) Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
2) Keypad: Arranged to permit entry and execution of programming, display, and control commands .

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

1) Pathway Class Designations: NFPA 72, Class B.
2) Install no more than 256 addressable devices on each signaling-line circuit.
3) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.

j. Serial Interfaces:

1) One dedicated RS 485 port for central-station operation using point ID DACT.
2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
3) One USB port for PC configuration.
4) One RS 232 port for voice evacuation interface.

k. Stairwell Pressurization: Provide output signal using addressable relay to start stairwell pressurization system. Signal must remain on until alarm conditions are cleared and fire-alarm system is reset. Signal must not stop in response to alarm acknowledge or signal silence commands.

1) Pressurization starts when alarm is received at FACU.
2) Alarm signals from smoke detectors at pressurization air supplies have higher priority than other alarm signals that start system.

l. Notification-Appliance Circuit:

1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

m. Elevator Recall: Initiate by one of the following alarm-initiating devices:

1) Elevator lobby detectors except lobby detector on designated floor.
2) Smoke detectors in elevator machine room.
3) Smoke detectors in elevator hoistway.

n. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.

o. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.

1) Water-flow switch associated with sprinkler in elevator pit may have delay to allow elevators to move to designated floor.

p. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must]be connected to fire-alarm system.

q. Remote Smoke-Detector Sensitivity Adjustment: Controls must 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 and print out final adjusted values on system printer.

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

s. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in separate cabinet located in fire command center

t. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.

1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
2) Programmable tone and message sequence selection.
3) Standard digitally recorded messages for "Evacuation" and "All Clear."

4) 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 FACU.

u. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
v. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
w. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals must be powered by 24 V(dc) source.
x. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
y. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
z. Batteries: Sealed lead calcium

D. Accessories:

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

2.3 MANUAL FIRE-ALARM BOXES

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate alarm, with addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
2. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:

B. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)

2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL
5. Performance Criteria:

    a. Regulatory Requirements:

        1) NFPA 72.
        2) UL 268.

    b. General Characteristics:
        1) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
        2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
        3) Integral Visual-Indicating Light: LED type, indicating detector has operated.
        4) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
        5) Operator at FACU, having designated access level, must 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.).

        6) Detector must have functional humidity range within 10 to 90 percent relative humidity.
        7) Color: White.
        8) Multiple levels of detection sensitivity for each sensor.
        9) Sensitivity levels based on time of day.

2.5 DUCT SMOKE DETECTORS

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

B. Description: Photoelectric-type, duct-mounted smoke detector.

C. Performance Criteria:

1. Regulatory Requirements:

    a. NFPA 72.

b. UL 268A.

2. General Characteristics:

a. Detectors must be four wire type.
b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
d. Integral Visual-Indicating Light: LED type, indicating detector has operated
e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:

1) Primary status.
2) Device type.
3) Present average value.
4) Present sensitivity selected.
5) Sensor range (normal, dirty, etc.).

g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
h. Each sensor must have multiple levels of detection sensitivity.
i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. Combination-Type Heat Detectors:
1. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
a. Notifier AFP Series (NFS Series)
b. Edwards System Technologies
c. Simplex 4100 True Alarm
d. Siemens MXL

2. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 521.

b. General Characteristics:

1) Temperature sensors must test for and communicate sensitivity range of device.

c. Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
d. Mounting: Adapter plate for outlet box mounting
e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
g. Color: White

B. Fixed-Temperature-Type Heat Detectors:
1. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
a. Notifier AFP Series (NFS Series)
b. Edwards System Technologies
c. Simplex 4100 True Alarm
d. Siemens MXL

2. Regulatory Requirements:

1) NFPA 72.
2) UL 521.

3. General Characteristics:

1) Actuated by temperature that exceeds fixed temperature of 190 deg
2) Mounting: Adapter plate for outlet box mounting.
3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
4) Detector must have functional humidity range of 10 to 90 percent.
5) Color: White .

2.7 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Voice/Tone Notification Appliances:

B. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

C. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 1480.

b. General Characteristics:

1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
2) High-Range Units: Rated 2 to 15 W.
3) Low-Range Units: Rated 1 to 2 W.
4) Mounting: Flush.
5) Matching Transformers: Tap range matched to acoustical environment of speaker location.
6) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

D. Fire-Alarm Visible Notification Appliances:
1. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
a. Notifier AFP Series (NFS Series)
b. Edwards System Technologies
c. Simplex 4100 True Alarm
d. Siemens MXL

2. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 1971.

b. General Characteristics:

1) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
2) Mounting: Wall mounted unless otherwise indicated.
3) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
4) Flashing must be in temporal pattern, synchronized with other units.
5) Strobe Leads: Factory connected to screw terminals.
6) Mounting Faceplate: Factory finished, red or white.

2.8 FIRE-ALARM REMOTE ANNUNCIATORS

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

B. Performance Criteria:

1. Regulatory Requirements:

a. NFPA 72.

2. General Characteristics:

a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, 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 must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
1. Notifier AFP Series (NFS Series)
2. Edwards System Technologies
3. Simplex 4100 True Alarm
4. Siemens MXL

B. Performance Criteria:

1. Regulatory Requirements:

a. NFPA 72.

2. General Characteristics:

a. Include address-setting means on module.
b. Store internal identifying code for control panel use to identify module type.
c. Listed for controlling HVAC fan motor controllers.
d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall, to circuit-breaker shunt trip for power shutdown

1) Allow control panel to switch relay contacts on command.
2) Have minimum of two normally open and two normally closed contacts available for field wiring.

f. Control Module:

1) Operate notification devices.
2) Operate solenoids for use in sprinkler service.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)

A. Subject to compliance with requirements, provide fire alarm components from one of the following systems:
   1. Notifier AFP Series (NFS Series)
   2. Edwards System Technologies
   3. Simplex 4100 True Alarm
   4. Siemens MXL

B. Performance Criteria:

   1. Regulatory Requirements:

      a. NFPA 72.

   2. General Characteristics:

      a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
      b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture two telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.
      c. Local functions and display at DACT must include the following:

         1) Verification that both telephone lines are available.
         2) Programming device.
         3) LED display.
         4) Manual test report function and manual transmission clear indication.
         5) Communications failure with central station or FACU.

      d. Digital data transmission must include the following:

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

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 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: 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 in accordance with requirements indicated:

1. Notify Construction Manager no fewer than fourteen days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install 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 other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
2. Mount manual fire-alarm box on background of contrasting color.
3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.

D. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must 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.

F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.

H. Remote Status and Alarm Indicators: Install in 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 below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.

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

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

A. Pathways must be installed in EMT.

3.7 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
1. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
2. Smoke dampers in air ducts of designated HVAC duct systems.
3. Magnetically held-open doors.
4. Electronically locked doors and access gates.
5. Alarm-initiating connection to elevator recall system and components.
6. Supervisory connections at valve supervisory switches.
7. Supervisory connections at elevator shunt-trip breaker.
8. Data communication circuits for connection to building management system.
9. Data communication circuits for connection to mass notification system.
10. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in location visible from FACU.

3.9 GROUNDING

A. Ground FACU and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

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

3.10 FIELD QUALITY CONTROL

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

B. Administrant for Tests and Inspections:
   1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

   1. Visual Inspection: Conduct visual inspection prior to testing.

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

   2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
   4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
   5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
   6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

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

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 DEMONSTRATION

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

3.12 MAINTENANCE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service must 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 must be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

END OF SECTION 284621.11

SECTION 31 11 00 – SITE CLEARING

PART I - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clearing and grubbing.
2. Topsoil stripping and stockpiling.
3. Protection of existing vegetation to remain.
4. Tree protection and Trimming.

B. Related Sections:
1. Division 31 Section "Earthwork".

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site on a full-time basis during execution of the Work.

B. Tree Pruning Standards: Comply with ANSI A300, "Trees, Shrubs, and Other Woody Plant Maintenance--Standard Practices," unless more stringent requirements are indicated.

1.4 PROTECTION

A. Description:

1. Protect existing trees, vegetation and site improvements to remain.
2. Damage or destruction of items intended to remain shall be repaired or replaced to the satisfaction of the Owner, without additional cost to the Owner.
3. Mark and protect trees and other existing landscaping to remain by barricades and by wrapping. Place barricades generally outside the drip-line.
4. Protect trees and other vegetation to remain from sprayed herbicides or soil poison.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wrapping: Burlap AASHTO-M182-60 Class 2.

B. Barricades: Minimum shall be U.V. resistant orange plastic snow fence, 4'-0" high with posts as required to comply with protection requirements.

C. Tree Wound Paint: Standard bituminous product.

D. Marking: Bright surveyor's tape.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination and Verification:

1. Contact Owner prior to clearing and grubbing to verify items of salvage.
2. Also verify all existing trees, landscaping and other items or areas which are to remain and which are to be cleared.

B. Dust Prevention: Use water sprinkling and other necessary means to prevent dust from becoming a nuisance to the Owner, public or concurrent performance of the work.

C. Limits:

1. Limits of clearing and grubbing shall be the construction limits as shown on the Drawings, or indicated and implied by the Contract Documents.
2. If any clarification of limits is necessary, contact Owner and Architect/Engineer.
3. If any work is necessary outside the contract limits, contact Owner and Architect/Engineer for approval prior to work.

D. Clearing:

1. Clean the site of all boulders, trash and debris as indicated and necessary.
2. Remove items and materials indicated on Drawings to be removed.
3. At areas to be covered by paving, walks, curbs, mechanical and electrical items, and where existing surfaces will be graded to new elevations, remove all trees, shrubs and other vegetation as required for installation of Work.
4. Refer to Drawings for additional trees, shrubs and other vegetation to be removed.
5. Saw damaged tree limbs clean and apply tree wound paint.
   a. Lawn areas: 8".
6. Apply tree wound paint to all cut ends of remaining stumps or roots to prevent regrowth.

E. Completion of Work: Remove barricades at completion of work and ensure site is clean and free from debris.

3.2 PREPARATION

A. Install temporary fencing located as indicated or outside the drip line of trees to protect remaining vegetation from construction damage.

B. Protect tree root systems from damage due to noxious materials caused by runoff or spillage while mixing, placing, or storing construction materials.

C. Protect root systems from flooding, eroding, or excessive wetting caused by dewatering operations.

D. Do not store construction materials, debris, or excavated material within the drip line of remaining trees.

E. Do not permit vehicles or foot traffic within the drip line; prevent soil compaction over root systems.

F. Do not allow fires under or adjacent to remaining trees or other plants.

3.3 EXCAVATION

A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees:

1. Hand clear and excavate to minimize damage to root systems.
2. Use narrow-tine spading forks and comb soil to expose roots.
3. Relocate roots in backfill areas where possible.
4. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and relocate them without breaking.
5. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches back from new construction.
6. Do not allow exposed roots to dry out before placing permanent backfill.
7. Provide temporary earth cover or pack with peat moss and wrap with burlap.
8. Water and maintain in a moist condition.
9. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

D. Where utility trenches are required within drip line of trees:

1. Tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut roots with sharp pruning instruments; do not break or chop.

3.4 REGRADING

A. Grade Lowering:

1. Where new finish grade is indicated below existing grade around trees, slope grade beyond drip line of trees.
2. Maintain existing grades within drip line of trees.

3. Where new finish grade is indicated below existing grade new trees, slope grade away from trees unless otherwise indicated.
4. Root Pruning: Prune tree roots exposed during grade lowering. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots with sharp pruning instruments; do not break or chop.

B. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

C. Moderate Fill: Where existing grade is more than 6 inches, but less than 12 inches, below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:

1. Carefully place drainage fill against tree trunk approximately 2 inches above elevation of finish grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within drip-line perimeter, place drainage fill up to 6 inches below elevation of grade.
2. Place filter fabric with edges overlapping 6 inches minimum.
3. Place fill layer of topsoil to finish grade. Do not compact drainage fill or topsoil. Hand grade to required finish elevations.

3.5 TREE PRUNING

A. Prune remaining trees affected by temporary and new construction.

B. Prune remaining trees to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by qualified arborist.

C. Pruning standards: Prune trees according to ANSI A300:

D. Cut branches with sharp pruning instruments, do not break or chop.

E. Chip branches removed from trees. Spread chips where indicated or as directed by Architect/Engineer.

3.6 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to written instructions of the qualified arborist.

B. Aerate surface soil, compacted during construction, 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

END OF SECTION 31 11 00

SECTION 312000 – EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavation, filling, backfilling and compacting.
2. Trenching and trench backfilling and compacting.
3. Mass earthwork and rough grading.
4. Finish grading, including spreading of topsoil.
5. Aggregates
6. Dewatering.
7. Soil stabilization.
8. Testing and inspection.

B. Related Sections:
1. Section 311100 - Site Clearing
2. Section 312500 - Erosion Control
3. Section 321216 – Asphalt Paving
4. Section 321623 – Sidewalks
5. Section 329113 – Soil Preparation
6. Section 329219 – Seeding
7. Section 330507 – Trenchless Installation of Utility Piping
8. Section 333000 – Sanitary Sewers

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
3. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
8. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
9. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
10. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
11. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D6031/D6031M - Standard Test Method for Logging In Situ Moisture Content and Density of Soil and Rock by the Nuclear Method in Horizontal, Slanted, and Vertical Access Tubes.
13. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 QUALITY ASSURANCE

A. Testing and Inspection:

1. All testing and inspection shall be performed by an independent Geotechnical Engineering Consultant ("Geotechnical Engineer") to demonstrate compliance with this specification.
2. The Geotechnical Engineer is responsible for all testing, sampling and inspection.
3. The Geotechnical Engineer, Owner and Engineer are responsible for approving materials, installation and procedures.
4. The Owner is responsible for providing these services.
5. The Contractor is responsible for all coordination, facilitation and scheduling with the Owner and Geotechnical Engineer.
6. Copies of certified tests shall be provided to the Owner/Engineer.

B. Topsoil:

1. All topsoil shall be tested and approved by the Geotechnical Engineer.
2. Refer to 1.4 Submittals for more information.

C. Any work in public right-of-way or other areas subject to the jurisdiction of any body shall be performed either to the requirements of that jurisdiction or to the requirements of this Specification, whichever is more stringent.

D. Furnish each material from single source throughout Work.

1.4 SUBMITTALS

A. All submittals shall be reviewed approved by Architect/Engineer and Geotechnical Engineer.

B. Product Data and Test Reports:

1. Field and laboratory tests and inspections.

2. Aggregates and Fill Materials: Include material specifications and sieve analysis. Include signed material certificate from manufacturer/supplier. Submit name of imported materials source.
3. Chemical modification: Include material specifications and signed material certificate from manufacturer/supplier.
4. Geosynthetic materials: Include material specifications and signed material certificate from manufacturer/supplier.

C. Topsoil:

1. Furnish topsoil analysis performed by the Geotechnical Engineer.
2. Analysis shall state the following: (Refer to Part 2 for minimum requirements)

    a. Percentage of organic matter.
    b. Gradation of sand, silt and clay, Include USDA textural classification.
    c. Cation exchange capacity.
    d. Deleterious material.
    e. pH.
    f. Mineral and plant nutrient content (phosphorus, potassium, magnesium, calcium).

3. Analysis shall state if topsoil is suitable for the intended use and as defined in this Specification, and shall state any requirements or recommendations necessary to make it suitable.
4. Analysis shall state annual nutrient requirements and recommendations.
5. This analysis is required for both on site and off site topsoil.
6. Samples of the topsoil shall be taken under the following conditions:

    a. Within four weeks prior to placing topsoil, take three representative samples of proposed topsoil.
    b. Within one week after placing topsoil, take three representative samples of in-place topsoil.
    c. All samples shall be taken in witness of the Owner, in areas approved by the Owner. Contractor to coordinate with Owner as required.

7. Provide copies of all topsoil analysis and recommendations to Owner and Architect/Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. All soil materials shall be approved by the Geotechnical Engineer.
2. All soil materials shall be suitable for each application.
3. Suitable soils are defined as soils which provide proper strength, compaction and drainage requirements and which are approved by the Geotechnical Engineer.

4. Fill material which is unsuitable due to excess moisture will not be classified as unsuitable if it can be dried to optimum moisture specified herein by manipulation, aeration or blending with other materials satisfactorily as approved by the Geotechnical Engineer.

B. Fill Materials:

1. Note: The following describes fill materials and their application for use. The materials shall be used for the listed applications, unless designated otherwise on the Drawings. If the Contractor has any questions or concerns regarding the materials or intended application, contact the Architect/Engineer for direction. Compaction requirements are the percentage of maximum dry density per ASTM D698 Standard Proctor Test, unless noted otherwise in the Geotechnical Report.

2. General fill:

   a. Suitable on-site or off-site fill material free of debris, roots, organic and frozen materials, and stones having a maximum dimension of 6".
   b. Minimum compaction: 95%.
   c. Application: General filling and backfilling of excavations outside of the building.

3. Structural fill:

   a. Suitable on-site or off-site fill material free of debris, roots, organic and frozen materials, and stones having a maximum dimension of 2".
   b. Minimum compaction: 100%.
   c. Application: Compacted subgrade under buildings, foundations and areas subject to structural loads.

4. Granular fill:

   a. Per requirements of MoDOT Type "1" Aggregate.
   b. Minimum compaction: 95%.
   c. Application: Backfilling of excavations and trenches which are under or within 5' of pavement, and underneath exterior concrete pavement, walks, curbs and slabs on grade.

5. Drainage Fill:

   a. General: crushed limestone or natural gravel with 100% passing the 1-inch sieve and no more than 4% passing the No. 10 sieve. Pea gravel or #53 stone are not acceptable.
   b. Minimum compaction: 95%.
   c. Application: Free draining material required for applications such as the outside of basement walls, the back side (earth side) of retaining walls, building slabs on grade, pipe embedment, pipe and conduit trench backfill.

6. Aggregate fill: Unless otherwise indicated, shall meet the following:

a. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone and natural or crushed sand.
b. ASTM D2940, with 100 percent passing a 1 ½ inch sieve and not more than 8 percent passing a No. 200 sieve. MoDOT Type "5" Aggregate is acceptable.
c. Minimum compaction: 95%.
d. Application: base course under concrete and other items per plans.

7. Impervious fill:

a. Clayey gravel and sand mixture capable of compacting to a dense state to prevent the flow of surface water or migration of groundwater.
b. Minimum compaction: 100%.
c. Application: Required in areas such as the top of basement walls and retaining walls where the surface water is to be drained away from the building or wall.

C. Soil Separator Fabric:

1. Nonwoven, needle-punched geotextile fabric manufactured from polyolefins or polyesters per ASTM M288, suitable for subsurface drainage and other specified applications.
2. Application: subsurface drains and as specified in Contract Documents.
3. Specifications (values based on Mirafi 140N):

a. Apparent opening size: 70 (U.S. Standard Sieve Size); ASTM D-4751-99A.
b. Flow rate: 135 gpm/sf; ASTM D-4491-99A.
c. Puncture strength: 65 lbs; ASTM D-4833-00.
d. Mullen Burst: 225 lb/sq. in.
e. Grab tensile/elongation: 155 lbs/50%.
f. UV Resistance: 70% at 500 hours.

D. Other Materials:

1. All other materials not specifically described but not required for proper completion of the Work of this Section, shall be as selected by the Contractor subject to the approval of the Architect/Engineer and Geotechnical Engineer.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. General:

1. Weather: Do not perform earthwork activities during inclement weather.
2. Dust: Use all necessary and appropriate means, such as water sprinkling, as required to prevent dust from being a nuisance to the Owner, public and concurrent performance of other work on the site.

3. Conflicts: Should the preceding job conditions or other items specified herein cause actual or possible conflicts, notify the Architect/Engineer immediately and do not proceed until such conflict has been resolved.

B. Preparation: Verify that the following has been completed prior to beginning earthwork:

1. Protective fencing has been installed for trees and vegetation to remain.
2 Site clearing (clearing and grubbing).
3. Erosion and sediment control measures are in place.

C. Protection:

1. For items indicated to remain, provide protection to prevent damage from construction activities. Any damage or destruction to items intended to remain intact shall be repaired or replaced to the satisfaction of the Owner at the Contractor's expense.
2. Topsoil: Protect placed topsoil from heavy machinery traffic. Remove and replace topsoil that is compacted by heavy machinery traffic.
3. Subgrade: Ditches and drains along the subgrade shall be maintained to drain effectively at all times. Repair subgrade of any ruts that may occur by reshaping and recompacting as required.
4. Utilities: Determine locations of existing utilities and the extent to which they may affect earthwork operations. Where service and utility lines are to remain, provide protection to prevent damage or disruption of services.
5. Damaged utilities shall be repaired immediately at the Contractor's expense.
6. Open excavation:

a. The Contractor is responsible for ensuring all open excavations are properly barricaded and protected at all times. This includes work such as mass excavation and trenching, and also includes other potentially dangerous conditions such as retention ponds.
b. Provide and install all necessary and appropriate means such as, but not limited to, signage, fencing, traffic barricades, and lighting to warn, discourage, and prevent danger to adjacent workers and general public.
c. Unless otherwise indicated, install a minimum 6' 10-guage chainlink fence around all open excavations, retention ponds, and other areas of potential danger, and maintain them while such conditions exist. Increase measures as required per site conditions.

3.2 EXCESS WATER CONTROL

A. Excess moisture: If excess moisture is present in soils, do not resume operations until moisture content and density are reported to be satisfactory by the Geotechnical Engineer.

B. Flooding: Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collecting in depressions.

C. Softened subgrade: Where soil has been softened or eroded by flooding or placement during inclement weather, remove all damaged areas and recompact as specified for fill and compaction.

D. Dewatering:

1. Provide and maintain ample means and devices with which to promptly remove and dispose of all water from every source entering the excavations or other parts of the work at all times during construction.
2. Dewater by means which will ensure dry excavations and the preservation of the final lines and grades at bottom of excavations, such as sump pumps, trenching, etc.
3. Do not use extreme measures or durations as to cause adverse effects to Project Site or adjoining properties.
4. Discharge to approved drains or channels. Contractor shall obtain State or local permits for discharge if such are required. Water discharged to streams shall be free of silt and other objectionable materials

3.3 EXCAVATION

A. General:

1. Excavation shall conform to OSHA and all other applicable safety regulations.
2. Excavation shall conform to the dimensions and elevations indicated on the Drawings, except as specified herein.
3. Excavation shall extend sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and inspection.
4. Remove unsuitable material below indicated depths and replace with suitable, compacted material or lean concrete, at the Architect/Engineer discretion.
5. Topsoil stripping: Strip topsoil to its depth from areas to be covered by building, by walks and by other work and where existing surface areas required grading in order to establish new elevations. Stockpile topsoil reasonably free of subsoil, debris and stones larger than 2-inch diameter in sufficient quantity to complete the work.
6. Legally dispose materials unsuitable for backfilling off-site.
7. Excavate rock Excavate rock, where encountered, to a distance of at least three (3) feet away from outside of structure walls. Bench any additional rock excavation required for stability during construction to maintain vertical cuts. Perform such additional excavation and furnish any additional backfill subsequently required at no extra cost to Owner.
8. Subgrade: Unless otherwise indicated, excavate to following subgrades:

    a. Slab-on-grade: Subgrade at bottom of drainage fill or at bottom of existing topsoil, whichever is lower.
    b. Drives and paving: Subgrade at bottom of aggregate base.
    c. Footing: Subgrade at indicated bottom of footing.
    d. Lawn area: Subgrade 4” below indicated surface elevation.

3.4 TRENCHING

A. General:

1. All trenching shall conform to OSHA and all other applicable safety standards.
2. Verification:

    a. Contractor shall verify all existing grades, inverts, utilities, obstacles and topographical conditions prior to any trenching, excavation or underground installations.
    b. In the event existing conditions are such as to prevent installations in accordance with the Contract Documents, immediately notify the Architect/Engineer and await decision before continuing work.
    c. Architect/Engineer decision will be final and binding upon the Contractor, and installations shall be in accordance with same.

3. Saw cut existing pavements to proper width for trenching.
4. Legally dispose materials unsuitable for trench backfilling off-site.

B. Width:

1. Trenches for piping shall be not less than 12” wide or more than 16” wider than the outside diameter of the pipe to be laid therein, and shall be excavated true-to-line, so that a clear space not less than 6” or more than 8” in width is provided on each side of the pipe.
2. For sewers, the maximum width of trench specified shall apply to the width at and below the level at the top of the pipe. The width of the trench above that level may be made as wide as necessary for sheeting and bracing, and proper installation of the Work.
3. Trenches shall be open vertical construction.

C. Depth:

1. Trench as required to provide the elevations shown on the drawings.
2. Where elevations are not shown on the drawings, trench to sufficient depth to give a minimum of 36” of fill above the top of the pipes measured from the adjacent finish grade.
3. Where trench excavation is inadvertently carried below proper elevation, backfill with approved material and then compact to provide a firm and unyielding subgrade and/or foundation at no additional cost to the Owner.

D. Trench Bracing:

1. Properly support all trenches in strict accordance with all pertinent rules and regulations.
2. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind, whether on public or private property, will be fully protected from damage.
3. In the event of damage to such improvements, immediately make all repairs and replacements necessary at no additional cost to the Owner.

4. Arrange all bracing, sheeting, and shoring so as to not place stress on any portion of the completed Work until the general construction thereof has proceeded far enough to provide sufficient strength.
5. All shoring and sheeting required to perform and protect the excavation and as required for the safety of employees and abutting structures shall be performed. All workmen performing work in 48" or deeper trench or excavation shall be protected by use of a welded sheet steel "safety box."
6. Removal: Exercise care in the drawing and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.

E. Bedding:

1. Where pipes or conduits are to be installed, excavate below the proposed alignment of the pipe and backfill with clean sand to provide uniform support unless otherwise noted on the Drawings.
2. Unless shown otherwise on Drawings, minimum bedding to be 4" below pipe.
3. Storm sewer pipes are to be bedded with stone.
4. Refer to Drawings and details for further information and requirements.

F. Grading and Handling of Trenched Material:

1. During excavation, material shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins.
2. Control the temporary stockpiling of trenched material in a manner to prevent water from running into the excavations.
3. Do not obstruct the surface drainage but provide means whereby stormwater is diverted into existing gutters, surface drains or other temporary drains.
4. Any water accumulated in the trenches shall be removed by pumping or by other approved methods.

3.5 FILLING, BACKFILLING AND COMPACTING

A. Prior to filling, backfilling and compacting, proofroll and remediate subgrade per Part 3 Quality Assurance.

B. Unless otherwise indicated, maximum lift thickness is 8" of uncompacted material. Maximum lift thickness in trenches is 6".

C. Moisture:

1. Thoroughly mix each layer to assure uniformity of material.
2. Supplement mixing with wetting or drying as required to obtain the moisture content required for the indicated percentages of compaction.
3. All fill shall be placed so that the moisture content is within +/- 2% of the optimum moisture content according to ASTM D698.
4. Do not use frozen materials in the fill or allow the fill to be placed upon frozen materials.

D. Backfilling:
1. Place backfill to the elevations indicated.

2. Trenches:
    a. Backfill pipes in 6 inch lifts deposited alternately on opposite sides of pipe to a plane 12 inches above pipe.
    b. No rock greater than one (1) foot, measured along its longest axis, shall be placed within two (2) feet of the top of a pipe in any backfill. No rocks greater than one (1) foot will be allowed in the backfill above service line terminations, tees and wyes.

3. Structures:
    a. Backfill only after concrete has attained 70 percent of its design strength
    b. Backfill adjacent to structures only after, in the opinion of the Engineer, a sufficient portion of the structure has been completed to resist the imposed soil load.
    c. Backfill within one (1) foot of structure shall be free of gravel, rock or shale particles larger than four (4) inches.
    d. Bring lifts up simultaneously on all sides of structures.
    e. Exercise caution in the use of heavy equipment in areas adjacent to structure to avoid high lateral stress on the structure walls. Use only light equipment to place backfill within twenty (20) feet of the structure.
    f. Where structural excavation has been through rock, backfill with compacted granular fill to top of rock formation, unless indicated otherwise on the drawings. Where entire excavation is in rock, terminate granular backfill 2 feet below finished grade. Place geotextile filter fabric over granular backfill and continue backfill to finish grade with suitable approved material.
    g.

E. Compaction:

1. Compaction shall be accomplished by approved means and shall meet the following densities for various parts of the Work. See Part 2 for density requirements of individual soil materials.
2. Compaction by flooding is not acceptable.
3. In cut areas where pavement is planned, scarify the upper 12” of subgrade prior to compaction.

F. Equipment:

1. Tracked equipment shall not be used as compaction equipment.
2. The static weight of compaction equipment utilized for the compaction of backfill materials near walls as defined in No.3 below shall not exceed 2,000 lbs. for non-vibratory equipment and 1,000 lbs. for vibratory equipment.
3. All heavy equipment, including compaction equipment heavier than noted herein, shall not be allowed closer to walls than 3 feet plus the vertical distance from backfill surface to the bottom of the wall.

3.6 GRADING

A. General:

1. After filling and backfilling operations are complete, neatly and evenly grade areas to be seeded or sodded.
2. Scarify subgrade to a depth of 6” and place minimum 4” topsoil (6” maximum).
3. Grade to obtain the elevations indicated within a tolerance of plus or minus 0.1 foot.
4. Slope finished subgrade surface to provide drainage away from building walls.

B. Treatment After Completion of Grading:

1. After grading is completed and inspected, permit no further excavation, filling, or grading except with the review of and the inspection by the Owner.
2. Use all necessary means to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.7 QUALITY ASSURANCE

A. Coordination:

1. A representative from the Geotechnical Engineer shall be present to observe and perform tests at all times earthwork is in progress.
2. Contractor shall provide minimum 72 hour notice to Geotechnical Engineer before each operation requiring testing or inspection.

B. Testing:

1. To verify adequacy of compaction, the Owner shall engage a qualified testing and inspecting agency to perform field tests and inspections and to submit reports. Contractor shall coordinate with and facilitate testing.
2. For trenches within street right-of-way, or under drives or parking lots, density tests representative of each three (3) feet of trench depth shall be taken at five hundred (500) linear foot intervals along the lines. Concentrate tests at cross streets and drives.
3. For trenches outside the street right-of-way, density tests representative of each three (3) feet of trench depth shall be taken at one thousand (1000) linear foot intervals along the lines.
4. For structural backfill, density tests representative of each 100 cubic yards of fill shall be taken.
5. For compacted subgrade, density tests representative of each 1,000 square yards of subgrade shall be taken per lift.

C. Approval and Remediation:

1. When testing and proofrolling indicate proper compaction has been obtained, and after approval from Geotechnical Engineer has been given, continue fill and backfill work until the indicated elevation is achieved.
2. If required density has not obtained, the Contractor shall remove the defective material and repeat operations until the required density is obtained and approval is given by the Geotechnical Engineer.

3. Cost of material removal, replacement, compaction and re-testing shall be the responsibility of the Contractor.

E. Correction of Settlement:

1. Settlement of embankments, backfill, or trenches occurring within the One Year Correction Period after Final Acceptance shall indicate defective work and shall be promptly corrected if the settlement results in the following:
   a. Visible depressions, ruts, or ground slumping.
   b. Pooling of water where positive slope existed or has been required.
   c. Voids beneath or beside slabs or structures.
   d. Movement of soil exposing unfinished or waterproofed structure surfaces.
   e. Movement of structures or facilities, including but not limited to foundation settlement, differential settlement, cracking, misalignment of adjacent objects, or movement of vertical elements out of plumb.
4. Contractor shall correct settlement and damages arising from or attributable to the settlement.
5. Make repairs within ten (10) days from and after due notification by Owner of embankment or backfill settlement and resulting damage.

F. Surplus Soil Materials
1. Unless otherwise indicated or directed by Owner, remove excess soil materials and legally dispose of off-site.

3.8 JOB COMPLETION

A. Upon completion of the Work of this Section:

1. Remove all trash and debris from earthwork operations.
2. Remove surplus equipment and tools.
3. Leave the site in a neat and orderly condition.
4. Restore all adjacent areas disrupted by earthwork activities to their original condition.
5. Protect areas from erosion until grass is established. Repair eroded areas as required.

END OF SECTION 31 20 00

SECTION 32 12 16 - ASPHALT PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving.
5. Asphalt paving overlay for existing paving.
6. Pavement markings.

B. Related Sections:
1. Section 312000 - Earthwork

1.02 REFERENCES

A. 2011 version of Missouri Standard Specifications for Highway Construction (MSSHC)
B. Asphalt Institute Publication MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.*
C. MoDOT Test Method TM 75

1.03 SUBMITTALS

A. Certified mix designs for each type of mix used.
B. Submit product information for asphalt and aggregate materials.
C. Certified in-place density testing.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate:

Graded aggregate shall consist of sound, durable rock particles, free from objectionable coatings. When the aggregate is tested in accordance with AASHTO T96-721 (Los Angeles Abrasion), the percentage of wear shall not exceed 50. The percentage of deleterious substances shall not exceed the following values, and the sum or percentages of all deleterious substances shall not exceed 8 percent.

Item	Percent
Deleterious Rock	8.0
Shale	1.0

Other foreign materials	0.5

The aggregates prior to mixing with asphalt binder shall comply with the following requirements as specified for its intended use:

AGGREGATE GRADING

Sieve	Percent by Weight Passing (Mass)		
	Base Course	BP-1	BP-2
1 inch	100	100	100
¾ inch	85-100	100	100
½ inch	60-90	85-100	95-100
No. 4	35-65	50-70	60-90
No. 8	25-50	30-55	40-70
No. 30	10-35	10-30	15-35
No. 200	5-12	4-12	4-12

Up to 15% Reclaimed asphalt pavement may be substituted in lieu of mineral aggregate.

B. Job mix formula:

At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design for verification and approval by Construction and Materials. The material shall be designed in accordance with Asphalt Institute Publication MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*. The mixture shall be compacted and tested at a minimum of three asphalt contents separated by a maximum of 0.5 percent in accordance with AASHTO T 245, except as herein noted. The test method shall be modified by short-term aging the specimens in accordance with AASHTO R 30. A detailed description of the mix design process shall be included with the job mix formula. Representative samples of each ingredient for the mixture shall be submitted with the mix design. Aggregate fractions shall be in accordance with the same proportions as the proposed job mix formula. A minimum of 150 pounds will be required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified.

Ingredient	Minimum Ammount
Aggregate	300 lbs
Hydrated Lime, Mineral Filler and /or Baghouse Fines	20 lbs
Asphalt Binder	10 gal.

D. Mixture Design:

Laboratories that participate and achieve a score of 3 or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 209, T 308 and T 245 will have the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.

E. Required Information

The mix design shall include raw data from the design process and shall contain the following information:

(a) Source, grade and specific gravity of asphalt binder.
(b) Source, type (formation, etc.) ledge number(s) if applicable, and gradation of the aggregate.
(c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including all raw data.
(d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.
(e) Percentage of each aggregate component.
(f) Combined gradation of the job mix.
(g) Percent of asphalt binder, by weight (mass), based on the total mixture.
(h) Bulk specific gravity by AASHTO T 166, Method A of a laboratory compacted mixture.
(i) Percent air voids of the laboratory compacted specimen.
(j) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA).
(k) Theoretical maximum specific gravity as determined by AASHTO T 209 in accordance with Sec 403.19.3 of the MSSHC, after the sample has been short-term aged in accordance with AASHTO R 30.
(l) Mixing temperature and molding temperature.
(m) Bulk specific gravity of the combined aggregate.
(n) Percent chert contained in each aggregate fraction.
(o) Baghouse fines added for design.
    I. Batch and continuous mix plants – Indicate which aggregate fraction to add baghouse percentage during production.
    II. Drum mix plants – Provide cold feed setting with and without baghouse percentage.

F. Mixture Approval

No mixture will be accepted for use until the job mix formula for the project is approved by Construction and Materials. The job mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new job mix formula may be required. In lieu of a new laboratory design, mixtures requiring adjustment beyond the limits allowed in Sec 401.8.2 of the MSSHC may be designed in the field based on characteristics

of plant-produced mixture in accordance with Sec 401 of the MSSHC and verified by Construction and Materials, which may require new aggregate characteristics.

G. Mixture Characteristics

Mixtures shall have the following properties, when tested in accordance with AASHTO T 245. The number of blows with the compaction hammer shall be 35. BP-1 and BP-2 mixtures shall have between 60 and 80 percent of the VMA filled with asphalt binder.

Percent Air Voids	AASTO T 245 Stability lb	Voids in Mineral Aggregate* (VMA)
3.5-4.5	750 (3350)	13.0

*Bituminous base mixtures that would require 12.0 percent Following Asphalt Institute MS-2 will have a minimum 12.0 percent requirement.

H. Moisture Susceptibility

Moisture susceptibility may be tested in accordance with AASHTO T 283. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. An approved anti-strip additive may be added to increase retained strength to a passing level.

I. Gradation Control

In producing mixtures for the project, the plant shall be operated such that no intentional deviations for the job-mix formula are made. The contractor shall determine on a daily basis at minimum, the gradation on the aggregate reclaimed from the RAP by either extraction or binder ignition. The gradation results shall be used to determine the daily specification compliance for the combined gradation. Mixtures as produced shall be subject to the following tolerances and controls:

(a) The total aggregate gradation shall be within the master range specified in MSSHC Section 401.3.
(b) The maximum variations form the approved job-mix formula shall be within the following tolerances:

Passing No. 8 sieve	+-5.0 percentage points
Passing No. 200 sieve	+-2.0 percentage points

(c) The quantity of asphalt binder introduced into the mixer shall be the quantity specified in the job-mix formula. No changes shall be made to the quantity of asphalt binder without written approval from the engineer. The quantity of asphalt binder determined by test on the final mixture shall not vary by more than +- 0.5 percent from the job-mix formula.

J. Sample Location.

The gradations of the total aggregate will be determined from samples taken for the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The RAP shall be sampled from the RAP feeding system n the asphalt plant. Samples for asphalt content determination may be taken at the plant.

K. Commercial Mixture

If specified in the contract that an approved commercial mixture may be used, the contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture proposed to be furnished. The statement shall include:

(a) The types and sources of aggregate, percentage range of each, and range of combined gradation.
(b) The percent and grade of asphalt binder.
(c) The mixing time and range of mixture temperature.

The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. It will not be necessary for the plant to meet the requirements of MSSHC Section 404. A field laboratory will not be required. If the proposed mixture and plant are approved by the engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truck load of each day's production, a certification that the material and mixture delivered are in conformance with the approved mixture. Upon completion of the work, a plant certification shall be furnished by the supplier for the total quantity delivered. The mixture shall be furnished by the supplier for the total quantity delivered. The mixture shall be transported, place and compacted in accordance with MSSHC Section 401.7. Without specific contract designation, an approved commercial mixture may be used in lieu of plant mix bituminous pavement or base course mixtures for work that is considered temporary construction and is to be maintained at the contractor's expense. Temporary construction will be defined as work that is to be removed prior to completion of the contract.

L. Moisture Content

The bituminous mixture, when sampled and tested in accordance with MoDOT Text Method TM 53, shall contain no more than 0.5 percent moisture by weight (mass) of the mixture.

M. Contamination

The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

PART 3 CONSTRUCTION REQUIREMENTS

A. Weather Limitations

Bituminous mixtures shall not be placed on any wet surface or frozen pavement. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

B. Subgrade Preparation

The subgrade upon which the bituminous mixture is to be placed shall be prepared in accordance with Specification Section 312000 and tacked or primed, as specified in the contract, or in accordance with MSSHC Sections 407 and 408, as applicable. For base widening

or utility trench repair work, the bottom of the trench shall be compacted until further consolidation is not visually evident, by use of a trench roller having a weight (mass) of no less than 300 psi of width of rear roller, or by mechanical tampers or other methods approved by the engineer. Suitable excavated material may be used in shouldering operations. On the outside of curves, the design depth of trench at the beginning of the superelevation transition shall be varied gradually to the minimum depth at the end of the superelevation transition. Slight transitioning of the width of the base widening will be necessary to permit the indicated angle of repose or shear angle outside of the ultimate edge of surface. The bottom of the trench shall in no case be less than 3 inches below the surface of the existing pavement. All surplus excavated material shall be disposed of by the contractor in areas to be secured by the contractor beyond the right of way limits. An acceptable written agreement with the property owner on whose property the material is placed shall be submitted to the engineer.

C. Hauling Equipment

Trucks used for hauling bituminous mixtures shall be in accordance with MSSHC Section 404.

D. Spreading

The base course, primed surface, or preceding course or layer shall be cleaned of all dirt, paced soil or any other foreign matter prior to spreading the bituminous mixture. The mixture shall be spread in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. When placing multiple layers with varying thicknesses, the thicker layer shall be placed first. The compacted thickness of a single layer of bituminous pavement mixture shall be no more than 2 inches for the surface course and 4 inches for the leveling course.

E. Irregularities

The mixture shall be spread without tearing the surface and struck off such that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with a suitable mixture at the contractor’s expense. The outside edge alignment shall be uniform. Irregularities shall be corrected by adding or removing mixture before compacting. In situations where there is a dispute in the existence of segregation, the area in question will be tested in accordance with MoDOT Test Method TM 75. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixtures shall be removed and replaced to the limits determined by the engineer.

F. Leveling Course

If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. Spot-leveling operations over small areas, with feather-edging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The mixture shall be practically free from segregation.

G. Base Widening

The specified total thickness of base widening shall be completed to the adjacent traveled way elevation as shown on the plans. Additional thickness of base widening may be placed as required prior to coldmilling, at eh contractor's expense, and shall subsequently be coldmilled to the same elevation as the traveled way, if conducive to expedite operations. On base-widening work, a succeeding layer of bituminous mixture may be place the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the engineer. At least one lane of the existing pavement and the adjacent shoulder shall be kept open to traffic at all times during construction, except for short intervals when the movement of the contractor's equipment will seriously hinder the flow of traffic. Intervals during which the contractor will be allowed to halt traffic shall be as designated by the engineer. The contractor shall not open more trench ahead of the first layer of the base widening than is necessary for placing that layer in one half a day's operations. The first layer of the base widening shall not be placed for a greater distance ahead of the final layer than is necessary for placing the final layer in one day's operation. Any changes in these lengths shall be made only with written permission from the engineer.

H. Edge Differential

For road ways constructed under traffic, no pavement edge differential shall be left in place fore more than seven days, unless approved by the engineer.

I. Joints

When a transverse vertical edge is to be left in place and opened to traffic, a temporary depth transition shall be constructed as approved by the engineer. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches. The joints in the final surface layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.

J. Surfaced Approaches

At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with MSSHC Section 408 and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed as shown on the plans or as directed by the engineer. Approaches shall not be surfaced before the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

K. Compaction

The compacted mixture shall have a minimum density of 92 percent of the theoretical maximum specific gravity. Density will be determined by the direct transmission nuclear method in accordance with MoDOT Test Method TM 41 or by a specific gravity method. When the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately. In lieu of density requirements, mixtures used for wedging, transitions, shoulders, temporary

bypasses to be maintained at the expense of the contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverages over the entire area with either a pneumatic tire roller weighing no less than 10 tons, a tandem-type steel wheel roller weighing no less than 10 tons or and approved vibratory roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

L. Quality Control

The contractor shall be responsible for, in-house or by third party, to maintain equipment and qualified personnel to perform QC field inspection, sampling and testing in accordance with applicable portions of MSSHC Section 403. A QC Plan will not be required. A proposed third party for dispute resolution shall be included with the mix design submittal.

M. Mixture Testing

The contractor shall test the mixture at least once every 1000 tons of production or a minimum of once per day for the gradation of the combined cold feeds or hot bins and the asphalt content. If RAP is used and AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MODOT Test Method TM 77. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used.

N. Failing Test

If a gradation or asphalt content test result falls outside of the specification tolerances, a review or adjustment of the plant setting and production shall be made and another sample shall be immediately taken. If the second test falls outside of the specification tolerances, production shall be immediately ceased until the mixture can be brought back into specification. Cold feed bins may be adjusted 5.0 percent. Material from different formations or ledges within the formation may be adjusted no more than 2.0 percent from the approved job mix formula. Mixtures requiring more than 5.0 percent adjustment will require a new mix design.

O. Retained Samples

One half of the contractor's sample for gradation and asphalt content and all cores shall be retained for the engineer. The contractor shall retain the samples for 7 days.

P. Pavement Testing

During construction, the engineer will designate as many tests as necessary to ensure that the course is being constructed of proper thickness, composition and density. Density of the roadway shall be determined by a daily sample consisting of four cores obtained by the contractor at stratified random locations selected by the engineer. A joint density sample shall consist of four cores taken from alternating sides of the lane placed at random locations selected by the engineer. The maximum theoretical density shown on the job mix formula shall be used for this determination. Samples, minimum theoretical density shown on the job mix formula shall be used for this determination. Samples, minimum 4-inch diameter cores, shall be taken the full depth of the layer to be tested. The contractor shall restore the surface from which samples have been taken immediately with the mixture under production or with a cold patch mixture acceptable to the engineer.

Q. Density Adjustment

Payment for mixture placed at or below the required minimum density will be adjusted as follows:

Field Density Percent of Maximum Theoretical Density	Percent of Contract Unit Price*
91.5 or above	100%
91.0 to 91.4, inclusive	97%
90.5 to 90.9, inclusive	94%
90.0 to 90.4, inclusive	90%
89.5 to 89.9, inclusive	80%
Below 89.5	Remove and Replace

Engineer may waive density adjustments for non-roadway areas.

R. Quality Assurance

Owner shall engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports. Contractor shall coordinate with and facilitate testing. QC/QA testing shall be performed by an independent laboratory and provide the Owner with copies of all reports. Acceptance tests are required at a rate of one independent sample per day when production exceeds 500 tons per day. A favorable comparison will be considered when a QA test is within the specification tolerances. At least once for every five days of production, a split of the contractor's sample will be tested. If the results of the split sample are not within five percent on all sieves above the no. 200, two percent on the No. 200 and 0.5 percent on the asphalt content from the contractor's results, another split sample will be taken jointly with the contractor and tested. If the second test results do not compare within the specification tolerances, production shall cease until the discrepancy is resolved. If the second test results compare within the above tolerances, production may continue. Results of QA testing will be furnished to the contractor within 24 hours of obtaining the sample.

S. Surface Tolerance

The finished layers shall be substantially free from waves or irregularities and shall be true to the established crown and grade. At transverse construction joints, the surface of all layers

shall not vary from a 10-foot straightedge applied parallel to the center line, by more than ¼ inch, except that the entire surface of the final layer of plant mix bituminous base, when this layer is used as the final riding surface course, or bituminous pavement mixture, shall not vary from the 10-foot straightedge by more than 1/8 inch. Areas exceeding this tolerance shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the engineer.

T. Defective Mixture

Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform with the surrounding area.

U. Pavement Marking

If the contractor's work has obliterated existing pavement markings on roadways or parking lots, the pavement marking shall be replaced at the contractor's expense in accordance with MSSHC Section 1048. Match existing.

V. Method of Measurement

Measurement will be in accordance with Division 1 – Unit prices.

END OF SECTION 32 12 16

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete paving for:

a. Concrete sidewalks.
b. Concrete
c. Concrete parking areas

1.2 SUBMITTALS

A. Product Data:

1. Submit data on concrete materials, joint filler, admixtures, and curing compounds.

B. Design Data:

1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Section 033000.

PART 2 - PRODUCTS

2.1 CONCRETE PAVING

A. Form Materials:

1. Form Materials: As specified in Section 033000.
2. Joint Filler: ASTM D1751; Asphalt impregnated fiberboard or felt, **1/4** inch thick.

B. Reinforcement:

1. Reinforcing Steel and Wire Fabric: As specified in Section 033000.

C. Concrete Materials:

1. Concrete Materials: As specified in Section 033000.

2.2 FABRICATION

A. Fabricate reinforcing in accordance with C**RSI Manual of Practice.**

2.3 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94 Option **A**.

2.4 ACCESSORIES

A. Curing Compound: ASTM C309, Type **1** Class **A**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify gradients and elevations of base.

B. Verify compacted granular base is ready to support paving and imposed loads.

3.2 PREPARATION

A. Moisten substrate to minimize absorption of water from fresh concrete.

3.3 INSTALLATION

A. Forms:

1. Place and secure forms to correct location, dimension, and profile.
2. Place joint filler in joints, vertical in position, in straight lines. Secure to formwork.
3. Place contraction joints at 20-foot intervals. Align joints.
4. Place joint filler between paving components and other appurtenances.

B. Reinforcement:

1. Place reinforcing as indicated on drawings.

C. Placing Concrete:

1. Place concrete in accordance with **Section 033000.**
2. Do not disturb reinforcing or formwork components during concrete placement.
3. Place concrete continuously between predetermined joints.

D. Finishing:

1. Apply curing compound on exposed concrete surfaces immediately after finishing.

3.4 FIELD QUALITY CONTROL

A. Inspect reinforcing placement for size, spacing, location, support.

B. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

C. Strength Test Samples:

1. Sample concrete and make one set of four cylinders for every placement.
2. Make one additional cylinder during cold weather concreting, and field cure.

D. Field Testing:

1. Slump Test Method: ASTM C143.
2. Air Content Test Method: ASTM C173
3. Temperature Test Method: ASTM C1064

E. Cylinder Compressive Strength Testing:

1. Test Method: ASTM C39/C39M.
2. Test **one** cylinder at **7** days.
3. Test two cylinders at 28 days.
4. Hold one cylinder to be tested at a later time if the 28 day breaks are low.

END OF SECTION 321313

APPENDIX

REPORT OF FINDINGS

HAZARDOUS MATERIALS SURVEY

Jefferson State Office Building
205 Jefferson Street
Jefferson City, Missouri 65101

January 2018

Prepared for:

McClure Engineering
4545 Oleatha Avenue
Saint Louis, Missouri 63116-1719

Prepared by:

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PE Project # 238.01.001

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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos Containing Material
AHERA	Asbestos Hazard Emergency Response Act
APCP	Air Pollution Control Program
CFR	Code of Federal Regulations
DHSS	Missouri Department of Health & Senior Services
DOT	Department of Transportation
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
LBP	Lead Based Paint
LF	Linear Feet
MDNR	Missouri Department of Natural Resources
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NOB	Non-friable Organically Bound
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PACM	Presumed Asbestos-Containing Material
PE	Professional Environmental Engineers, Inc.
PLM	Polarized Light Microscopy
PPE	Personal Protective Equipment
RACM	Regulated Asbestos-Containing Material
SF	Square Feet
TSI	Thermal System Insulation
USEPA	United States Environmental Protection Agency
RCRA	Resource Conservation and Recovery Act
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

Professional Environmental Engineers, Inc. (PE) was contracted by McClure Engineering to perform a Hazardous Materials Survey, consisting of limited suspect asbestos-containing material (ACM) inspection and a limited Lead Based Paint (LBP) survey of the Jefferson State Office Building at 205 Jefferson Street, Jefferson City, MO 65101. Mr. Michael Thierry, a licensed asbestos and lead inspector in the State of Missouri, performed the ACM and LBP Limited survey on January 12, 2018. Mr. Thierry's asbestos and lead licenses are included in **Appendix A**.

1.1 SITE DESCRIPTION

The Jefferson State Office Building is a 14-story office building with basement and penthouse areas. The building has interior walls constructed of drywall, cinder block and concrete. The hallways and office areas have 2'x 2' white ceiling tiles. The building has a forced air HVAC system with air handler rooms located on each floor.

1.2 REGULATORY SUMMARY

Occupational exposure to asbestos is regulated by the Occupational Safety and Health Administration (OSHA) in all industries under 29 Code of Federal Regulations (CFR) 1910.1001 and construction work under 29 CFR 1926.1101. To establish applicability of these regulations, the presence of asbestos must be determined by analytical testing, or for some materials presumed to contain asbestos based on pre-1981 installation date. Additionally, regulations covering asbestos have also been established by USEPA and Missouri Department of Natural Resources (MDNR) as well as local governing bodies. For a material to be considered ACM, it must contain more than one percent asbestos. Facilities with ACM or Presumed Asbestos-Containing Material (PACM) may be required to comply with the following regulations:

- 29 CFR 1926.1101 OSHA Construction Standard
- 40 CFR Part 61, Subpart M National Emission Standard for Asbestos

Asbestos exposure in the following situations is regulated by the OSHA Construction Standard 29 CFR 1926.1101:

1) *Demolition or salvage of structures where asbestos is present;*
2) *Removal or encapsulation of materials containing asbestos;*
3) *Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos;*
4) *Installation of products containing asbestos;*
5) *Asbestos spill/emergency cleanup; and*

6) Transportation, disposal, storage, containment of and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed.

7) Coverage under this standard shall be based on the nature of the work operation involving asbestos exposure.

Examples of suspect thermal system insulation (TSI) materials include pipe and tank insulation. Suspect surfacing materials include items applied to walls, ceilings, and structural beams such as sprayed-on fireproofing. Suspect miscellaneous materials include ceiling and floor tile, transite wallboard, and roofing material.

1.3 ASBESTOS CONTAINING MATERIAL (ACM) SURVEY

The limited ACM survey was performed to assess suspect ACMs within the building for the proposed removal of the perimeter registers, vertical supply and return piping, HVAC metal duct work and basement chillers per the Asbestos Hazard Emergency Response Act (AHERA) sampling protocols, as well as in accordance with state and local regulations. The scope of work for the ACM survey is presented below.

1. Perform a condition assessment and quantify the suspect ACM's per homogeneous materials in the proposed work areas.
2. Collect and analyze suspect ACM samples by polarized light microscopy in accordance with the Environmental Protection Agency (EPA) Method 600/R-93/116.
3. Collect a minimum of three samples per homogenous material of miscellaneous building materials, three samples of suspect friable materials thermal systems insulation and seven samples of suspect surfacing materials. (PE will utilize a "first stop positive" analytical determination to minimize sampling/analytical costs).
4. Utilize a licensed Asbestos Inspector to conduct all site activities in compliance with applicable regulations.
5. Provide a comprehensive report of findings detailing the materials inventory, suspect ACM's identified, samples collected, locations of sampled materials, quantities, condition assessment and laboratory results.

1.4 LEAD BASED PAINT (LBP) SURVEY

The LBP limited survey was performed to assess suspect lead painted surfaces within the proposed renovation areas located within the Jefferson State Office Building, 205 Jefferson Street, Jefferson City, MO 65101. The scope of work for the limited LBP survey is presented below.

1. Perform a limited LBP survey in representative areas were proposed renovation including at a minimum, analyzing walls and ceilings and painted surfaces. The

survey will be performed utilizing an X-Ray Fluorescence (XRF) analyzer by a licensed Missouri Lead Risk Assessor.

2. Mark up existing floor plan to note areas of elevated levels of lead.
3. Prepare a comprehensive report of findings detailing the samples collected, locations of sampled materials, and the XRF results.

2.0 SUMMARY OF RESULTS

A summary of the results of the surveys performed at the Jefferson State Office Building is presented below.

2.1 ASBESTOS CONTAINING MATERIALS RESULTS

Fifty-one (51) samples were collected by inspector Michael Thierry on January 12, 2018 and analyzed by EMSL Analytical, 3029 South Jefferson, St. Louis, MO 63118. All samples were analyzed by polarized light microscopy in accordance with the EPA Method 600/R-93/116. The laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) for bulk sample analysis. A copy of EMSLs NVLAP accreditation is included in **Appendix B**. The USEPA classifies an ACM as containing one percent or greater asbestos by content. The bulk sampling analytical reports are included in **Appendix C**. The quantities are estimated to reflect both visual determinations of ACM's as well as estimated quantities behind wall partitions and pipe chases. The ACM sampling results are presented in **Table 1**, Asbestos Analytical Data. A summary of identified materials are presented as follows:

Table 1
Summary of Suspect ACM Materials Sampled and Analytical Data
205 Jefferson Street, Jefferson City, Missouri

Sample Number	Location (Rooms)	Description	Quantity	Condition	PLM Result % Asbestos by Weight
205 Jefferson Street, Jefferson City, Missouri					
B1	Basement Mechanical Room	Chiller Insulation	560 sf	Good	**68% Chrysotile**
B2					**Stop 1st Positive**
B3					**Stop 1st Positive**
B4	Basement Mechanical Room	Tan Gasket Insulation	18 each	Good	None Detected
B5					None Detected
B6					None Detected
B10	Basement Mechanical Room	Red Gasket Insulation		Good	None Detected
B11					None Detected
B12					None Detected
B7	Basement Mechanical Room	Mudded Fittings on Chiller Pipes	26 Large Fittings 20 LF	Good	**79% Chrysotile**
B8					**Stop 1st Positive**
B9					**Stop 1st Positive**
B13	Basement Mechanical Room	Black Coating Fiberglass Insulation	>50 lf	Fair	None Detected None Detected
B14					None Detected None Detected
B15					None Detected None Detected

Sample Number	Location (Rooms)	Description	Quantity	Condition	PLM Result % Asbestos by Weight
B16	Ceiling Deck on All Floors	Ceiling Tile Residue Tile Adhesives	All Floors	Good	None Detected None Detected
B17					None Detected None Detected
B18					None Detected None Detected
B19	All Floors	Riser Insulation Coating	All Floors	Good	None Detected None Detected
B20					None Detected None Detected
B21					None Detected None Detected
B22	All Floors	Duct Lining (Fiberglass)	All Floors	Good	None Detected
B23					None Detected
B24					None Detected
B25	All Floors	2'x 2' White Rough Texture Ceiling Tile	All Floors	Good	None Detected
B26					None Detected
B27					None Detected
B28	8th Floor: Women's Restroom Fan Room Pipe Chase	Mudded Fittings (Assume each Women's Restroom Fan Room Pipe Chase	7 each Approx. 100 Each	Poor	**18% Amosite 8% Chrysotile**
B29					**Stop 1st Positive**
B30					**Stop 1st Positive**
B31	All Floors	Drywall 3rd Floor	All Floors	Good	None Detected
B32		Drywall 4th Floor			None Detected
B33		Drywall 6th Floor			None Detected
B34		Drywall 7th Floor			None Detected
B35		Drywall 8th Floor			None Detected
B36		Drywall 10th Floor			None Detected
B37		Drywall 13th Floor			None Detected
B38	All Floors	Joint Compound 3rd Floor	All Floors	Good	None Detected
B39		Joint Compound 4th Floor			None Detected
B40		Joint Compound 6h Floor			None Detected
B41		Joint Compound 7th Floor			None Detected
B42		Joint Compound 8th Floor			None Detected
B43		Joint Compound 10th Floor			None Detected
B44		Joint Compound 13th Floor			None Detected

Sample Number	Location (Rooms)	Description	Quantity	Condition	PLM Result % Asbestos by Weight
B45	14th Floor	Spray Fire Proofing	>5,000 sf	Good	None Detected
B46					None Detected
B47					None Detected
B48					None Detected
B49					None Detected
B50					None Detected
B51					None Detected

The Environmental Protection Agency (EPA) and Missouri Department of Natural Resources (MDNR) classify an ACM as containing 1% or greater asbestos by content. The items in bold red highlights are ACM.

2.2 LEAD BASED PAINT RESULTS

PE used a Niton x-ray fluorescence (XRF) to test for lead based paint on different painted components at various locations in the Jefferson State. The results of the sampling are provided in **Table 2** below:

Table 2
Summary of Painted Lead Based Paint Testing Results
205 Jefferson Street, Jefferson City, Missouri

Sample Number	Component	Substrate	Color	Results (mg/cm^2)
205 Jefferson Street, Jefferson City, Missouri				
Basement Mechanical Room				
L1	Chiller Meter	Metal	Black	0.11
L2	Chiller Pipe	Metal	Black	0.02
L3	Chiller	Metal	Black	0.01
L4	Chiller Frame	Metal	Black	0.01
L5	Chiller Bracket	Metal	Black	0.02
L6	Chiller Tank	Metal	Black	0.00
L7	Chiller Meter	Metal	Black	0.08
L8	Chiller Pipe	Metal	Black	0.02
L9	Chiller	Metal	Black	0.04
L10	Chiller Frame	Metal	Black	0.02
L11	Chiller Bracket	Metal	Black	0.03
L12	Chiller Tank	Metal	Black	0.01
3rd Floor Fan Room				
L13	Wall	Drywall	White	0.00
L14	Wall	Glazed Block	Tan	0.04
L15	Duct	Metal	Silver	0.00

Sample Number	Component	Substrate	Color	Results (mg/cm^2)
L16	Motor	Metal	Gray	0.01
L17	Window Frame	Metal	Brown	0.00
L18	Pipe	Metal	Black	0.00
3rd Floor Hallway				
L19	Wall	Drywall	White	0.00
L20	Wall	Drywall	White	0.00
L21	Ceiling	Drywall	White	0.01
L22	Ceiling Trim	Wood	Brown	0.00
L23	Trim	Plastic	Brown	0.02
L24	Duct	Metal	Silver	0.05
3rd Floor Office Areas North Side				
L25	Wall	Drywall	White	0.00
L26	Column	Concrete	Beige	0.01
L27	Fan Coil Top	Wood	Brown	0.00
L28	Fan Coil Vent	Metal	Brown	0.00
L29	Fan Coil Side	Wood	White	0.00
L30	Fan Coil Vent	Metal	Silver	0.01
L31	Window Frame	Metal	Brown	0.02
3rd Floor Office Areas East Side				
L32	Wall	Drywall	White	0.02
L33	Column	Concrete	Beige	0.00
L34	Fan Coil Vent	Metal	Brown	0.00
L35	Fan Coil Side	Wood	White	0.01
L36	Fan Coil Vent	Metal	Silver	0.02
L37	Window Frame	Metal	Brown	0.00
3rd Floor Office Areas South Side				
L38	Wall	Drywall	White	0.02
L39	Column	Concrete	Beige	0.00
L40	Fan Coil Vent	Metal	Brown	0.00
L41	Fan Coil Side	Wood	White	0.00
L42	Fan Coil Vent	Metal	Silver	0.00
L43	Window Frame	Metal	Brown	0.09
3rd Floor Office Areas West Side				
L44	Wall	Drywall	White	0.00
L45	Column	Concrete	Beige	0.04
L46	Fan Coil Top	Wood	Brown	0.01
L47	Fan Coil Vent	Metal	Brown	0.01
L48	Fan Coil Side	Wood	White	0.02
L49	Fan Coil Vent	Metal	Silver	0.00
L50	Window Frame	Metal	Brown	0.04
7th Floor Fan Room				

Sample Number	Component	Substrate	Color	Results (mg/cm^2)
L51	Wall	Drywall	White	0.00
L52	Wall	Glazed Block	Tan	0.00
L53	Duct	Metal	Silver	0.00
L54	Motor	Metal	Gray	0.00
L55	Window Frame	Metal	Brown	0.00
L56	Pipe	Metal	Black	0.01
7th Floor Hallway				
L57	Wall	Drywall	White	0.00
L58	Wall	Drywall	White	0.00
L59	Ceiling	Drywall	White	0.00
L60	Ceiling Trim	Wood	Brown	0.01
L61	Trim	Plastic	Brown	0.01
L62	Duct	Metal	Silver	0.00
7th Floor Office Areas North Side				
L63	Wall	Drywall	White	0.01
L64	Column	Concrete	Beige	0.07
L65	Fan Coil Top	Wood	Brown	0.01
L66	Fan Coil Vent	Metal	Brown	0.00
L67	Fan Coil Side	Wood	White	0.02
L68	Fan Coil Vent	Metal	Silver	0.00
L69	Window Frame	Metal	Brown	0.14
7th Floor Office Areas East Side				
L70	Wall	Drywall	White	0.00
L71	Column	Concrete	Beige	0.00
L72	Fan Coil Vent	Metal	Brown	0.01
L73	Fan Coil Side	Wood	White	0.00
L74	Fan Coil Vent	Metal	Silver	0.00
L75	Window Frame	Metal	Brown	0.06
7th Floor Office Areas South Side				
L76	Wall	Drywall	White	0.00
L77	Column	Concrete	Beige	0.00
L78	Fan Coil Vent	Metal	Brown	0.02
L79	Fan Coil Side	Wood	White	0.00
L80	Fan Coil Vent	Metal	Silver	0.01
L81	Window Frame	Metal	Brown	0.10
7th Floor Office Areas West Side				
L82	Wall	Drywall	White	0.00
L83	Column	Concrete	Beige	0.01
L84	Fan Coil Top	Wood	Brown	0.01
L85	Fan Coil Vent	Metal	Brown	0.00
L86	Fan Coil Side	Wood	White	0.01

Sample Number	Component	Substrate	Color	Results (mg/cm^2)
L87	Fan Coil Vent	Metal	Silver	0.01
L88	Window Frame	Metal	Brown	0.04
8th Floor Fan Room				
L89	Wall	Drywall	White	0.00
L90	Wall	Glazed Block	Tan	0.00
L91	Duct	Metal	Silver	0.00
L92	Motor	Metal	Gray	0.02
L93	Window Frame	Metal	Brown	0.03
L94	Pipe	Metal	Black	0.00
8th Floor Hallway				
L95	Wall	Drywall	White	0.00
L96	Wall	Drywall	White	0.01
L97	Ceiling	Drywall	White	0.02
L98	Ceiling Trim	Wood	Brown	0.00
L99	Trim	Plastic	Brown	0.60
L100	Duct	Metal	Silver	0.01
8th Floor Office Areas North Side				
L101	Wall	Drywall	White	0.00
L102	Column	Concrete	Beige	0.01
L103	Fan Coil Top	Wood	Brown	0.00
L104	Fan Coil Vent	Metal	Brown	0.01
L105	Fan Coil Side	Wood	White	0.00
L106	Fan Coil Vent	Metal	Silver	0.01
L107	Window Frame	Metal	Brown	0.03
8th Floor Office Areas East Side				
L108	Wall	Drywall	White	0.00
L109	Column	Concrete	Beige	0.02
L110	Fan Coil Vent	Metal	Brown	0.00
L111	Fan Coil Side	Wood	White	0.01
L112	Fan Coil Vent	Metal	Silver	0.00
L113	Window Frame	Metal	Brown	0.08
8th Floor Office Areas South Side				
L114	Wall	Drywall	White	0.00
L115	Column	Concrete	Beige	0.00
L116	Fan Coil Vent	Metal	Brown	0.02
L117	Fan Coil Side	Wood	White	0.00
L118	Fan Coil Vent	Metal	Silver	0.01
L119	Window Frame	Metal	Brown	0.01
8th Floor Office Areas West Side				
L120	Wall	Drywall	White	0.00
L121	Column	Concrete	Beige	0.00

Sample Number	Component	Substrate	Color	Results (mg/cm^2)
L122	Fan Coil Top	Wood	Brown	0.01
L123	Fan Coil Vent	Metal	Brown	0.00
L124	Fan Coil Side	Wood	White	0.00
L125	Fan Coil Vent	Metal	Silver	0.00
L126	Window Frame	Metal	Brown	0.00

The Missouri Department of Health and Human Services classifies a LBP material as containing 1.0 milligram/square centimeter (mg/cm^2) or greater. All 126 items sampled were less than 1.0 milligram/square centimeter (mg/cm^2) and are not classified as lead based paints. The performance characteristics sheet and calibration sheet for the XRF is provided in **Appendix D**.

3.0 SUMMARY AND RECOMMENDATIONS

3.1 ASBESTOS CONTAINING MATERIALS

EPA classifies an ACM as containing greater than 1% asbestos by content. Of the 18 different homogeneous materials identified and 58 total samples collected, 3 homogeneous materials tested as being greater than 1% asbestos by content and are classified as ACM per EPA and MDNR regulations. A summary for each property is presented below:

Table 3
Identified Asbestos Material
205 Jefferson Street, Jefferson City, Missouri

Sample Number	Location (Room)	Material Type	Quantity
205 Jefferson Street, Jefferson City, Missouri			
B1	Basement Mechanical Room	Chiller Insulation	560 sf
B7		Mudded Fittings on Chiller Pipes	26 Large Fittings 20 LF Pipe Insulation
B28	8th Floor: Women's Restroom Fan Room Pipe Chase	Mudded Fittings (Assume each Women's Restroom Fan Room Pipe Chase	7 each Approx. 100 Each

The materials listed in the Table 3 are greater than 1 % asbestos by content and are classified as ACM's. If any of these ACM's are to be impacted during future renovation or demolition activities they are required to be abated in accordance with the National Emission Standard for Hazardous Air Pollutants (NESHAP) for Asbestos 40 CFR Part 61 Control regulations prior renovation of the building space. A licensed Missouri asbestos abatement contractor is required to perform the abatement activities in compliance with applicable laws and regulations.

This was a limited asbestos survey. It is recommended that a full asbestos inspection be conducted to ensure all suspect building materials have been sampled prior to renovation activities.

3.2 LEAD BASED PAINTS

One hundred and twenty-six (126) painted components were tested for lead. All of the tested components were negative for lead.

4.0 REFERENCES

OSHA General Industry Standard - 29 CFR 1910.1001

OSHA Construction Standard - 29 CFR 1926.1101

National Emission Standard for Asbestos - 40 CFR Part 61, Subpart M

USEPA 40 CFR – Resource Conservation and Recovery Act

The United States Department of Housing and Urban Development (HUD) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

State of Missouri Code of Regulations (CSR) Title 19, Division 30, Chapter 70 Lead Abatement and Assessment Licensing, Training Accreditation

State of Missouri Code of Regulations (CSR) Title 10, Division 25, Hazardous Waste Management

Missouri Department of Natural Resources, Asbestos Requirements for Demolition and Renovation Projects, February 2014

Missouri Department of Natural Resources, Asbestos Fact Sheet, March 2000

5.0 SIGNATURE AND QUALIFICATIONS

This limited asbestos and LBP survey was conducted by Michael Thierry. Mr. Thierry has specific qualifications based on education, training, licensure and experience to assess this building and property and conduct sampling of suspect ACMs and LBPs. Mr. Thierry has conducted this limited asbestos inspection and LBP survey in conformance with standard industry practices and in compliance with applicable Federal, state and local regulations.

1/31/2018

Michael Thierry
Asbestos Inspector/Lead Risk Assessor

Date

Appendix A

Asbestos Inspector & Lead Rick Assessor Certifications

Expiration Date **7/28/2018** Certificate Number: 7118072117MOIR979

Training Date: **7/21/2017**

Missouri State Certificate for Asbestos Related Occupations

issued by Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102
Phone (573) 751-4817

Michael E Thierry

has successfully completed the requirements for certification as a INSPECTOR. This Missouri State Certification is subject to review and the director may deny, suspend or revoke the certification per RSMo chapter 643.230.

7/28/2017
Date

Kyra L Moore
Director of Air Pollution Control Program

CERTIFICATION NUMBER: 7118072117MOIR979

THIS CERTIFIES

Michael E Thierry

HAS COMPLETED THE CERTIFICATION REQUIREMENTS FOR

Inspector

APPROVED: 7/28/2017 **TRAINING DATE 7/21/2017**

EXPIRES: 7/28/2018

Kyra L Moore
Director of Air Pollution Control Program

STATE OF MISSOURI
DEPARTMENT OF HEALTH AND SENIOR SERVICES

LEAD OCCUPATION LICENSE REGISTRATION

Issued to:

Michael E. Thierry

The person, firm or corporation whose name appears on this certificate has fulfilled the requirements for licensure as set forth in the Missouri Revised Statutes 701.300-701.338, as long as not suspended or revoked, and is hereby authorized to engage in the activity listed below.

Lead Risk Assessor
Category of License

Issuance Date:	**8/8/2017**
Expiration Date:	**8/8/2019**
License Number:	**110808-300003469**

Randall W. Williams, MD, FACOG
Director
Department of Health and Senior Services

Lead Licensing Program, PO Box 570, Jefferson City, MO 65102

Appendix B

Laboratory Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200742-0

EMSL Analytical, Inc.

St. Louis, MO

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2017-04-01 through 2018-03-31

Effective Dates

DEPARTMENT OF COMMERCE * UNITED STATES OF AMERICA *

For the National Voluntary Laboratory Accreditation Program

Appendix C

Laboratory Bulk Sampling Analytical Reports

EMSL Analytical, Inc.

3029 S. Jefferson Saint Louis, MO 63118
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 391800477
Customer ID: PROF34
Customer PO:
Project ID:

Attention: Michael Thierry
Professional Environmental Engineers
500 South Ewing - Suite E
Saint Louis, MO 63103

Project: 238.01.001 205 Jefferson St

Phone: (314) 486-3774
Fax: (314) 531-0068
Received Date: 01/15/2018 8:00 AM
Analysis Date: 01/18/2018
Collected Date:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B1		Gray Fibrous Homogeneous		32% Non-fibrous (Other)	68% Chrysotile
391800477-0001					
B2					Positive Stop (Not Analyzed)
391800477-0002					
B3					Positive Stop (Not Analyzed)
391800477-0003					
B4		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0004					
B5		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0005					
B6		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0006					
B7		Gray Fibrous Homogeneous		21% Non-fibrous (Other)	79% Chrysotile
391800477-0007					
B8					Positive Stop (Not Analyzed)
391800477-0008					
B9					Positive Stop (Not Analyzed)
391800477-0009					
B10		Red Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0010					
B11		Red Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0011					
B12		Red Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0012					
B13-Layer 1-Coating		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0013					
B13-Layer 2-TSI		Orange Fibrous Homogeneous	93% Glass	7% Non-fibrous (Other)	None Detected
391800477-0013A					
B14-Layer 1-Coating		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0014					
B14-Layer 2-TSI		Orange Fibrous Homogeneous	94% Glass	6% Non-fibrous (Other)	None Detected
391800477-0014A					

Initial report from: 01/18/2018 19:39:30

EMSL Analytical, Inc.
3029 S. Jefferson Saint Louis, MO 63118
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 391800477
Customer ID: PROF34
Customer PO:
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B15-Layer 1-Coating *391800477-0015*		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B15-Layer 2-TSI *391800477-0015A*		Orange Fibrous Homogeneous	95% Glass	5% Non-fibrous (Other)	None Detected
B16-Layer 1-Ceiling Tile *391800477-0016*		Brown Fibrous Homogeneous	88% Cellulose	12% Non-fibrous (Other)	None Detected
B16-Layer 2-Adhesive *391800477-0016A*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B17-Layer 1-Ceiling Tile *391800477-0017*		Brown Fibrous Homogeneous	89% Cellulose	11% Non-fibrous (Other)	None Detected
B17-Layer 2-Adhesive *391800477-0017A*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B18-Layer 1-Ceiling Tile *391800477-0018*		Brown Fibrous Homogeneous	92% Cellulose	8% Non-fibrous (Other)	None Detected
B18-Layer 2-Adhesive *391800477-0018A*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B19-Layer 1-Riser *391800477-0019*		Various Non-Fibrous Homogeneous	36% Cellulose	64% Non-fibrous (Other)	None Detected
B19-Layer 2-Coating *391800477-0019A*		Gray Non-Fibrous Homogeneous	3% Cellulose	97% Non-fibrous (Other)	None Detected
B20-Layer 1-Riser *391800477-0020*		Various Non-Fibrous Homogeneous	37% Cellulose	63% Non-fibrous (Other)	None Detected
B20-Layer 2-Coating *391800477-0020A*		Gray Non-Fibrous Homogeneous	4% Cellulose	96% Non-fibrous (Other)	None Detected
B21-Layer 1-Riser *391800477-0021*		Various Non-Fibrous Homogeneous	38% Cellulose	62% Non-fibrous (Other)	None Detected
B21-Layer 2-Coating *391800477-0021A*		Gray Non-Fibrous Homogeneous	9% Cellulose	91% Non-fibrous (Other)	None Detected
B22 *391800477-0022*		Various Fibrous Homogeneous	95% Glass	5% Non-fibrous (Other)	None Detected
B23 *391800477-0023*		Various Fibrous Heterogeneous	96% Glass	4% Non-fibrous (Other)	None Detected
B24 *391800477-0024*		Various Non-Fibrous Homogeneous	97% Glass	3% Non-fibrous (Other)	None Detected
B25 *391800477-0025*		White Fibrous Heterogeneous	26% Cellulose 35% Min. Wool	26% Perlite 13% Non-fibrous (Other)	None Detected
B26 *391800477-0026*		White Fibrous Heterogeneous	27% Cellulose 36% Min. Wool	27% Perlite 10% Non-fibrous (Other)	None Detected

Initial report from: 01/18/2018 19:39:30

EMSL Analytical, Inc.
3029 S. Jefferson Saint Louis, MO 63118
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 391800477
Customer ID: PROF34
Customer PO:
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B27		White Fibrous Homogeneous	22% Cellulose 34% Glass	18% Perlite 26% Non-fibrous (Other)	None Detected
391800477-0027					
B28-Layer 1-Wrap		Gray Fibrous Homogeneous	98% Fibrous (Other)	2% Non-fibrous (Other)	None Detected
391800477-0028					
B28-Layer 2-Fitting		White Non-Fibrous Homogeneous		74% Non-fibrous (Other)	18% Amosite 8% Chrysotile
391800477-0028A					
B29					Positive Stop (Not Analyzed)
391800477-0029					
B30					Positive Stop (Not Analyzed)
391800477-0030					
B31		Various Non-Fibrous Heterogeneous	9% Cellulose 8% Glass	83% Non-fibrous (Other)	None Detected
391800477-0031					
B32		Various Non-Fibrous Heterogeneous	16% Cellulose 5% Glass	79% Non-fibrous (Other)	None Detected
391800477-0032					
B33		White Non-Fibrous Homogeneous	7% Glass	93% Non-fibrous (Other)	None Detected
391800477-0033					
B34		Various Non-Fibrous Heterogeneous	18% Cellulose 7% Glass	75% Non-fibrous (Other)	None Detected
391800477-0034					
B35		Various Non-Fibrous Heterogeneous	19% Cellulose 8% Glass	73% Non-fibrous (Other)	None Detected
391800477-0035					
B36		Various Non-Fibrous Heterogeneous	16% Cellulose 5% Glass	79% Non-fibrous (Other)	None Detected
391800477-0036					
B37		Various Non-Fibrous Homogeneous	15% Cellulose 8% Glass	77% Non-fibrous (Other)	None Detected
391800477-0037					
B38		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0038					
B39		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0039					
B40		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0040					
B41		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0041					
B42		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0042					
B43		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0043					
B44		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
391800477-0044					

Initial report from: 01/18/2018 19:39:30

EMSL Analytical, Inc.
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http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order: 391800477
Customer ID: PROF34
Customer PO:
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B45		Gray Fibrous Homogeneous	77% Min. Wool	23% Non-fibrous (Other)	None Detected
391800477-0045					
B46		Gray Fibrous Homogeneous	78% Min. Wool	22% Non-fibrous (Other)	None Detected
391800477-0046					
B47		Gray Fibrous Homogeneous	79% Min. Wool	21% Non-fibrous (Other)	None Detected
391800477-0047					
B48		Gray Fibrous Homogeneous	76% Min. Wool	24% Non-fibrous (Other)	None Detected
391800477-0048					
B49		Gray Fibrous Homogeneous	77% Min. Wool	23% Non-fibrous (Other)	None Detected
391800477-0049					
B50		Gray Fibrous Homogeneous	78% Min. Wool	22% Non-fibrous (Other)	None Detected
391800477-0050					
B51		Gray Non-Fibrous Homogeneous	76% Min. Wool	24% Non-fibrous (Other)	None Detected
391800477-0051					

Analyst(s)
Sue Ferrario (42)
Stuart Kinquist (13)

Jeff Siria, Laboratory Manager
or Other Approved Signatory

Initial report from: 01/18/2018 19:39:30

OrderID: 391800477

EMSL Analytical, Inc.
3029 South Jefferson

St. Louis, MO 63118
PHONE: (314)-577-0150
FAX: (314)-776-3313

EMSL ANALYTICAL, INC.

Asbestos Bulk Building Material Chain of Custody

EMSL Order Number *(Lab Use Only)*: 391800477

Company : Professional Environmental Engineers		**EMSL-Bill to:** ☑ Same ☐ Different If Bill to is Different note instructions in Comments** *Third Party Billing requires written authorization from third party*	
Street: 500 South Ewing - Suite E			
City: Saint Louis	**State/Province:** MO	**Zip/Postal Code:** 63103	**Country:** US
Report To (Name): Michael Thierry		**Telephone #:** 314-486-3774	
Email Address: thierry@pe-engrs.com		**Fax #:** 314-531-0068	**Purchase Order:**
Project Name/Number: 238.01.001 205 Jefferson St		**Please Provide Results:** ☐ Fax ☑ Email ☐ Mail	
U.S. State Samples Taken: MO		**CT Samples:** ☐ Commercial/Taxable ☐ Residential/Tax Exempt	

Turnaround Time (TAT) Options* – Please Check

☐ 3 Hour ☐ 6 Hour ☐ 24 Hour ☐ 48 Hour ☐ 72 Hour ☑ 96 Hour ☐ 1 Week ☐ 2 Week

**For TEM Air 3 hr through 6 hr, please call ahead to schedule. *There is a premium charge for 3 Hour TEM AHERA or EPA Level II TAT. You will be asked to sign an authorization form for this service. Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide.*

PLM - Bulk (reporting limit)	TEM – Bulk
☑ PLM EPA 600/R-93/116 (<1%)	☐ TEM EPA NOB – EPA 600/R-93/116 Section 2.5.5.1
☐ PLM EPA NOB (<1%)	☐ NY ELAP Method 198.4 (TEM)
Point Count ☐ 400 (<0.25%) ☐ 1000 (<0.1%)	☐ Chatfield Protocol (semi-quantitative)
Point Count w/Gravimetric ☐ 400 (<0.25%) ☐ 1000 (<0.1%)	☐ TEM % by Mass – EPA 600/R-93/116 Section 2.5.5.2
☐ NIOSH 9002 (<1%)	☐ TEM Qualitative via Filtration Prep Technique
☐ NY ELAP Method 198.1 (friable in NY)	☐ TEM Qualitative via Drop Mount Prep Technique
☐ NY ELAP Method 198.6 NOB (non-friable-NY)	**Other**
☐ OSHA ID-191 Modified	☐
☐ Standard Addition Method	

☑ **Check For Positive Stop – Clearly Identify Homogenous Group** **Date Sampled:** 1/12/2018

Samplers Name: Michael Thierry **Samplers Signature:** MTL

Sample #	HA #	Sample Location	Material Description

Client Sample # (s): B1 - B51 **Total # of Samples:** 51

Relinquished (Client): MTL **Date:** 1/13/18 **Time:** 9:01 AM

Received (Lab): [signature] **Date:** 1-15-18 **Time:** 8:00

Comments/Special Instructions:

EMSL Order Number (Lab Use Only)

391800477

SAMPLE NUMBER	HA #	SAMPLE DESCRIPTION/LOCATION	VOLUME (if applicable)	Date/Time Sampled
B1	1	Chiller Insulation		01/12/18
B2		Chiller Insulation		01/12/18
B3		Chiller Insulation		01/12/18
B4	2	Tan Gasket		01/12/18
B5		Tan Gasket		01/12/18
B6		Tan Gasket		01/12/18
B7	3	Mudded Fitting		01/12/18
B8		Mudded Fitting		01/12/18
B9		Mudded Fitting		01/12/18
B10	4	Red Gasket		01/12/18
B11		Red Gasket		01/12/18
B12		Red Gasket		01/12/18
B13	5	Black Jacket Coating (TSI)		01/12/18
B14		Black Jacket Coating (TSI)		01/12/18
B15		Black Jacket Coating (TSI)		01/12/18
B16	6	Ceiling Tile Adhesive		01/12/18
B17		Ceiling Tile Adhesive		01/12/18
B18		Ceiling Tile Adhesive		01/12/18
B19	7	Riser Coating		01/12/18
B20		Riser Coating		01/12/18
B21		Riser Coating		01/12/18

EMSL Order Number (Lab Use Only)

391800477

SAMPLE NUMBER	HA #	SAMPLE DESCRIPTION/LOCATION	VOLUME (if applicable)	Date/Time Sampled
B22	8	Metal Duct Lining		01/12/18
B23		Metal Duct Lining		01/12/18
B24		Metal Duct Lining		01/12/18
B25	9	2'x 2' White Rough Texture ceiling Tile		01/12/18
B26		2'x 2' White Rough Texture ceiling Tile		01/12/18
B27		2'x 2' White Rough Texture ceiling Tile		01/12/18
B28	10	Mudded Fitting (3" line)		01/12/18
B29		Mudded Fitting (3" line)		01/12/18
B30		Mudded Fitting (3" line)		01/12/18
B31	11	Drywall		01/12/18
B32		Drywall		01/12/18
B33		Drywall		01/12/18
B34		Drywall		01/12/18
B35		Drywall		01/12/18
B36		Drywall		01/12/18
B37		Drywall		01/12/18
B38	12	Joint Compound		01/12/18
B39		Joint Compound		01/12/18
B40		Joint Compound		01/12/18
B41		Joint Compound		01/12/18
B42		Joint Compound		01/12/18
B43		Joint Compound		01/12/18
B44		Joint Compound		01/12/18

EMSL Order Number (Lab Use Only)

391800477

SAMPLE NUMBER	HA #	SAMPLE DESCRIPTION/LOCATION	VOLUME (if applicable)	Date/Time Sampled
B45	13	Spray Insulation		01/12/18
B46		Spray Insulation		01/12/18
B47		Spray Insulation		01/12/18
B48		Spray Insulation		01/12/18
B49		Spray Insulation		01/12/18
B50		Spray Insulation		01/12/18
B51		Spray Insulation		01/12/18

Appendix D

Performance Characteristics Sheet, XRF Certification and Calibration Sheet

Performance Characteristic Sheet

EFFECTIVE DATE: **September 24, 2004** **EDITION NO.: 1**

MANUFACTURER AND MODEL:

Make: *Niton LLC*
Tested Model: *XLp 300*
Source: ^{109}Cd
Note: This PCS is also applicable to the equivalent model variations indicated below, for the Lead-in-Paint K+L variable reading time mode, in the XLi and XLp series:

XLi 300A, XLi 301A, XLi 302A and XLi 303A.
XLp 300A, XLp 301A, XLp 302A and XLp 303A.
XLi 700A, XLi 701A, XLi 702A and XLi 703A.
XLp 700A, XLp 701A, XLp 702A, and XLp 703A.

Note: The XLi and XLp versions refer to the shape of the handle part of the instrument. The differences in the model numbers reflect other modes available, in addition to Lead-in-Paint modes. The manufacturer states that specifications for these instruments are identical for the source, detector, and detector electronics relative to the Lead-in-Paint mode.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Lead-in-Paint K+L variable reading time mode.

XRF CALIBRATION CHECK LIMITS:

0.8 to 1.2 mg/cm^2 (inclusive)

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds.

SUBSTRATE CORRECTION:

For XRF results using Lead-in-Paint K+L variable reading time mode, substrate correction is <u>not</u> needed for:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

INCONCLUSIVE RANGE OR THRESHOLD:

K+L MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results not corrected for substrate bias on any substrate	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted in August 2004 on 133 testing combinations. The instruments that were used to perform the testing had new sources; one instrument's was installed in November 2003 with 40 mCi initial strength, and the other's was installed June 2004 with 40 mCi initial strength.

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Substrate correction is not needed for brick, concrete, drywall, metal, plaster or wood when using Lead-in-Paint K+L variable reading time mode, the normal operating mode for these instruments. If substrate correction is desired, refer to Chapter 7 of the HUD Guidelines for guidance on correcting XRF results for substrate bias.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use the K+L variable time mode readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten re-test XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For the Lead-In-Paint K+L variable reading time mode, the instrument continues to read until it is moved away from the testing surface, terminated by the user, or the instrument software indicates the reading is complete. The following table provides testing time information for this testing mode. The times have been adjusted for source decay, normalized to the initial source strengths as noted above. Source strength and type of substrate will affect actual testing times. At the time of testing, the instruments had source strengths of 26.6 and 36.6 mCi.

Testing Times Using K+L Reading Mode (Seconds)						
	All Data			Median for laboratory-measured lead levels (mg/cm^2)		
Substrate	25^{th} Percentile	Median	75^{th} Percentile	Pb < 0.25	0.25 ≤ Pb<1.0	1.0 ≤ Pb
Wood Drywall	4	11	19	11	15	11
Metal	4	12	18	9	12	14
Brick Concrete Plaster	8	16	22	15	18	16

CLASSIFICATION RESULTS:

XRF results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet was developed by the Midwest Research Institute (MRI) and QuanTech, Inc., under a contract between MRI and the XRF manufacturer. HUD has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.*

Certificate of Achievement

Michael Thierry

Professional Environmental Engeers

Has successfully completed the
Thermo Fisher Scientific NITON Analyzers Manufacturer's Training Course
and is now certified in radiation safety and monitoring, device operation,
and machine maintenance of the ***NITON XRF Analyzer.***
Certificate issued by Thermo Fisher Scientific NITON Analyzers
(CIH's – The ABIH Awards 1 CM point, approval # 07-1596)

ThermoFisher
SCIENTIFIC

Victoria Grzybinski

Training Coordinator

Kenneth P. Ufford

Director of Training

0033000000QKJp6

Certificate Number

2007 Sept 11 / Omaha, NE

Date & Site of Course

Calibration Check Test Results

Address/Unit No. 205 Jefferson Street
Jefferson City, MO 65101

Device XLP-300A

Date 1/12/2018 **XRF Serial No.** 22755

Contractor Professional Environmental Engineers

Inspector Michael Thierry

Inspector Signature 

Calibration Check Tolerance Used : Pn 500-934

First Calibration Check

Red NIST SRM 2573: 1.04 mg/cm^2			First Average	Difference Between First Average and 1.04 mg/cm^2
First Reading	Second Reading	Third Reading		
1	1	1	1	0.04

Second Calibration Check

Red NIST SRM 1.02 mg/cm^2			First Average	Difference Between First Average and 1.04 mg/cm^2
First Reading	Second Reading	Third Reading		
1.1	1	0.9	1	0.04

Third Calibration Check

Red NIST SRM 1.02 mg/cm^2			First Average	Difference Between First Average and 1.04 mg/cm^2
First Reading	Second Reading	Third Reading		

Fourth Calibration Check

Red NIST SRM 1.02 mg/cm^2			First Average	Difference Between First Average and 1.04 mg/cm^2
First Reading	Second Reading	Third Reading		

*** If the difference of the Calibration Check Average from the red NIST SRM 1.04 mg/cm2 film value is greater than the specified Calibration Check Tolerance for this device, consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful calibration check test.**

REPORT OF FINDINGS

Pre-Renovation Asbestos Survey

Jefferson State Office Building
205 Jefferson Street
Jefferson City, Missouri 65101

September 21, 2021

Prepared for:

Ms. Sarah Dollar
Project Manager
McClure Engineering
1000 Clark Avenue
St. Louis, Missouri 63102

Prepared by:

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PE Project #238.01.003

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1.0 INTRODUCTION

Professional Environmental Engineers, Inc. (PE) was contracted by McClure Engineering to perform an asbestos containing materials (ACM) survey of flooring materials at the Jefferson State Office Building located at 205 Jefferson Street, Jefferson City, Missouri (Subject Property). The survey included all fourteen floors of the building and the basement.

Mr. Matt Honerkamp conducted the ACM survey of the Subject Property with the assistance of the building's maintenance staff. The survey was non-destructive in nature. The survey was performed from August 9 through August 11, 2021, while the building was occupied.

Property Description

The Jefferson State Office Building is a 14-story office building with basement and penthouse areas. The building has interior walls constructed of drywall, cinder block and concrete. The flooring materials consist of broadloom wall-to-wall carpet, carpet squares, 12" vinyl composite tile (VCT) floor tile, ceramic tile, terrazzo, mastic on concrete, painted concrete or bare concrete floors. The building has a forced air HVAC system with air handler rooms located on each floor. Some floors are known to have been abated of asbestos floor tile, but floor tile may still remain under existing wall partitions and mastics may have been left in-place.

1.1 Asbestos Containing Material Survey

PE performed a suspect ACM survey of flooring materials to determine if any ACMs are present within the subject property which could be impacted or disrupted during future flooring renovation activities. The scope of work for the project is presented below.

1. Review of available building plans and any previous studies to understand the current building conditions.
2. Conduct a reconnaissance of all accessible areas to identify suspect flooring ACMs and obtain representative samples of these materials. Any area that may contain ACM and is not accessible should be reported as Assumed ACMs according to OSHA.
3. Sampling was conducted in accordance with the EPA's Guidance for Controlling Asbestos-Containing Material in Buildings, June 1985, including the following:
   * Collect at least three bulk samples for each homogeneous area of suspect ACM.
   * The test, evaluation and sample collections were conducted by a State accredited inspector.
4. Laboratory analyses for the presence of asbestiform minerals utilizing Polarized Light Microscopy (PLM) coupled with Dispersion Staining as detailed in the EPA's "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" (EPA 40 CFR 763, Subpart F, Appendix A). The analytical procedures for determining the percent of asbestos in bulk samples to permit the use of visual area estimation shall also follow the "National Emission Standard for Hazardous Air Pollutants" (NESHAP) regulations (40 CFR Part 61, dated November 20, 1990).
5. Performed a condition assessment and quantify all suspect ACMs per homogeneous materials.

6. Utilized licensed Asbestos Inspectors to conduct all site activities in compliance with applicable regulations.

2.0 SUMMARY OF RESULTS

2.1 Asbestos Containing Materials

Occupational exposure to asbestos is regulated by the Occupational Safety and Health Administration (OSHA) in all industries under 29 Code of Federal Regulations (CFR) 1910.1001 and construction work under 29 CFR 1926.1101. To establish applicability of these regulations, the presence of asbestos must be determined by analytical testing, or for some materials presumed to contain asbestos based on pre-1981 installation date. Additionally, regulations covering asbestos have also been established by the USEPA and Missouri Department of Natural Resources (MDNR) as well as local governing bodies. For a material to be considered ACM, it must contain more than one percent asbestos. OSHA does not recognize the >1% standard and believes that any concentration of asbestos in the material may present an occupational exposure. Buildings with ACM or Presumed Asbestos-Containing Material (PACM) may be required to comply with the following regulations:

- 29 CFR 1926.1101 OSHA Construction Standard
- 40 CFR Part 61, Subpart M National Emission Standard for Hazardous Air Pollutants

Asbestos exposure in the following situations is regulated by the OSHA Construction Standard 29 CFR 1926.1101:

1) *Demolition or salvage of structures where asbestos is present;*
2) *Removal or encapsulation of materials containing asbestos;*
3) *Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos;*
4) *Installation of products containing asbestos;*
5) *Asbestos spill/emergency cleanup;*
6) *Transportation, disposal, storage, containment of and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed; and*
7) *Coverage under this standard shall be based on the nature of the work operation involving asbestos exposure.*

Examples of suspect thermal systems insulation (TSI) materials include pipe and tank insulation. Suspect surfacing materials include items applied to walls, ceilings, and structural beams such as sprayed-on fireproofing. Suspect miscellaneous materials include ceiling and floor tile, transite wallboard, and roofing materials.

Mr. Matt Honerkamp is a licensed asbestos inspector in the State of Missouri performed the subject property ACM flooring survey from August 9 through August 11, 2021. A copy of Mr. Honerkamp's asbestos inspector's license is included in **Appendix A**. The bulk sampling analytical report is included in **Appendix C.** Per federal and state regulations, samples are collected in accordance with the below sampling frequency table.

SAMPLING FREQUENCY TABLE

TYPE OF MATERIAL	MINIMUM NUMBER OF SAMPLES
Surfacing Materials	
<1,000 Square Feet	3
1,000 – 5,000 Square Feet	5
>5,000 Square Feet	7 Plus 1 additional sample for each additional 5,000 square feet, or one from each unit, whichever is greater (see Note 1)
Thermal Systems Insulation	3
Miscellaneous Materials	3

PE collected three (3) representative bulk samples of flooring materials per homogeneous area. A total of 123 samples (3 samples each of 41 homogeneous areas) were collected during the survey. PE used a "Stop at First Positive Approach" to the laboratory analysis. If the first sample within the group was positive, the remaining samples were not analyzed.

Suspect asbestos containing materials (ACMs) were analyzed by polarized light microscopy (PLM) with the EPA Method 600/R-93/116 by EMSL Analytical, Inc. (EMSL), 100 Green Park Industrial Park, St. Louis, Missouri 63123. The laboratory is accredited by the *National Voluntary Laboratory Accreditation Program* (NVLAP) for bulk sample analysis. A copy of EMSL's accreditation is included in **Appendix B**.

The Environmental Protection Agency (EPA) classifies an ACM as containing greater than 1 % asbestos by content. Floor sample numbers are designated by the floor number the sample was collected on followed by the sample group number of homogeneous flooring materials. The ACM results are presented in **Table 1**.

Table 1
Summary of Suspect ACM Analytical Data
Jefferson State Office Building

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
1-1A	East Kitchenette	12" Brown Floor Tile/Mastic	352 SF (includes West	Tile = None Detected Mastic = 8% Chrysotile
1-1B	East Kitchenette	12" Brown Floor Tile/Mastic		Tile = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
			Kitchenette and Elevator Lobby)	Mastic = Positive Stop (Not Analyzed)
1-1C	East Kitchenette	12" Brown Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
1-2A	Rooms 103/104 Hallway	Flooring Beneath Carpet Squares		Adhesive = None Detected Flooring = None Detected Adhesive = 9% Chrysotile
1-2B	Rooms 103/104 Hallway	Flooring Beneath Carpet Squares	10,880 SF	Adhesive = None Detected Flooring = None Detected Adhesive = Positive Stop (Not Analyzed)
1-2C	Rooms 103/104 Hallway	Flooring Beneath Carpet Squares		Adhesive = None Detected Flooring = None Detected Adhesive = Positive Stop (Not Analyzed)
1-3A	File Storage Area	Black Staining Beneath Carpet Squares	-----	None Detected
1-3B	File Storage Area	Black Staining Beneath Carpet Squares	-----	None Detected
1-3C	File Storage Area	Black Staining Beneath Carpet Squares	-----	None Detected
1-4A	Mail Room	Mastic Beneath Carpet	1,790 SF	8 % Chrysotile
1-4B	Mail Room	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
1-4C	Mail Room	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
2-5A	Elevator Lobby	12" Brown Floor Tile/Mastic	630 SF	Tile = None Detected No Mastic Present
6-5B	Elevator Lobby	12" Brown Floor Tile/Mastic	630 SF	Tile = None Detected No Mastic Present
9-5C	Elevator Lobby	12" Brown Floor Tile/Mastic	630 SF	Tile = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
				No Mastic Present
2-6A	By Elevator Lobby	Mastic Beneath Carpet	12,300 SF	9 % Chrysotile
2-6B	By Elevator Lobby	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
2-6C	West-Ctr. of Floor	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
3-7A	Mechanical Room	12" Beige Pattern Floor Tile/Mastic	529 SF	Tile = None Detected Mastic = 6% Chrysotile
3-7B	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
3-7C	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
3-8A	Communications Room	Floor Mastic	12,300 SF	7 % Chrysotile
3-8B	Communications Room	Floor Mastic		Positive Stop (Not Analyzed)
3-8C	West Side of Floor	Floor Mastic		Positive Stop (Not Analyzed)
4-9A	South Large Conference Room	Floor Mastic	12,300 SF	8 % Chrysotile
4-9B	South Large Conference Room	Floor Mastic		Positive Stop (Not Analyzed)
4-9C	Pipe Chase Hallway	Floor Mastic		Positive Stop (Not Analyzed)
1-10A	DSS Office	Mastic Beneath Carpet Squares	325 SF	Mastic = 6% Chrysotile Flooring = None Detected
1-10B	DSS Office	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
1-10C	DSS Office	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
1-11A	Cafeteria	12" Beige Pattern Floor Tile/Mastic	-----	None Detected
1-11B	Cafeteria	12" Beige Pattern Floor Tile/Mastic	-----	None Detected
1-11C	Cafeteria	12" Beige Pattern Floor Tile/Mastic	-----	None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
1-12A	Kitchen Area Office	12" White Pattern Floor Tile/Mastic	1,086 SF (includes Kitchen)	Tile = None Detected Mastic = 6% Chrysotile
1-12B	Kitchen Area Office	12" White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
1-12C	Kitchen Area Office	12" White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
1-13A	Kitchen	6" Ceramic Tile/Grout	-----	None Detected
1-13B	Kitchen	6" Ceramic Tile/Grout	-----	None Detected
1-13C	Kitchen	6" Ceramic Tile/Grout	-----	None Detected
5-14A	Mechanical Room	12" Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 9% Chrysotile
5-14B	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
5-14C	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
1-15A	DESE Conference Room	Mastic Beneath Carpet Squares	760 SF	Mastic = None Detected Flooring = None Detected Mastic = 6% Chrysotile
1-15B	State Board of Education Room	Mastic Beneath Carpet Squares	1,600 SF	Positive Stop (Not Analyzed)
1-15C	Adjacent Hallway	Mastic Beneath Carpet Squares	864 SF	Positive Stop (Not Analyzed)
6-16A	Kitchenette	12" Brown Floor Tile/Mastic	72 SF	Tile = None Detected Mastic = 7% Chrysotile
9-16B	Kitchenette	12" Brown Floor Tile/Mastic	72 SF	Tile = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
				Mastic = Positive Stop (Not Analyzed)
14-16C	Kitchenette	12” Brown Floor Tile/Mastic	135 SF	Tile = None Detected Mastic = Positive Stop (Not Analyzed)
6-17A	Electrical Closet	Floor Mastic	12,300 SF	8 % Chrysotile
6-17B	Electrical Closet	Floor Mastic		Positive Stop (Not Analyzed)
6-17C	By West Wall	Floor Mastic (Beneath Carpet)		Positive Stop (Not Analyzed)
7-18A	Electrical Closet	Floor Mastic	12,300 SF	9 % Chrysotile
7-18B	Electrical Closet	Floor Mastic		Positive Stop (Not Analyzed)
7-18C	Mechanical Room Hallway	Floor Mastic Beneath Carpet		Positive Stop (Not Analyzed)
8-19A	West-Ctr. Wall	Mastic Beneath Carpet	6,725 SF	6 % Chrysotile
8-19B	West-Ctr. Wall	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
8-19C	West-Ctr. Wall	Mastic Beneath Carpet		Positive Stop (Not Analyzed)
9-20A	Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 7% Chrysotile
9-20B	Mechanical Room	12” Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
9-20C	Mechanical Room	12” Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
10-21A	North-Ctr. of Floor	Mastic Beneath Carpet Squares	12,300 SF	Mastic = None Detected Flooring = None Detected Mastic = 8% Chrysotile
10-21B	North-Ctr. of Floor	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
10-21C	North-Ctr. of Floor	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
11-22A	Near NW Corner	Mastic Beneath Carpet Squares	8,000 SF	Mastic = 9% Chrysotile Flooring = None Detected Flooring = None Detected
11-22B	Near NW Corner	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
11-22C	Near NW Corner	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
13-23A	Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 6% Chrysotile
13-23B	Mechanical Room	12” Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
13-23C	Mechanical Room	12” Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
13-24A	SE Office	Old Carpet/Mastic Beneath Partition Wall	Throughout Building	Carpet = None Detected Mastic = None Detected Mastic = 7% Chrysotile
13-24B	SE Office	Old Carpet/Mastic Beneath Partition Wall		Carpet = None Detected Mastic = None Detected Mastic = Positive Stop (Not Analyzed)
13-24C	SE Office	Old Carpet/Mastic Beneath Partition Wall		Carpet = None Detected Mastic = Positive Stop (Not Analyzed)
13-25A	Training Room	Mastic Beneath Carpet Squares		Mastic = 9% Chrysotile Flooring = None Detected Flooring = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
13-25B	Training Room	Mastic Beneath Carpet Squares	12,300 SF	Positive Stop (Not Analyzed)
13-25C	Training Room	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
14-26A	Elevator Lobby	12" Brown Floor Tile/Mastic	420 SF	Tile = None Detected No Mastic Present
14-26B	Elevator Lobby	12" Brown Floor Tile/Mastic		Tile = None Detected No Mastic Present
14-26C	Elevator Lobby	12" Brown Floor Tile/Mastic		Tile = None Detected No Mastic Present
11-27A	Mechanical Room	12" Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 6% Chrysotile
11-27B	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
11-27C	Mechanical Room	12" Beige Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
11-28A	Caucus Room Entrance	Mastic Beneath Old Partition Wall	Throughout Building	Mastic = None Detected Mastic = 7% Chrysotile Wall = None Detected Wall = None Detected
11-28B	Caucus Room Entrance	Mastic Beneath Old Partition Wall		Positive Stop (Not Analyzed)
11-28C	Caucus Room Entrance	Mastic Beneath Old Partition Wall		Positive Stop (Not Analyzed)
11-29A	Meeting/Viewing Room	Mastic Beneath Carpet Squares		Mastic = None Detected Mastic = 8% Chrysotile Flooring = None Detected Flooring = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
11-29B	Meeting/Viewing Room	Mastic Beneath Carpet Squares	(Included with Sample Group 22)	Positive Stop (Not Analyzed)
11-29C	Meeting/Viewing Room	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
12-30A	West-Ctr. of Floor	Mastic Beneath Carpet Squares	12,300 SF	Mastic = 9% Chrysotile Flooring = None Detected Mastic = None Detected
12-30B	West-Ctr. of Floor	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
12-30C	West-Ctr. of Floor	Mastic Beneath Carpet Squares		Positive Stop (Not Analyzed)
B-31A	Elevator Lobby	12” Brown Floor Tile/Mastic	630 SF	Tile = None Detected Mastic = 6% Chrysotile
B-31B	Elevator Lobby	12” Brown Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
B-31C	Elevator Lobby	12” Brown Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
B-32A	Room J1	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-32B	Room J1	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-32C	Women’s Restroom	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-33A	B-15 Hallway	12” White/Brown Pattern Floor Tile/Mastic	880 SF	Tile = None Detected Mastic = 7% Chrysotile
B-33B	B-15 Hallway	12” White/Brown Pattern Floor Tile/Mastic		Tile = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
				Mastic = Positive Stop (Not Analyzed)
B-33C	B-15 Hallway	12” White/Brown Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
B-34A	Men’s Restroom	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-34B	Men’s Restroom	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-34C	Men’s Restroom	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-35A	Print Shop	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected Leveler = None Detected
B-35B	Print Shop	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected Leveler = None Detected
B-35C	Print Shop	12” White/Gray Pattern Floor Tile/Mastic	-----	Tile = None Detected Mastic = None Detected
B-36A	Media Production Services Area	Mastic Beneath Carpet	-----	Mastic = None Detected Flooring = None Detected Mastic = None Detected
B-36B	Media Production Services Area	Mastic Beneath Carpet	-----	Mastic = None Detected Flooring = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
				Mastic = None Detected
B-36C	Media Production Services Area	Mastic Beneath Carpet	-----	Mastic = None Detected Flooring = None Detected Mastic = None Detected
B-37A	Media Production Services Area	12” White Pattern Floor Tile/Mastic	308 SF	Tile = None Detected Mastic = 8% Chrysotile
B-37B	Media Production Services Area	12” White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
B-37C	Media Production Services Area	12” White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = Positive Stop (Not Analyzed)
B-38A	Media Production Services Area Office	Glue Beneath Carpet Squares	-----	None Detected
B-38B	Media Production Services Area Office	Glue Beneath Carpet Squares	-----	None Detected
B-38C	Media Production Services Area Office	Glue Beneath Carpet Squares	-----	None Detected
6-39A	Women’s Restroom	Clay Tile Grout	-----	None Detected
10-39B	Women’s Restroom	Clay Tile Grout	-----	None Detected
14-39C	Women’s Restroom	Clay Tile Grout	-----	None Detected
6-40A	Men’s Restroom	Clay Tile Grout	-----	None Detected
10-40B	Men’s Restroom	Clay Tile Grout	-----	None Detected
14-40C	Men’s Restroom	Clay Tile Grout	-----	None Detected
13-41A	Kitchenette	12” White Pattern Floor Tile/Mastic	72 SF	Tile = None Detected Mastic = None Detected Mastic = 7% Chrysotile
13-41B	Kitchenette	12” White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = None Detected

Floor-Sample Number	Sample Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
				Mastic = Positive Stop (Not Analyzed)
13-41C	Kitchenette	12" White Pattern Floor Tile/Mastic		Tile = None Detected Mastic = None Detected Mastic = Positive Stop (Not Analyzed)

3.0 SUMMARY AND RECOMMENDATIONS

PE completed a suspect ACM survey of flooring materials for the subject property prior to proposed renovation activities. The conclusions from the investigation are reported below.

The Environmental Protection Agency (EPA) and Missouri Department of Natural Resources (MDNR) classifies an asbestos containing material as containing greater than 1% asbestos by content. The below listed building materials were identified as ACMs. A licensed asbestos abatement contractor in the state of Missouri should be retained to abate all identified ACMs in compliance with applicable regulations prior to demolition. The building owner or building owner's designee shall have a Missouri air sampling professional perform air monitoring before, during and after the asbestos abatement.

Table 2
Summary of Identified ACM Analytical Data
Jefferson State Office Building

Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
First Floor - East Kitchenette	12" Brown Floor Tile/Mastic	352 SF (includes West Kitchenette and Elevator Lobby)	Tile = None Detected Mastic = 8% Chrysotile
First Floor – NE Corner	Flooring Beneath Carpet Squares	10,880 SF	Adhesive = None Detected Flooring = None Detected Adhesive = 9% Chrysotile

Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
First Floor - Mail Room	Mastic Beneath Carpet	1,790 SF	8 % Chrysotile
Second Floor	Mastic Beneath Carpet	12,300 SF	9 % Chrysotile
Third Floor - Mechanical Room	12” Beige Pattern Floor Tile/Mastic	529 SF	Tile = None Detected Mastic = 6% Chrysotile
Third Floor	Floor Mastic	12,300 SF	7 % Chrysotile
Fourth Floor	Floor Mastic	12,300 SF	8 % Chrysotile
First Floor - DSS Office	Mastic Beneath Carpet Squares	325 SF	Mastic = 6% Chrysotile Flooring = None Detected
First Floor - Kitchen Area/ Office	12” White Pattern Floor Tile/Mastic	1,086 SF (includes Kitchen)	Tile = None Detected Mastic = 6% Chrysotile
Fifth Floor - Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 9% Chrysotile
First Floor - DESE Conference Room	Mastic Beneath Carpet Squares	760 SF	Mastic = None Detected Flooring = None Detected Mastic = 9% Chrysotile
Sixth Floor – Kitchenette	12” Brown Floor Tile/Mastic	72 SF	Tile = None Detected Mastic = 7% Chrysotile
Sixth Floor	Floor Mastic	12,300 SF	8 % Chrysotile

Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
Seventh Floor	Floor Mastic Beneath Carpet	12,300 SF	9 % Chrysotile
Eighth Floor	Mastic Beneath Carpet	6,725 SF	6 % Chrysotile
Ninth Floor - Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 7% Chrysotile
Tenth Floor	Mastic Beneath Carpet Squares	12,300 SF	Mastic = None Detected Flooring = None Detected Mastic = 8% Chrysotile
Eleventh Floor	Mastic Beneath Carpet Squares	8,000 SF	Mastic = 9% Chrysotile Flooring = None Detected Flooring = None Detected
Thirteenth Floor - Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 6% Chrysotile
Thirteenth Floor - SE Office	Old Carpet/Mastic Beneath Partition Wall	Throughout Building	Carpet = None Detected Mastic = None Detected Mastic = 7% Chrysotile
Thirteenth Floor	Mastic Beneath Carpet Squares	12,300 SF	Mastic = 9% Chrysotile Flooring = None Detected Flooring = None Detected
Eleventh Floor - Mechanical Room	12” Beige Pattern Floor Tile/Mastic	378 SF	Tile = None Detected Mastic = 6% Chrysotile
Eleventh Floor - Caucus Room Entrance	Mastic Beneath Old Partition Wall		Mastic = None Detected

Location	Description	Estimated Quantity	PLM Result % Asbestos by Weight
		Throughout Building	Mastic = 7% Chrysotile Wall = None Detected Wall = None Detected
Eleventh Floor	Mastic Beneath Carpet Squares	(Included with Sample Group 22)	Mastic = None Detected Mastic = 8% Chrysotile Flooring = None Detected Flooring = None Detected
Twelfth Floor	Mastic Beneath Carpet Squares	12,300 SF	Mastic = 9% Chrysotile Flooring = None Detected Mastic = None Detected
Basement - Elevator Lobby	12" Brown Floor Tile/Mastic	630 SF	Tile = None Detected Mastic = 6% Chrysotile
Basement - B-15 Hallway	12" White/Brown Pattern Floor Tile/Mastic	880 SF	Tile = None Detected Mastic = 7% Chrysotile
Basement - Media Production Services Area	12" White Pattern Floor Tile/Mastic	308 SF	Tile = None Detected Mastic = 8% Chrysotile
Thirteenth Floor – Kitchenette	12" White Pattern Floor Tile/Mastic	72 SF	Tile = None Detected Mastic = None Detected Mastic = 7% Chrysotile

PE collected a total of 123 bulk samples (3 samples each of 41 homogeneous areas). Twenty-nine (29) of the forty-one (41) homogeneous areas contained >1% asbestos. The ACMs were observed in good (intact) condition at the time of the survey. Overall, the black mastic on the floors contains asbestos. The elevator lobbies, kitchenettes and some of the mechanical rooms have black mastic beneath 12" floor tile. Some of the mechanical rooms have painted concrete floors. Overall, there's asbestos-containing mastic beneath carpet under the partition walls on all the floors. It's difficult to determine the extent of black mastic beneath carpet squares on

each floor. Where it was difficult to determine, PE estimated the black mastic to exist throughout the floors. A cost per square foot for the removal of any carpet and black mastic could be provided by the asbestos abatement contractor as part of their bid. PE did not encounter any black mastic beneath carpet squares on the fifth, ninth and fourteenth floors in the areas observed. The fifth floor excluding the elevator lobby, kitchenette and mechanical room was reportedly abated of all floor tile/mastic. The laboratory reported "no mastic present" in Sample Groups 5 and 26, which represented the 12" brown floor tile mastic in the elevator lobbies. Sample Group 31 represented the 12" brown floor tile mastic in the basement elevator lobby and the mastic contained 6% Chrysotile asbestos. PE believes the 12" brown floor tile mastic in the basement elevator lobby is homogeneous (similar in appearance, color, texture and date of application) with the other floors and therefore all of the mastic should be treated as an asbestos containing material. Sample Location Maps are included in **Appendix D**. Asbestos Location Maps are included in **Appendix E**.

PE's asbestos survey was limited in that non-destructive sampling techniques were utilized during the survey. If any additional suspect ACMs are identified during renovation activities – it is recommended that these building materials be sampled and tested for asbestos content by a licensed asbestos inspector and qualified laboratory.

4.0 SIGNATURE AND QUALIFICATIONS

This suspect flooring ACM survey was conducted by Mr. Matt Honerkamp of PE. Specific qualifications based on education, training, licensure, and experience to assess this building and property and to conduct sampling for this inspector are provided in **Appendix A**. This Pre-Renovation Asbestos Survey was completed in conformance with standard industry practices and in compliance with applicable Federal, state, and local regulations.

Matt Honerkamp
Asbestos Inspector

September 21, 2021
Date

5.0 REFERENCES

National Emission Standard for Hazardous Air Pollutants - 40 CFR Part 61, Subpart M

OSHA General Industry Standard - 29 CFR 1910.1001

OSHA Construction Standard - 29 CFR 1926.1101

State of Missouri Code of Regulations (CSR) Title 10, Division 25, Hazardous Waste Management

USEPA 40 CFR – Resource Conservation and Recovery Act

APPENDIX A
Asbestos Inspector’s Qualifications

Missouri Department of NATURAL RESOURCES

dnr.mo.gov

Michael L. Parson, Governor

Dru Buntin, Acting Director

July 6, 2021

Matthew Honerkamp
2665 Scott Ave Ste B
Saint Louis, MO 63103

CERTIFICATION NUMBER:
7118061821MOIR3419

THIS CERTIFIES
Matthew Honerkamp
HAS COMPLETED THE CERTIFICATION
REQUIREMENTS FOR
Inspector

APPROVED: **07/07/2021**
EXPIRES: **07/07/2022**
TRAINING DATE: **06/18/2021**

Director of Air Pollution Control Program

RE: **Missouri Asbestos Occupation Certification Card**

Enclosed is your certification card for Asbestos Inspector, as issued by the Asbestos Unit of the Missouri Department of Natural Resources' Air Pollution Control Program.

Missouri Certification Number: 7118061821MOIR3419
Course Training Date: June 18, 2021
Missouri Certification Approval Date: July 07, 2021
Missouri Certification Expiration Date: July 07, 2022

Note:

- All Missouri-certified asbestos personnel must comply with the following statutes and regulations:
  - Sections 643.225 to 643.250, RSMo;
  - 10 CSR 10-6.241 *Asbestos Projects-Registration, Abatement, Notification, Inspection, Demolition, and Performance Requirements; and*
  - 10 CSR 10-6.250 *Asbestos Projects-Certification, Accreditation and Business Exemption Requirements.*
- To keep your occupation certification up-to-date, you must complete an annual refresher course and submit a renewal application each year.
- In order to be eligible to renew your certification, you must successfully complete a refresher course with a Missouri-accredited training provider within 12 months of the expiration date of your current training certificate. If you exceed this grace period, you will be required to retake a Missouri-accredited initial course in order to be eligible for Missouri certification.

To obtain a copy of the certification renewal application, or review regulations and requirements, please visit our website at http://dnr.mo.gov/env/apcp/asbestos/index.htm.

If you have any questions please call the Air Pollution Control Program at 573-751-4817.

AIR POLLUTION CONTROL PROGRAM

Director of Air Pollution Control Program

APPENDIX B
Laboratory Accreditation

United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200742-0

EMSL Analytical, Inc.

St. Louis, MO

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2021-04-01 through 2022-03-31

Effective Dates

For the National Voluntary Laboratory Accreditation Program

NVLAP® National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

EMSL Analytical, Inc.
100 Green Park Industrial Park
St. Louis, MO 63123
Dr. Jeff Siria Ph.D
Phone: 314-577-0150 Fax: 314-776-3313
Email: jsiria@emsl.com
http://www.emsl.com

ASBESTOS FIBER ANALYSIS — NVLAP LAB CODE 200742-0

Bulk Asbestos Analysis

Code	*Description*
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	*Description*
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

APPENDIX C
Laboratory Bulk Sampling Analytical Report

EMSL Analytical, Inc.

100 Green Park Industrial Court Saint Louis, MO 63123

Tel/Fax: (314) 577-0150 / (314) 776-3313

http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Attention:	Bill Pietroburgo	**Phone:**	(314) 486-3772
	Professional Environmental Engineers	**Fax:**	(314) 531-0068
	2665 Scott Avenue	**Received Date:**	08/13/2021 8:00 AM
	Suite B	**Analysis Date:**	08/19/2021
	St. Louis, MO 63103	**Collected Date:**	
Project:	McClure Engr. / Jefferson State Office Bldg.		

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
1-1A-Floor Tile *392108222-0001*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-1A-Mastic *392108222-0001A*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
1-1B-Floor Tile *392108222-0002*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-1B-Mastic *392108222-0002A*					Positive Stop (Not Analyzed)
1-1C-Floor Tile *392108222-0003*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-1C-Mastic *392108222-0003A*					Positive Stop (Not Analyzed)
1-2A-Adhesive *392108222-0004*		Peach Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2A-Flooring *392108222-0004A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2A-Adhesive *392108222-0004B*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
1-2B-Adhesive *392108222-0005*		Peach Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2B-Flooring *392108222-0005A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2B-Adhesive *392108222-0005B*					Positive Stop (Not Analyzed)
1-2C-Adhesive *392108222-0006*		Peach Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2C-Flooring *392108222-0006A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-2C-Adhesive *392108222-0006B*					Positive Stop (Not Analyzed)
1-3A-Adhesive *392108222-0007* *No black layer present.*		Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 08/19/2021 20:33:55

EMSL Analytical, Inc.
100 Green Park Industrial Court Saint Louis, MO 63123
Tel/Fax: (314) 577-0150 / (314) 776-3313
http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
1-3A-Flooring *392108222-0007A* *No black layer present.*		Gray Non-Fibrous Homogeneous		16% Quartz 84% Non-fibrous (Other)	None Detected
1-3A-Flooring *392108222-0007B* *No black layer present.*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-3B-Adhesive *392108222-0008* *No black layer present.*		Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-3B-Flooring *392108222-0008A* *No black layer present.*		Gray Non-Fibrous Homogeneous		17% Quartz 83% Non-fibrous (Other)	None Detected
1-3B-Flooring *392108222-0008B* *No black layer present.*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-3C-Adhesive *392108222-0009*		Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-3C-Flooring *392108222-0009A*		Black Non-Fibrous Homogeneous		27% Quartz 73% Non-fibrous (Other)	None Detected
1-4A-Mastic *392108222-0010*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
1-4A-Mastic *392108222-0010A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-4B *392108222-0011*					Positive Stop (Not Analyzed)
1-4C *392108222-0012*					Positive Stop (Not Analyzed)
2-5A *392108222-0013* *No mastic present.*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
6-5B *392108222-0014* *No mastic present.*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9-5C *392108222-0015* *No mastic present.*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
2-6A-Mastic *392108222-0016*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
2-6A-Mastic *392108222-0016A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
2-6B *392108222-0017*					Positive Stop (Not Analyzed)
2-6C *392108222-0018*					Positive Stop (Not Analyzed)
3-7A-Floor Tile *392108222-0019*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
3-7A-Mastic *392108222-0019A*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
3-7B-Floor Tile *392108222-0020*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
3-7B-Mastic *392108222-0020A*					Positive Stop (Not Analyzed)
3-7C-Floor Tile *392108222-0021*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
3-7C-Mastic *392108222-0021A*					Positive Stop (Not Analyzed)
3-8A *392108222-0022*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
3-8B *392108222-0023*					Positive Stop (Not Analyzed)
3-8C *392108222-0024*					Positive Stop (Not Analyzed)
4-9A-Mastic *392108222-0025*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
4-9A-Mastic *392108222-0025A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
4-9B *392108222-0026*					Positive Stop (Not Analyzed)
4-9C *392108222-0027*					Positive Stop (Not Analyzed)
1-10A-Mastic *392108222-0028*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
1-10A-Flooring *392108222-0028A*		Gray Non-Fibrous Homogeneous		19% Quartz 81% Non-fibrous (Other)	None Detected
1-10B *392108222-0029*					Positive Stop (Not Analyzed)
1-10C *392108222-0030*					Positive Stop (Not Analyzed)

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EMSL Order:	392108222
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Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
1-11A-Floor Tile *392108222-0031* *No mastic present.*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-11A-Leveler *392108222-0031A* *No mastic present.*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-11B-Floor Tile *392108222-0032* *No mastic present.*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-11B-Leveler *392108222-0032A* *No mastic present.*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-11C-Floor Tile *392108222-0033*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-11C-Mastic *392108222-0033A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-12A-Floor Tile *392108222-0034*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-12A-Mastic *392108222-0034A*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
1-12B-Floor Tile *392108222-0035*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-12B-Mastic *392108222-0035A*					Positive Stop (Not Analyzed)
1-12C-Floor Tile *392108222-0036*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-12C-Mastic *392108222-0036A*					Positive Stop (Not Analyzed)
1-13A *392108222-0037*		Gray Non-Fibrous Homogeneous		12% Quartz 88% Non-fibrous (Other)	None Detected
1-13B *392108222-0038*		Gray Non-Fibrous Homogeneous		13% Quartz 87% Non-fibrous (Other)	None Detected
1-13C *392108222-0039*		Gray Non-Fibrous Homogeneous		16% Quartz 84% Non-fibrous (Other)	None Detected
5-14A-Floor Tile *392108222-0040*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
5-14A-Mastic *392108222-0040A*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
5-14B-Floor Tile *392108222-0041*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
5-14B-Mastic *392108222-0041A*					Positive Stop (Not Analyzed)
5-14C-Floor Tile *392108222-0042*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
5-14C-Mastic *392108222-0042A*					Positive Stop (Not Analyzed)
1-15A-Mastic *392108222-0043*		Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
1-15A-Flooring *392108222-0043A*		Gray Non-Fibrous Homogeneous		16% Quartz 84% Non-fibrous (Other)	None Detected
1-15A-Mastic *392108222-0043B*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
1-15B *392108222-0044*					Positive Stop (Not Analyzed)
1-15C *392108222-0045*					Positive Stop (Not Analyzed)
6-16A-Floor Tile *392108222-0046*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
6-16A-Mastic *392108222-0046A*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
9-16B-Floor Tile *392108222-0047*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9-16B-Mastic *392108222-0047A*					Positive Stop (Not Analyzed)
14-16C-Floor Tile *392108222-0048*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
14-16C-Mastic *392108222-0048A*					Positive Stop (Not Analyzed)
6-17A *392108222-0049*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
6-17B *392108222-0050*					Positive Stop (Not Analyzed)
6-17C *392108222-0051*					Positive Stop (Not Analyzed)
7-18A *392108222-0052*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
7-18B *392108222-0053*					Positive Stop (Not Analyzed)

Initial report from: 08/19/2021 20:33:55

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EMSL Order: 392108222
Customer ID: PROF34
Customer PO: N/A
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
7-18C *392108222-0054*					Positive Stop (Not Analyzed)
8-19A-Mastic *392108222-0055*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
8-19A-Mastic *392108222-0055A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
8-19B *392108222-0056*					Positive Stop (Not Analyzed)
8-19C *392108222-0057*					Positive Stop (Not Analyzed)
9-20A-Floor Tile *392108222-0058*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9-20A-Mastic *392108222-0058A*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
9-20B-Floor Tile *392108222-0059*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9-20B-Mastic *392108222-0059A*					Positive Stop (Not Analyzed)
9-20C-Floor Tile *392108222-0060*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9-20C-Mastic *392108222-0060A*					Positive Stop (Not Analyzed)
10-21A-Mastic *392108222-0061*		Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
10-21A-Flooring *392108222-0061A*		Gray Non-Fibrous Homogeneous		18% Quartz 82% Non-fibrous (Other)	None Detected
10-21A-Mastic *392108222-0061B*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
10-21B *392108222-0062*					Positive Stop (Not Analyzed)
10-21C *392108222-0063*					Positive Stop (Not Analyzed)
11-22A-Mastic *392108222-0064*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
11-22A-Flooring *392108222-0064A*		Gray Non-Fibrous Homogeneous		19% Quartz 81% Non-fibrous (Other)	None Detected
11-22A-Flooring *392108222-0064B*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 08/19/2021 20:33:55

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EMSL Order: 392108222
Customer ID: PROF34
Customer PO: N/A
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
11-22B *392108222-0065*					Positive Stop (Not Analyzed)
11-22C *392108222-0066*					Positive Stop (Not Analyzed)
13-23A-Floor Tile *392108222-0067*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-23A-Mastic *392108222-0067A*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
13-23B-Floor Tile *392108222-0068*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-23B-Mastic *392108222-0068A*					Positive Stop (Not Analyzed)
13-23C-Floor Tile *392108222-0069*		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-23C-Mastic *392108222-0069A*					Positive Stop (Not Analyzed)
13-24A-Carpet *392108222-0070*		Various Fibrous Heterogeneous	87% Synthetic	13% Non-fibrous (Other)	None Detected
13-24A-Mastic *392108222-0070A*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-24A-Mastic *392108222-0070B*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
13-24B-Carpet *392108222-0071*		Various Fibrous Heterogeneous	88% Synthetic	12% Non-fibrous (Other)	None Detected
13-24B-Mastic *392108222-0071A*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-24B-Mastic *392108222-0071B*					Positive Stop (Not Analyzed)
13-24C-Carpet *392108222-0072*		Various Fibrous Homogeneous	89% Synthetic	11% Non-fibrous (Other)	None Detected
13-24C-Mastic *392108222-0072A*					Positive Stop (Not Analyzed)
13-25A-Mastic *392108222-0073*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
13-25A-Flooring *392108222-0073A*		Gray Non-Fibrous Homogeneous		19% Quartz 81% Non-fibrous (Other)	None Detected
13-25A-Flooring *392108222-0073B*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 08/19/2021 20:33:55

EMSL Analytical, Inc.

100 Green Park Industrial Court Saint Louis, MO 63123

Tel/Fax: (314) 577-0150 / (314) 776-3313

http://www.EMSL.com / saintlouislab@emsl.com

EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
13-25B					Positive Stop (Not Analyzed)
392108222-0074					
13-25C					Positive Stop (Not Analyzed)
392108222-0075					
14-26A		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0076					
No mastic present.					
14-26B		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0077					
No mastic present.					
14-26C		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0078					
No mastic present.					
11-27A-Floor Tile		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0079					
11-27A-Mastic		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
392108222-0079A					
11-27B-Floor Tile		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0080					
11-27B-Mastic					Positive Stop (Not Analyzed)
392108222-0080A					
11-27C-Floor Tile		Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0081					
11-27C-Mastic					Positive Stop (Not Analyzed)
392108222-0081A					
11-28A-Mastic		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0082					
11-28A-Mastic		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
392108222-0082A					
11-28A-Wall		Black Non-Fibrous Homogeneous		17% Quartz 83% Non-fibrous (Other)	None Detected
392108222-0082B					
11-28A-Wall		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0082C					
11-28B					Positive Stop (Not Analyzed)
392108222-0083					
11-28C					Positive Stop (Not Analyzed)
392108222-0084					
11-29A-Mastic		Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
392108222-0085					

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EMSL Order: 392108222
Customer ID: PROF34
Customer PO: N/A
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
11-29A-Mastic *392108222-0085A*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
11-29A-Flooring *392108222-0085B*		Gray Non-Fibrous Homogeneous		18% Quartz 82% Non-fibrous (Other)	None Detected
11-29A-Flooring *392108222-0085C*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
11-29B *392108222-0086*					Positive Stop (Not Analyzed)
11-29C *392108222-0087*					Positive Stop (Not Analyzed)
12-30A-Mastic *392108222-0088*		Black Non-Fibrous Homogeneous		91% Non-fibrous (Other)	9% Chrysotile
12-30A-Flooring *392108222-0088A*		Gray Non-Fibrous Homogeneous		19% Quartz 81% Non-fibrous (Other)	None Detected
12-30A-Mastic *392108222-0088B*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
12-30B *392108222-0089*					Positive Stop (Not Analyzed)
12-30C *392108222-0090*					Positive Stop (Not Analyzed)
B-31A-Floor Tile *392108222-0091*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-31A-Mastic *392108222-0091A*		Black Non-Fibrous Homogeneous		94% Non-fibrous (Other)	6% Chrysotile
B-31B-Floor Tile *392108222-0092*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-31B-Mastic *392108222-0092A*					Positive Stop (Not Analyzed)
B-31C-Floor Tile *392108222-0093*		Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-31C-Mastic *392108222-0093A*					Positive Stop (Not Analyzed)
B-32A-Floor Tile *392108222-0094*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-32A-Mastic *392108222-0094A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-32B-Floor Tile *392108222-0095*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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EMSL Order: 392108222
Customer ID: PROF34
Customer PO: N/A
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B-32B-Mastic *392108222-0095A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-32C-Floor Tile *392108222-0096*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-32C-Mastic *392108222-0096A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-33A-Floor Tile *392108222-0097*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-33A-Mastic *392108222-0097A*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
B-33B-Floor Tile *392108222-0098*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-33B-Mastic *392108222-0098A*					Positive Stop (Not Analyzed)
B-33C-Floor Tile *392108222-0099*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-33C-Mastic *392108222-0099A*					Positive Stop (Not Analyzed)
B-34A-Floor Tile *392108222-0100*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-34A-Mastic *392108222-0100A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-34B-Floor Tile *392108222-0101*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-34B-Mastic *392108222-0101A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-34C-Floor Tile *392108222-0102*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-34C-Mastic *392108222-0102A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35A-Floor Tile *392108222-0103*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35A-Mastic *392108222-0103A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35A-Leveler *392108222-0103B*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35B-Floor Tile *392108222-0104*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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EMSL Order: 392108222
Customer ID: PROF34
Customer PO: N/A
Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B-35B-Mastic *392108222-0104A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35B-Leveler *392108222-0104B*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35C-Floor Tile *392108222-0105*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-35C-Mastic *392108222-0105A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36A-Mastic *392108222-0106*		Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36A-Flooring *392108222-0106A*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36A-Mastic *392108222-0106B*		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36B-Mastic *392108222-0107*		Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36B-Flooring *392108222-0107A*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36B-Mastic *392108222-0107B*		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36C-Mastic *392108222-0108*		Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36C-Flooring *392108222-0108A*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-36C-Mastic *392108222-0108B*		Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-37A-Floor Tile *392108222-0109*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-37A-Mastic *392108222-0109A*		Black Non-Fibrous Homogeneous		92% Non-fibrous (Other)	8% Chrysotile
B-37B-Floor Tile *392108222-0110*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-37B-Mastic *392108222-0110A*					Positive Stop (Not Analyzed)
B-37C-Floor Tile *392108222-0111*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-37C-Mastic *392108222-0111A*					Positive Stop (Not Analyzed)

Initial report from: 08/19/2021 20:33:55

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EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
B-38A *392108222-0112*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-38B *392108222-0113*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
B-38C *392108222-0114*		Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
6-39A *392108222-0115*		Gray Non-Fibrous Homogeneous		14% Quartz 86% Non-fibrous (Other)	None Detected
10-39B *392108222-0116*		Gray Non-Fibrous Homogeneous		11% Quartz 89% Non-fibrous (Other)	None Detected
14-39C *392108222-0117*		Gray Non-Fibrous Homogeneous		15% Quartz 85% Non-fibrous (Other)	None Detected
6-40A *392108222-0118*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
10-40B *392108222-0119*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
14-40C *392108222-0120*		Various Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41A-Floor Tile *392108222-0121*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41A-Mastic *392108222-0121A*		Orange Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41A-Mastic *392108222-0121B*		Black Non-Fibrous Homogeneous		93% Non-fibrous (Other)	7% Chrysotile
13-41B-Floor Tile *392108222-0122*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41B-Mastic *392108222-0122A*		Orange Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41B-Mastic *392108222-0122B*					Positive Stop (Not Analyzed)
13-41C-Floor Tile *392108222-0123*		White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41C-Mastic *392108222-0123A*		Orange Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
13-41C-Mastic *392108222-0123B*					Positive Stop (Not Analyzed)

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EMSL Order:	392108222
Customer ID:	PROF34
Customer PO:	N/A
Project ID:	

Analyst(s)

Donald Schmidt (13)
Sue Ferrario (130)
Sarah Kuper (18)

Jeff Siria, Laboratory Manager
or Other Approved Signatory

Initial report from: 08/19/2021 20:33:55

OrderID: 392108222

EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(lab use only)*: 392108222

PHONE:
FAX:

Company Name : Professional Env. Engineers	EMSL Customer ID: PROF34
Street: 2665 Scott Ave Suite B	City: St. Louis / State or Province: MO
Zip/Postal Code: 63103 / Country: USA	Telephone #: 636-219-0509 / Fax #: —
Report To (Name): Bill Pietroburgo	Please Provide Results via: ☐ Fax ☒ Email
email Address: bpietroburgo@pe-engrs.com	Purchase Order Number: N/A
Client Project ID: McClure Engr. / Jefferson State office Bldg.	EMSL Project ID *(internal use only)*:
State or Province Collected: MO	CT only ☐ Commercial/Taxable ☐ Residential/Tax Exempt

EMSL-Bill to: ☒ Same ☐ Different - *If bill to is different note instructions in comment. Third party billing requires written authorization from third party*

Turnaround Time (TAT) Options Please Check

☐ 3 Hr[1] | ☐ 4-4.5Hr[1] AHERA Only | ☐ 6 Hr[1] | ☐ 24 Hr | ☐ 32 Hr[2] | ☐ 48 Hr | ☐ 72 Hr | ☐ 96 Hr | ☒ 1 Week | ☐ 2 Week

[1]*Premium Service Charge applies for 3 Hour TEM AHERA or EPA Level II TAT – you will be asked to sign an authorization form. TEM Air 3-6 Hour, please call ahead to schedule*
[2] *32 Hour TAT available for select tests only; samples must be submitted by 11:30 am.*

PCM - Air
- ☐ NIOSH 7400
- ☐ w/ OSHA 8hr. TWA

PLM - Bulk (reporting limit)
- ☒ PLM EPA 600/R-93/116 (<1%)
- ☐ PLM EPA NOB (<1%)

Point Count
- ☐ 400 (<0.25%) ☐ 1000 (<0.1%)

Point Count w/Gravimetric
- ☐ 400 (<0.25%) ☐ 1000 (<0.1%)
- ☐ NYS 198.1 (friable - NY)
- ☐ NYS 198.6 NOB (non-friable-NY)
- ☐ NYS 198.8 SOF-V
- ☐ NIOSH 9002 (<1%)

TEM – Air[1]
- ☐ AHERA 40 CFR, Part 763
- ☐ NIOSH 7402
- ☐ EPA Level II
- ☐ ISO 10312

TEM - Bulk
- ☐ TEM EPA NOB
- ☐ NYS NOB 198.4 (non-friable-NY)
- ☐ TEM EPA 600/R-93/116 with milling prep (<0.1%)*

TEM – Water: EPA 100.2
Fibers >10µm ☐ Waste ☐ Drinking
All Fiber Sizes ☐ Waste ☐ Drinking

TEM- Settled Dust
- ☐ Microvac - ASTM D 5755
- ☐ Wipe - ASTM D6480
- ☐ Carpet Sonication (EPA 600/J-93/167)

Soil – Rock – Vermiculite (reporting limit)
- ☐ PLM EPA 600/R-93/116 with milling prep (<0.25%)
- ☐ TEM EPA 600/R-93/116 with milling prep (<0.1%)*
- ☐ TEM Qualitative via Filtration Prep
- ☐ TEM Qualitative via Drop Mount Prep
- ☐ Cincinnati Method EPA 600/R-04/004 – PLM/TEM

*Lower reporting limits avaialble on request

Other test (please specify):

☒ **Stop At First Positive** *(clearly identify homogenous areas below)*

Filter Pore Size (Air Samples): ☐ 0.8µm ☐ 0.45µm

Sampler's Name: Matt Honerkamp **Sampler's Signature:** Matt Honerkamp

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
1-1A	12" Brn. Floor Tile/Mastic - East Kitchenette	N/A	8-9-21 11:20
1-1B	"		
1-1C	"		
1-2A	Flooring Beneath Carpet Sq. - Rooms 103/104 Hallway		
1-2B	"		

Client Sample # (s): 1A - 4IC **Total # of Samples:** 123

Relinquished by (Client): Matt Honerkamp **Date:** 8-12-21 **Time:** 17:20

Received by (Lab): Betty Barton **Date:** 8-13-21 **Time:** 8:00D

Comments/Special Instructions:

Please also email results to: mhonerkamp@pe-engrs.com

OrderID: 392108222

EMSL ANALYTICAL, INC.
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Asbestos Chain of Custody

EMSL Order Number (*Lab Use Only*): 392108222

PHONE:
FAX:

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
1-2C	Flooring Beneath Carpet Sq. - Floor #193/104 Hallway	N/A	8-9→8-11-21
1-3A	Black Staining Beneath Carpet Sq. -	File/Storage Area	
1-3B	—		
1-3C	—		
1-4A	Black Mastic Beneath Carpet -	Mail Room	
1-4B	—		
1-4C	—		
2-5A	12" Brn. Floor Tile/Mastic - Elev. Lobby		
6-5B	—		
9-5C	—		
2-6A	Mastic Beneath Carpet - By Elev. Lobby		
2-6B	—		
2-6C	— West Ctr. of Floor		
3-7A	12" Beige Pattern Floor Tile/Mastic - Mech. Rm.		
3-7B	—		
3-7C	—		
3-8A	Floor Mastic - Comm. Rm.		
3-8B	-		
3-8C	- West Side of Floor		
4-9A	Floor Mastic - S. Lg. Conf. Rm.		
4-9B	—		

***Comments/Special Instructions:**

AE/McClure Engr.

Page 2 of 7 pages

OrderID: 392108222

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Asbestos Chain of Custody

EMSL Order Number (*Lab Use Only*):

392108222

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Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
4-9C	Floor Mastic – Pipe Chase Hallway	N/A	8-9→8-11-21
1-10A	Mastic Beneath Carpet Sq. – DSS Office		
1-10B	–		
1-10C	–		
1-11A	12" Beige Pattern Floor Tile/Mastic – Cafe		
1-11B	–		
1-11C	–		
1-12A	12" White Pattern Floor Tile/Mastic – Kitchen Area		
1-12B	–		
1-12C	–		
1-13A	6" Ceramic Tile Grout – Kitchen		
1-13B	–		
1-13C	–		
5-14A	12" Beige Pattern Floor Tile/Mastic – Mech. Rm.		
5-14B		–	
5-14C		–	
1-15A	Mastic Beneath Carpet Sq. – DESE Conf. Rm.		
1-15B	– State Board of Educ. Rm.		
1-15C	– Adj. Hallway		
6-16A	12" Brn. Floor Tile/Mastic – Kitchenette		
9-16B	–		

***Comments/Special Instructions:**

PE/McClure Engr.

Page 3 of 7 pages

OrderID: 392108222

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Asbestos Chain of Custody

EMSL Order Number (*Lab Use Only*): 392108222

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Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
14-16C	12" Brn. Floor Tile/Mastic - Kitchenette	N/A	8-9→8-11-21
6-17A	Floor Mastic — Elec. Closet		
6-17B	—		
6-17C	(Beneath Carpet) - By West Wall		
7-18A	Floor Mastic — Elec. Closet		
7-18B	—		
7-18C	(Beneath Carpet) - Mech. Rm. Hallway		
8-19A	Mastic Beneath Carpet - West Ctr. Wall		
8-19B	—		
8-19C	—		
9-20A	12" Beige Pattern Floor Tile/Mastic - Mech. Rm.		
9-20B		—	
9-20C		—	
10-21A	Mastic Beneath Carpet Sq. - N. Ctr. of Floor		
10-21B	—		
10-21C	—		
11-22A	Mastic Beneath Carpet Sq. - Near NW Corner		
11-22B	—		
11-22C	—		
13-23A	12" Beige Pattern Floor Tile/Mastic - Mech. Rm.		
13-23B		—	

***Comments/Special Instructions:**

PE/McClure Engr.

Page 4 of 7 pages

OrderID: 392108222

EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(Lab Use Only)*: 392108222

PHONE:
FAX:

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
13-23C	12" Beige Pattern Floor Tile/Mastic - Mech. Rm.	N/A	8-9-18-11-2
13-24A	Carpet/Mastic Beneath Old Wall Partition - SE Office		
13-24B	—		
13-24C	—		
13-25A	Mastic Beneath Carpet Sq. - Training Room		
13-25B	—		
13-25C	—		
14-26A	12" Brn. Floor Tile/Mastic - Elev. Cobby		
14-26B	—		
14-26C	—		
11-27A	12" Beige Pattern Floor Tile/Mastic - Mech. Rm.		
11-27B	—		
11-27C	—		
11-28A	Mastic Beneath Old Partition Wall - Caucus Rm. Ent.		
11-28B	—		
11-28C	—		
11-29A	Mastic Beneath Carpet Sq. - Meeting/Viewing Room		
11-29B	—		
11-29C	—		
12-30A	Mastic Beneath Carpet Sq. - West Ctr. of Floor		
12-30B	—		

***Comments/Special Instructions:**

PE / McClure Engr.

OrderID: 392108222

EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(Lab Use Only)*: 392108222

PHONE:
FAX:

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
12-30C	Mastic Beneath Carpet Sq. - West-Ctr. of Floor	N/A	8-9-18-11-21
B-31A	12" Brn. Floor Tile/Mastic - Elev. Lobby		
B-31B	"		
B-31C	"		
B-32A	12" White/Gray Pattern Floor Tile/Mastic - Rm. V-1		
B-32B	"		
B-32C	" - Women's RR		
B-33A	12" White/Brown Pattern Floor Tile/Mastic - B-15 Hallway		
B-33B	"		
B-33C	"		
B-34A	12" White/Gray Pattern Floor Tile/Mastic - Men's RR		
B-34B	"		
B-34C	"		
B-35A	12" White/Gray Pattern Floor Tile/Mastic - Print Shop		
B-35B	"		
B-35C	"		
B-36A	Mastic Beneath Carpet - Media Prod. Services Area		
B-36B	"		
B-36C	"		
B-37A	12" White Pattern Floor Tile/Mastic - Media Prod. Services Area		
B-37B	"		

***Comments/Special Instructions:**

PE/McClure Engr.

Page 6 of 7 pages

OrderID: 392108222

EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(Lab Use Only)*: 392108222

PHONE:
FAX:

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
B-37C	12" White Pattern Floor Tile/Mastic -	Media Prod. Services Area	N/A 8-9-18 11:2
B-38A	Glue Beneath Carpet Sq. -	Media Prod. Services Area office	
B-38B	"	"	
B-38C	"	"	
G-39A	Clay Tile Grout - Women's RR		
10-39B	"		
14-39C	"		
6-40A	Clay Tile Grout - Men's RR		
10-40B	"		
14-40C	"		
13-41A	12" White Pattern Floor Tile/Mastic -	Kitchenette	
13-41B	"	"	
13-41C	"	"	

***Comments/Special Instructions:**

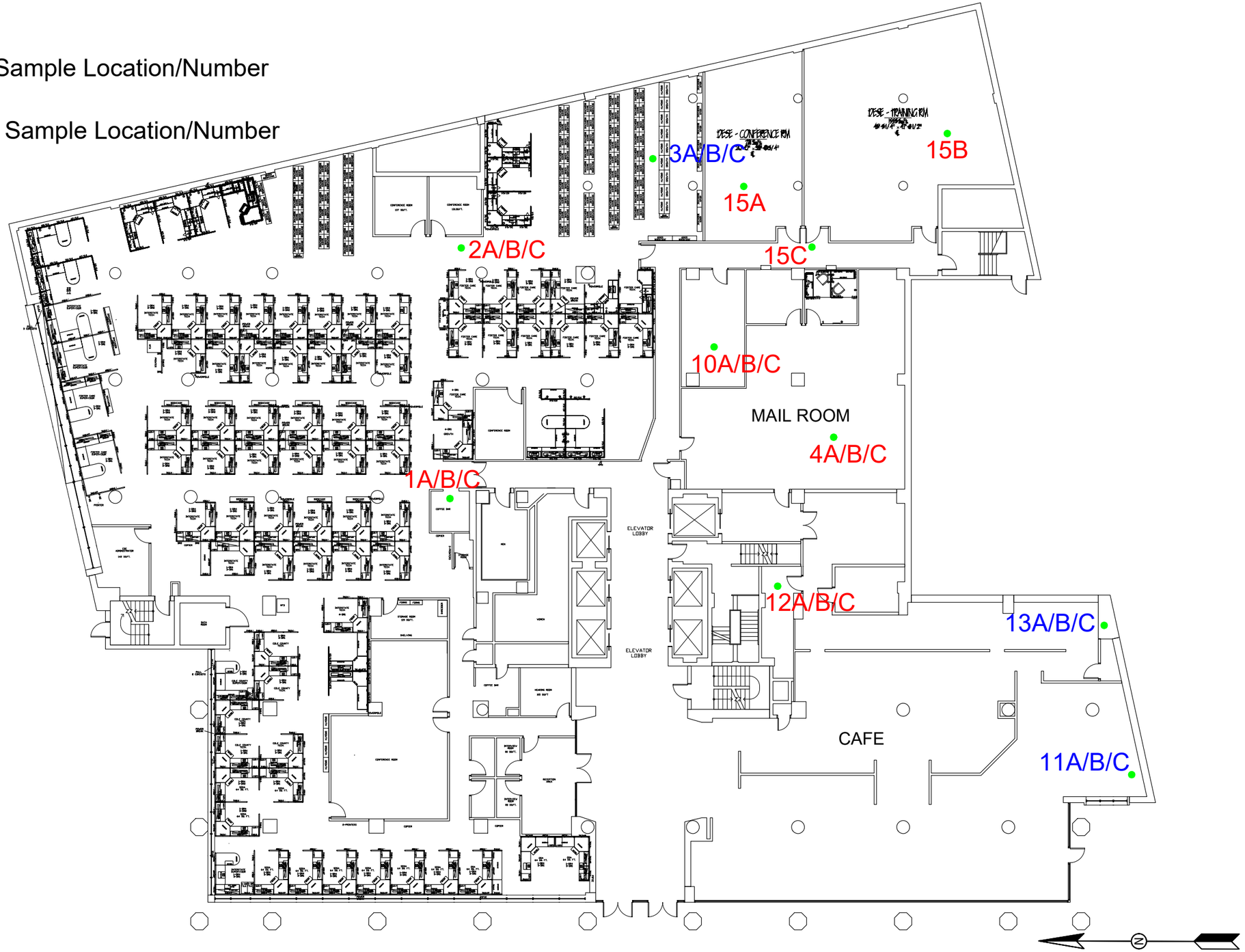
PE/McClure Engr.

Page 7 of 7 pages

APPENDIX D
Sample Location Maps

Legend

- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



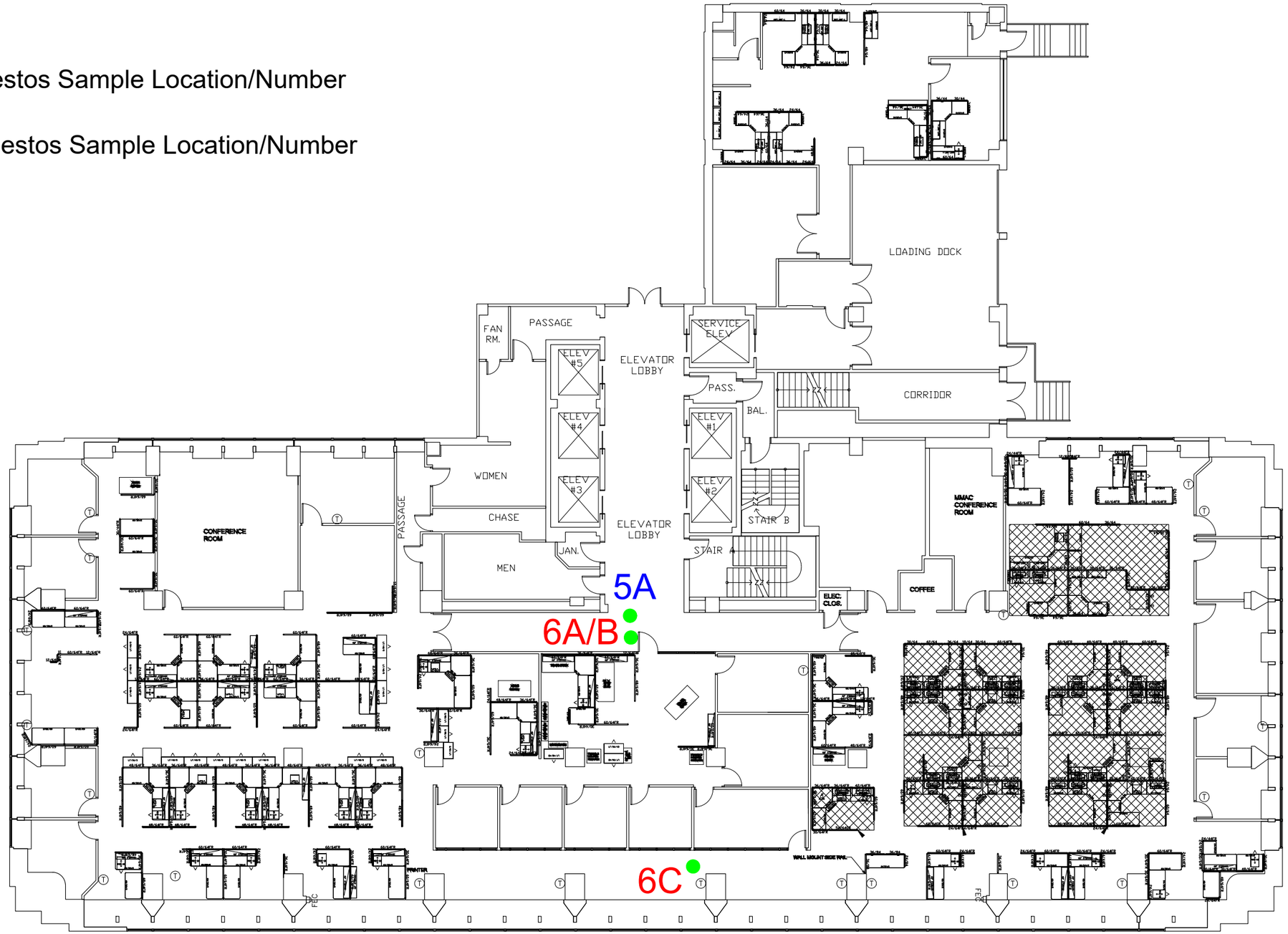
Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

1st Floor		Date: 8/30/21
Project No.	238.01.003	Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

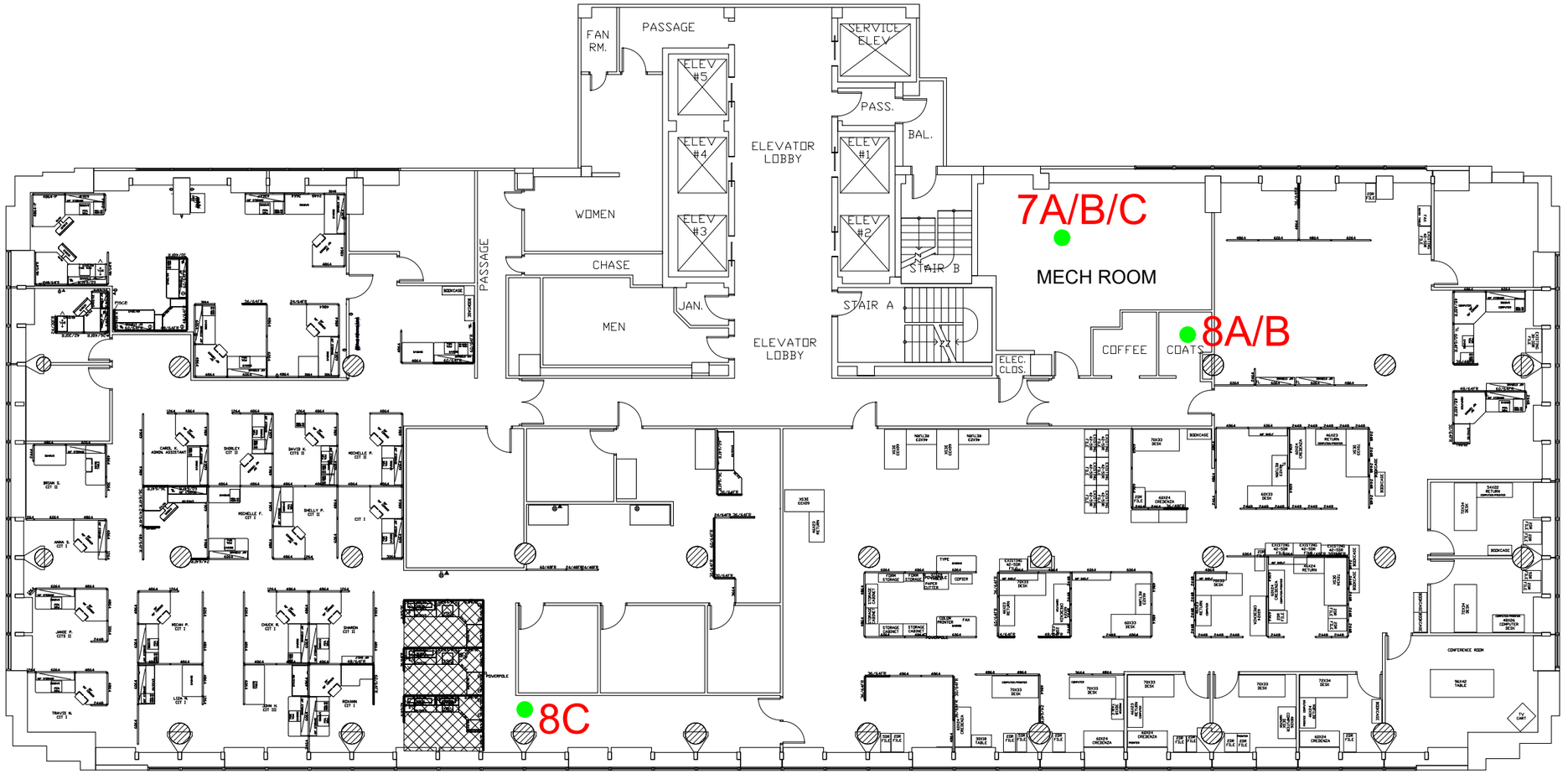
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	2nd Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

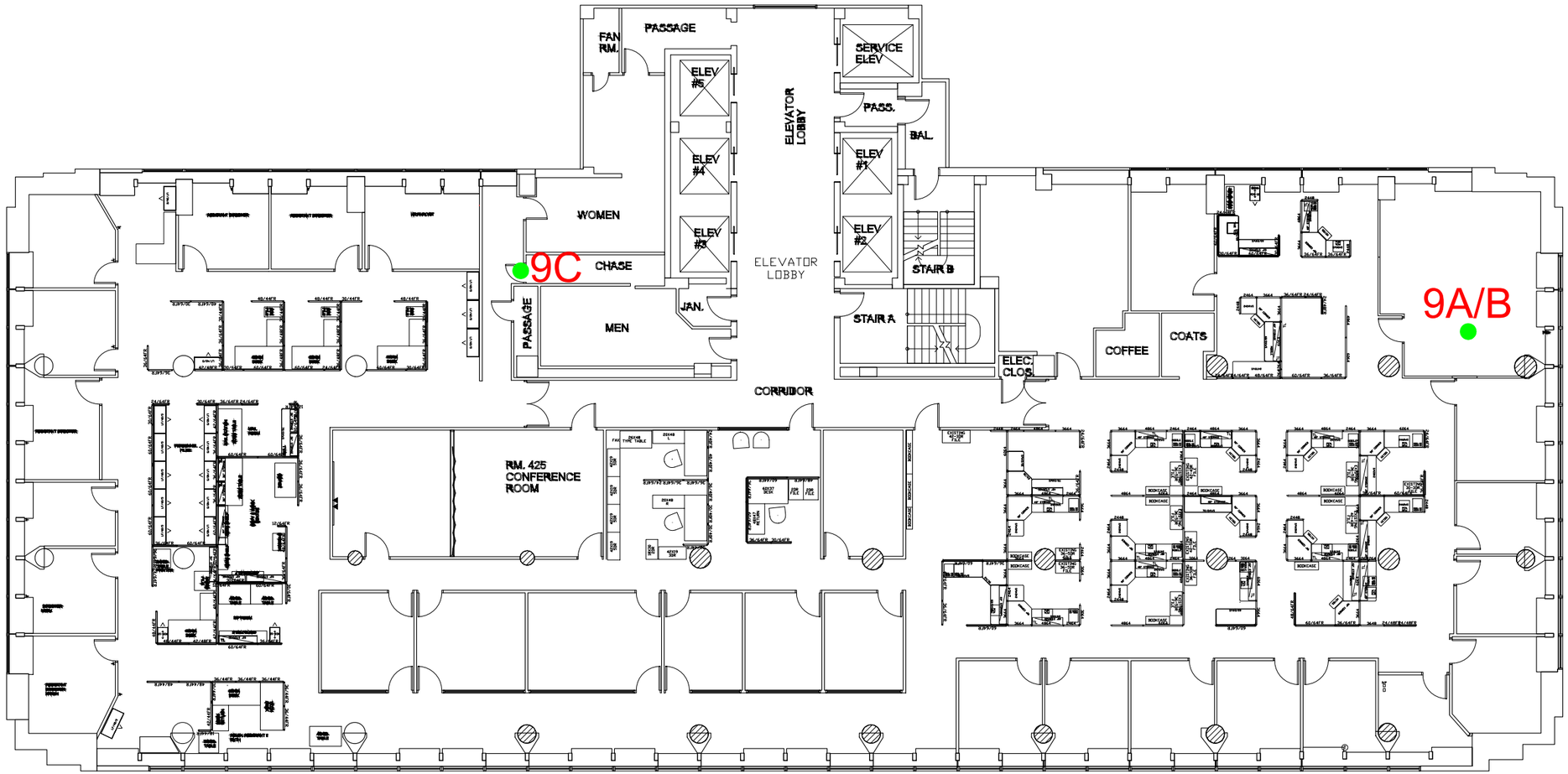
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	3rd Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

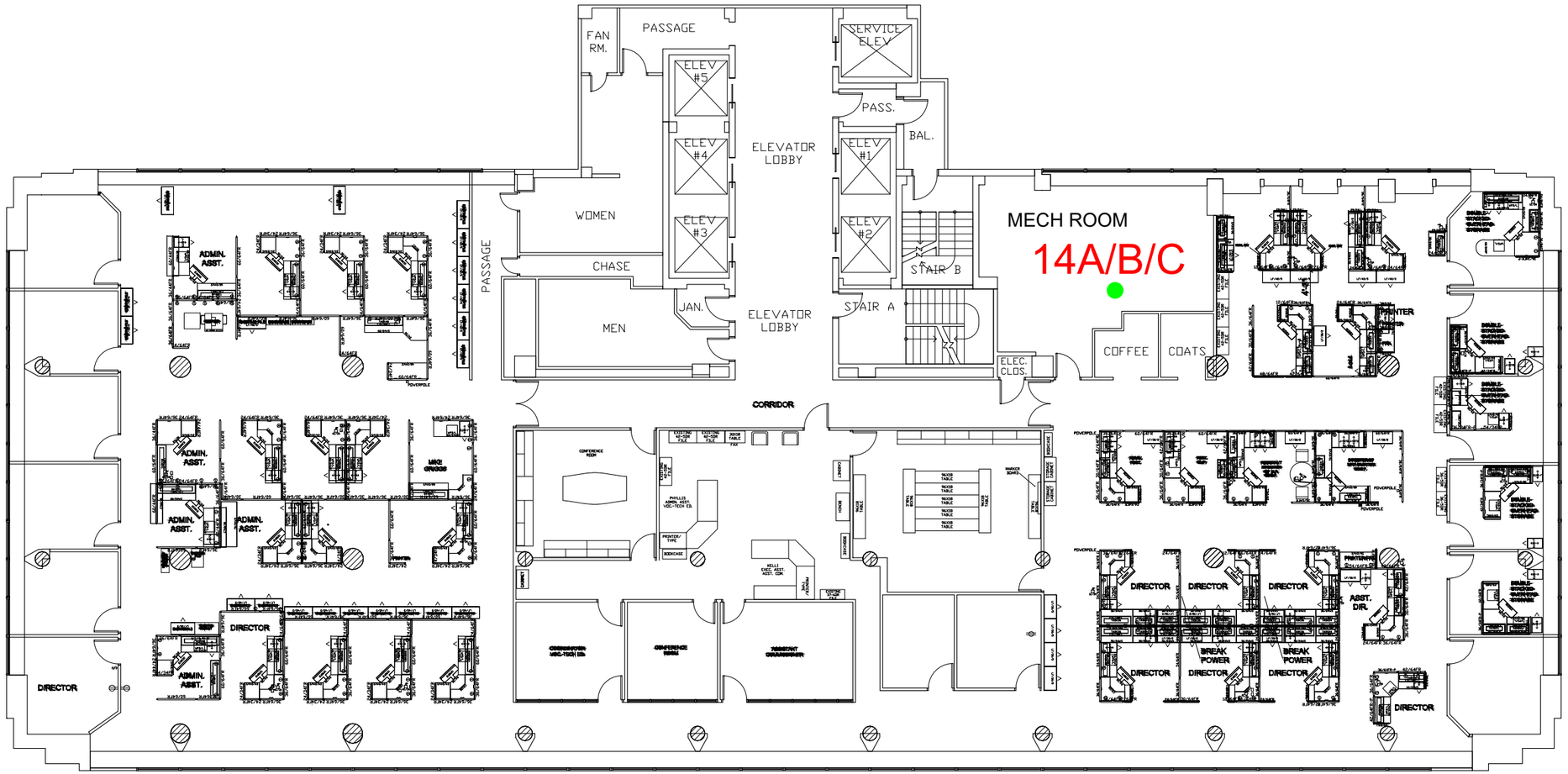
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	4th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

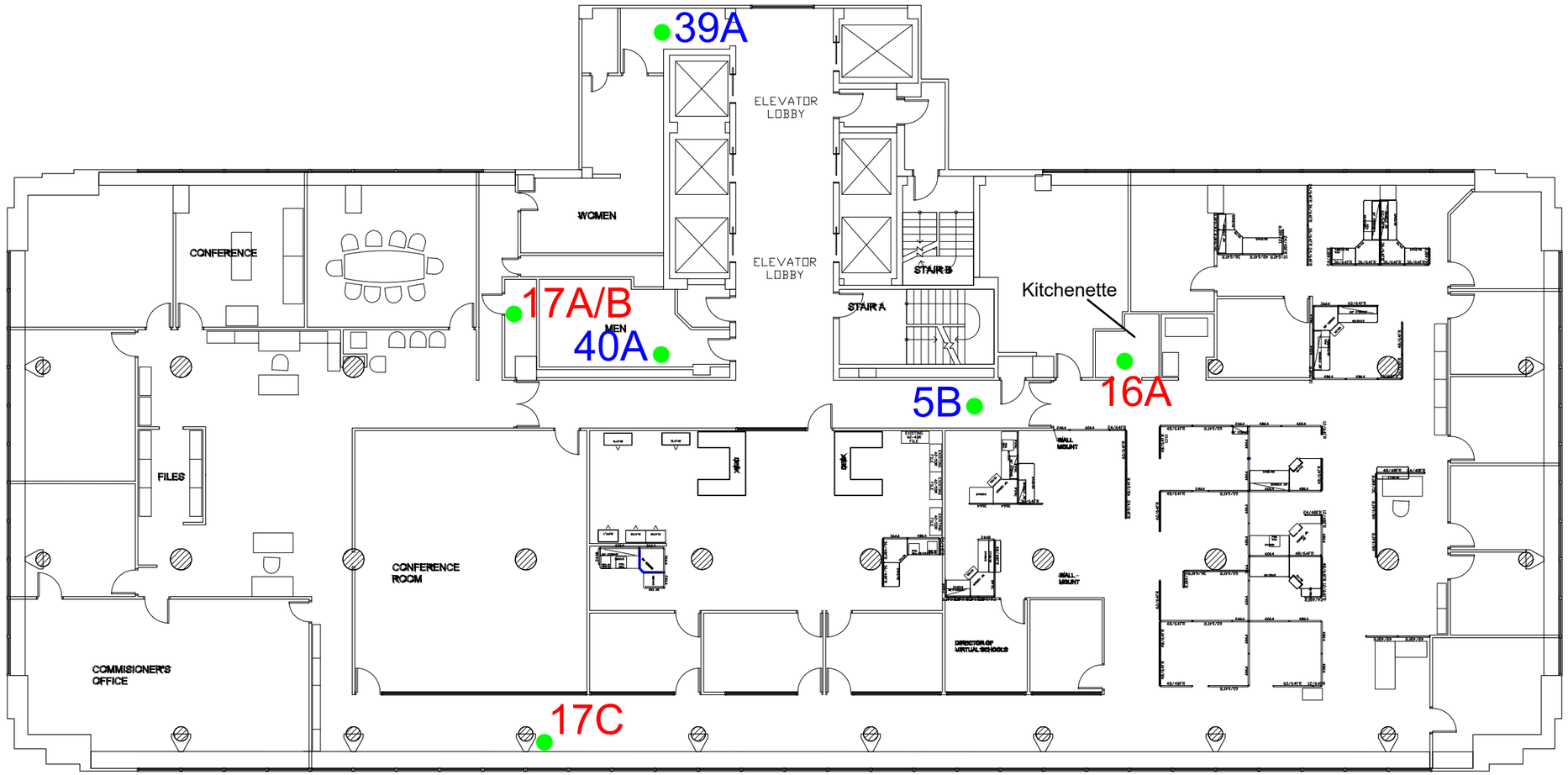
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	5th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

- 1A — Positive Asbestos Sample Location/Number
- 1A — Negative Asbestos Sample Location/Number



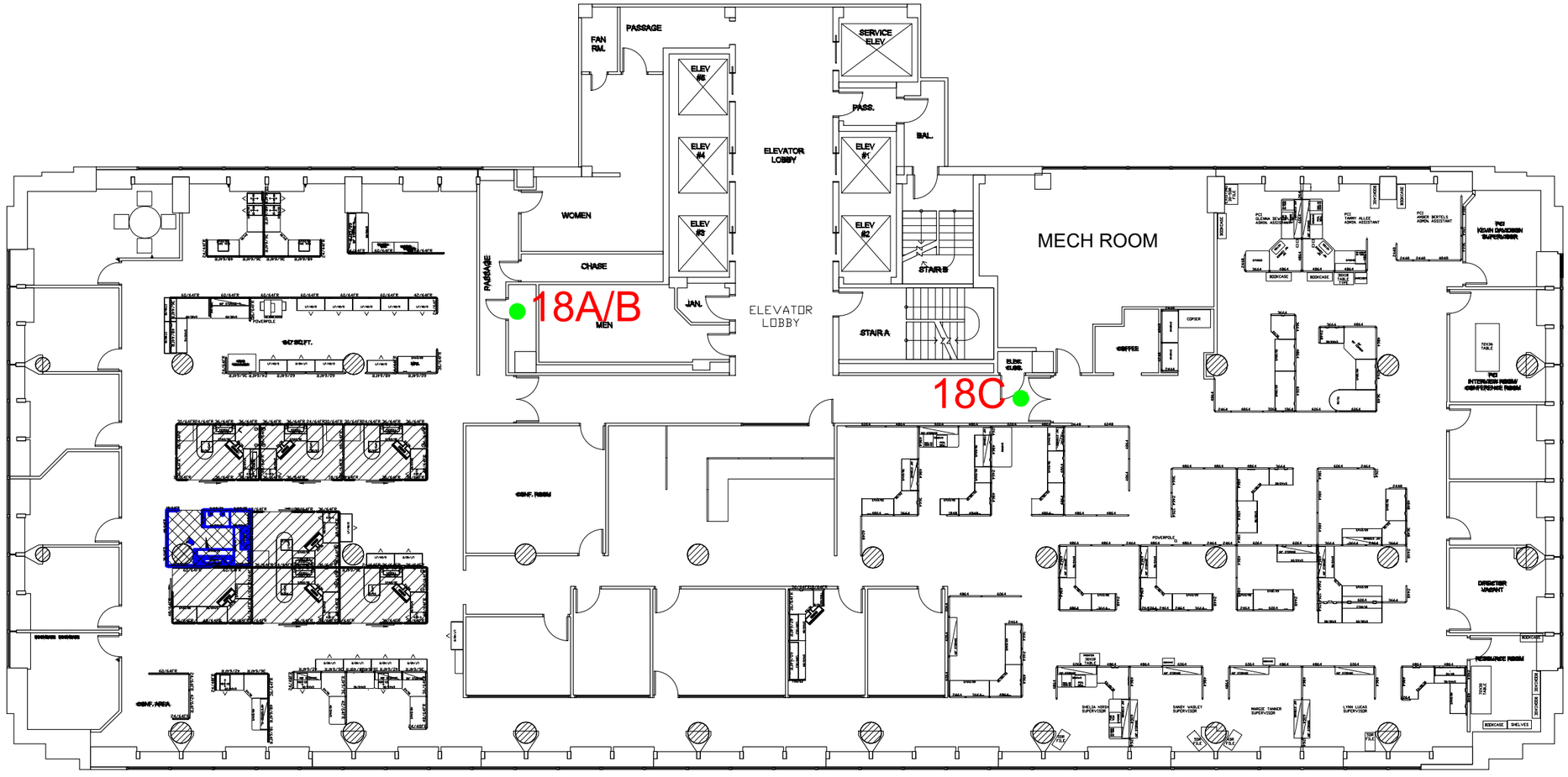
Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

6th Floor		Date: 8/30/21
Project No.	238.01.003	Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

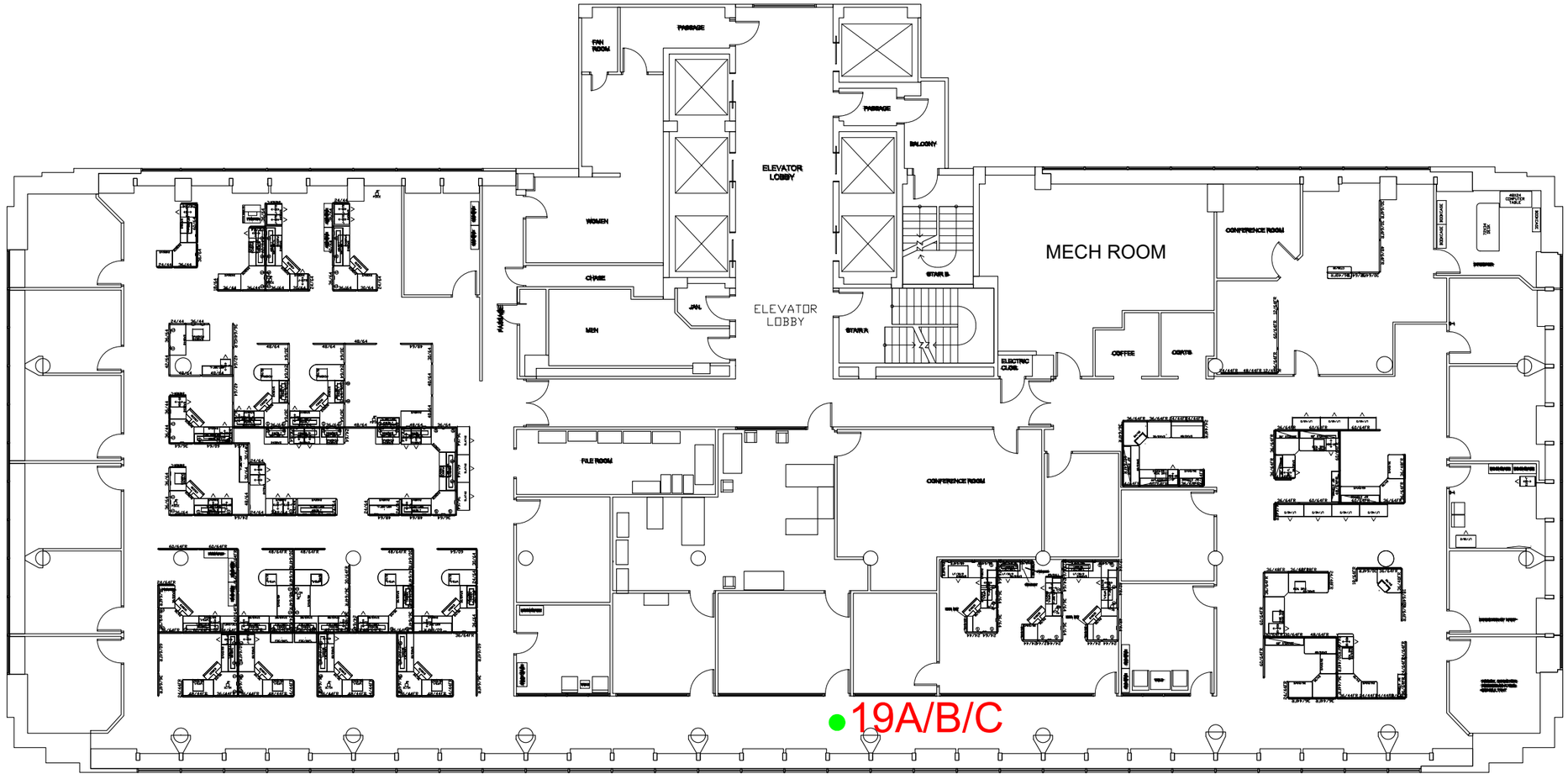
7th Floor | Date: 8/30/21

Project No. 238.01.003 | Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

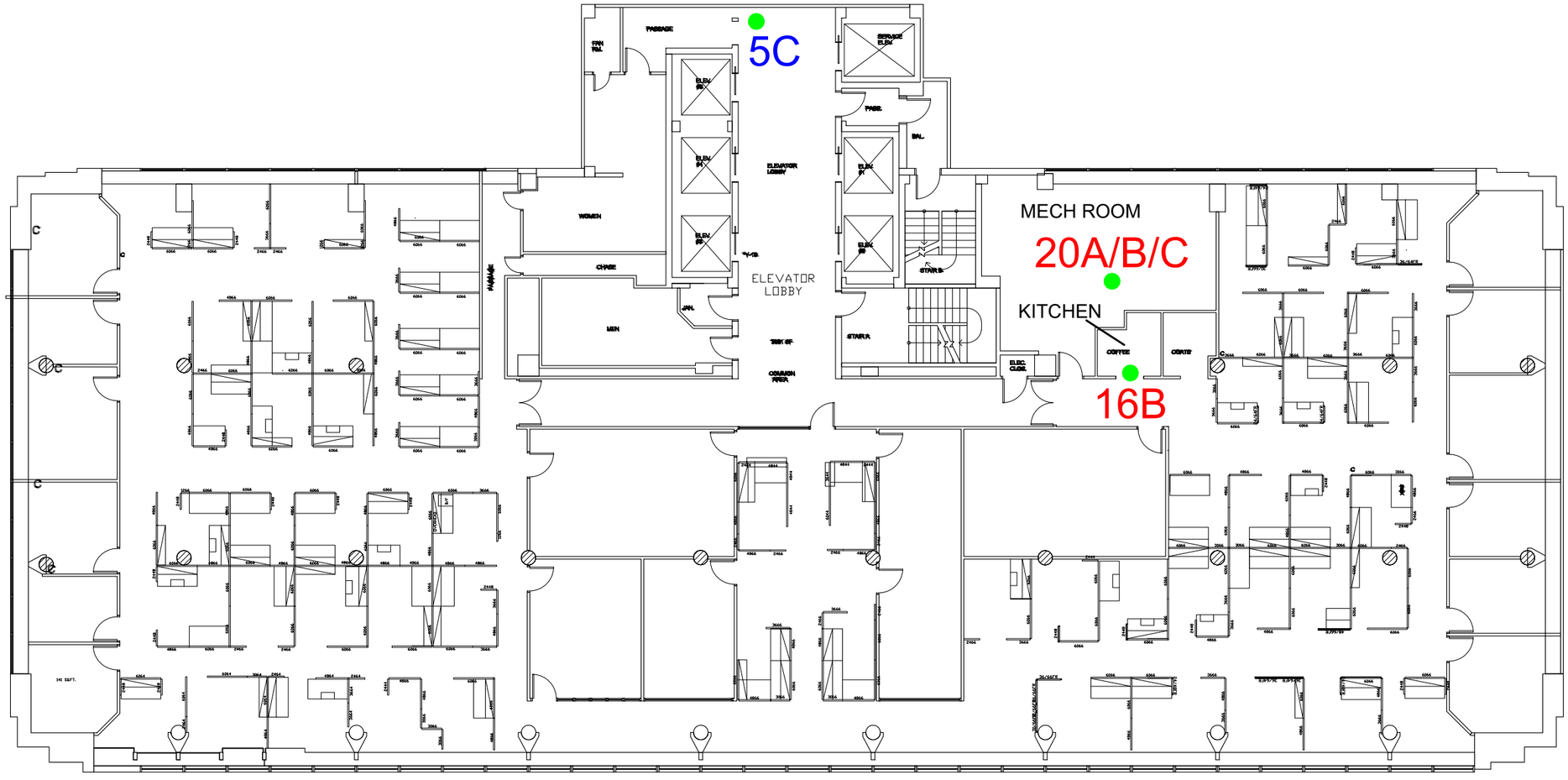
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	8th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

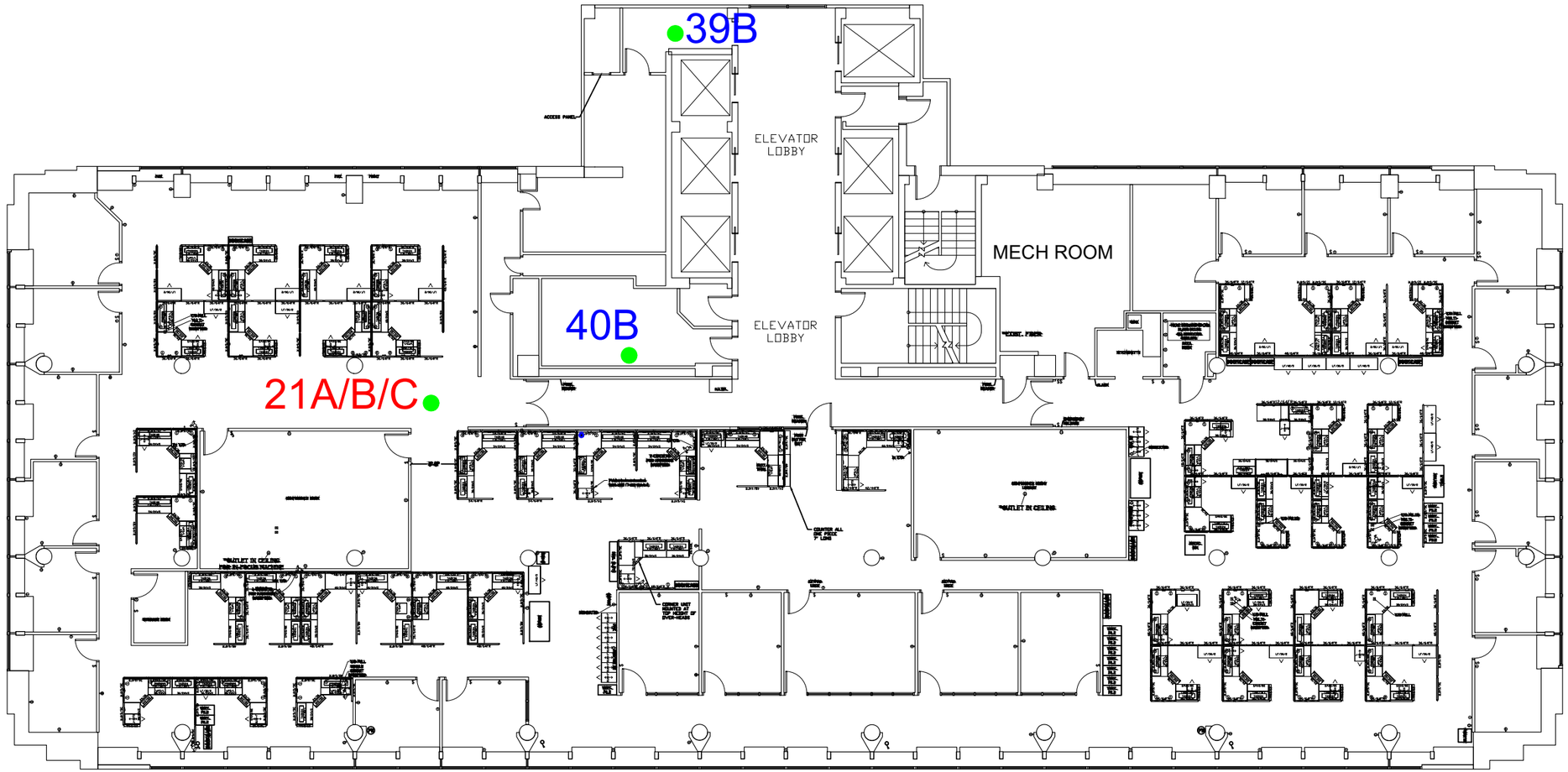
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	9th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number

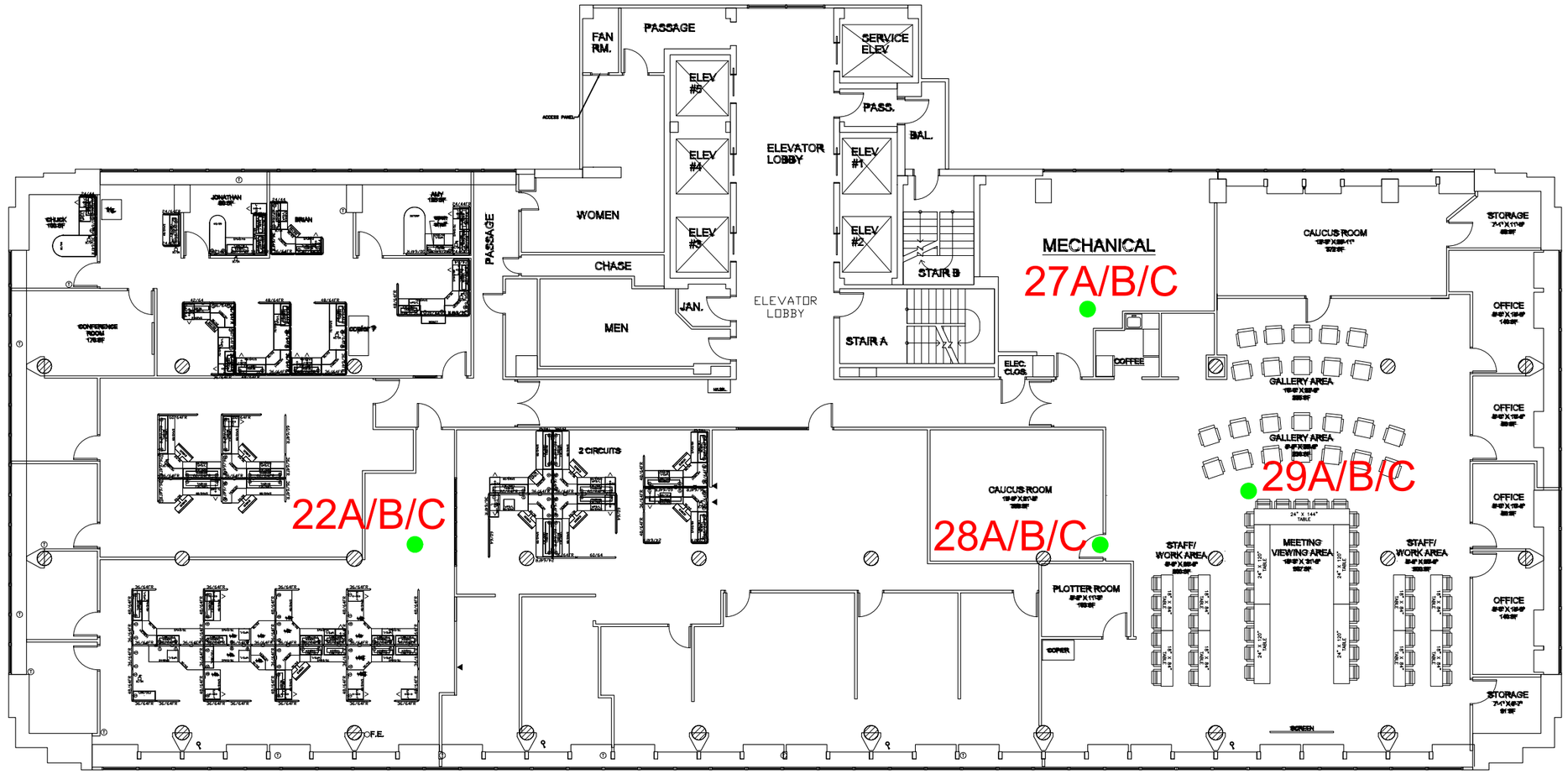


Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

10th Floor		Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
Project No.	238.01.003	Drawn By: GW	

Legend

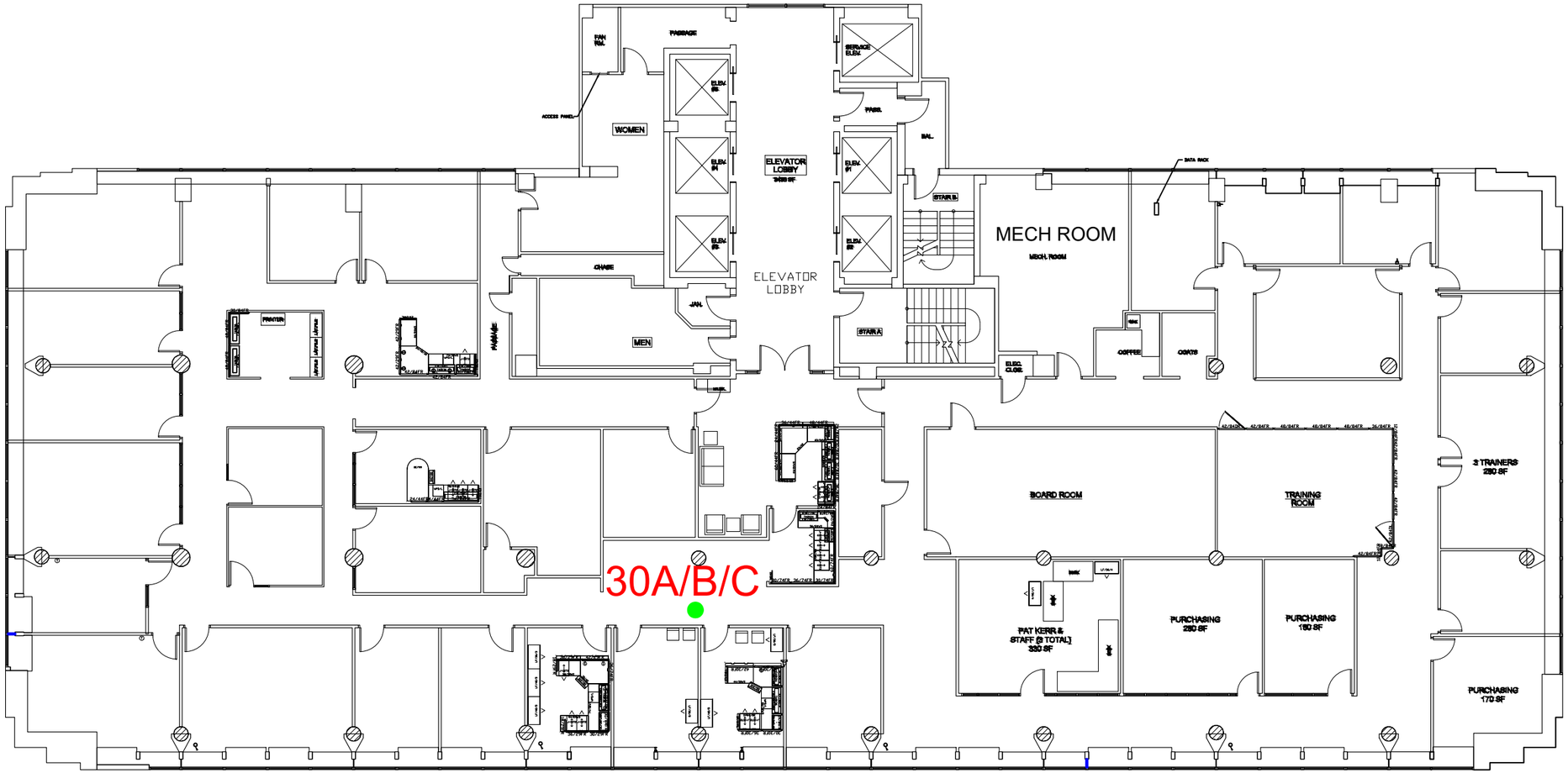
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	11th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

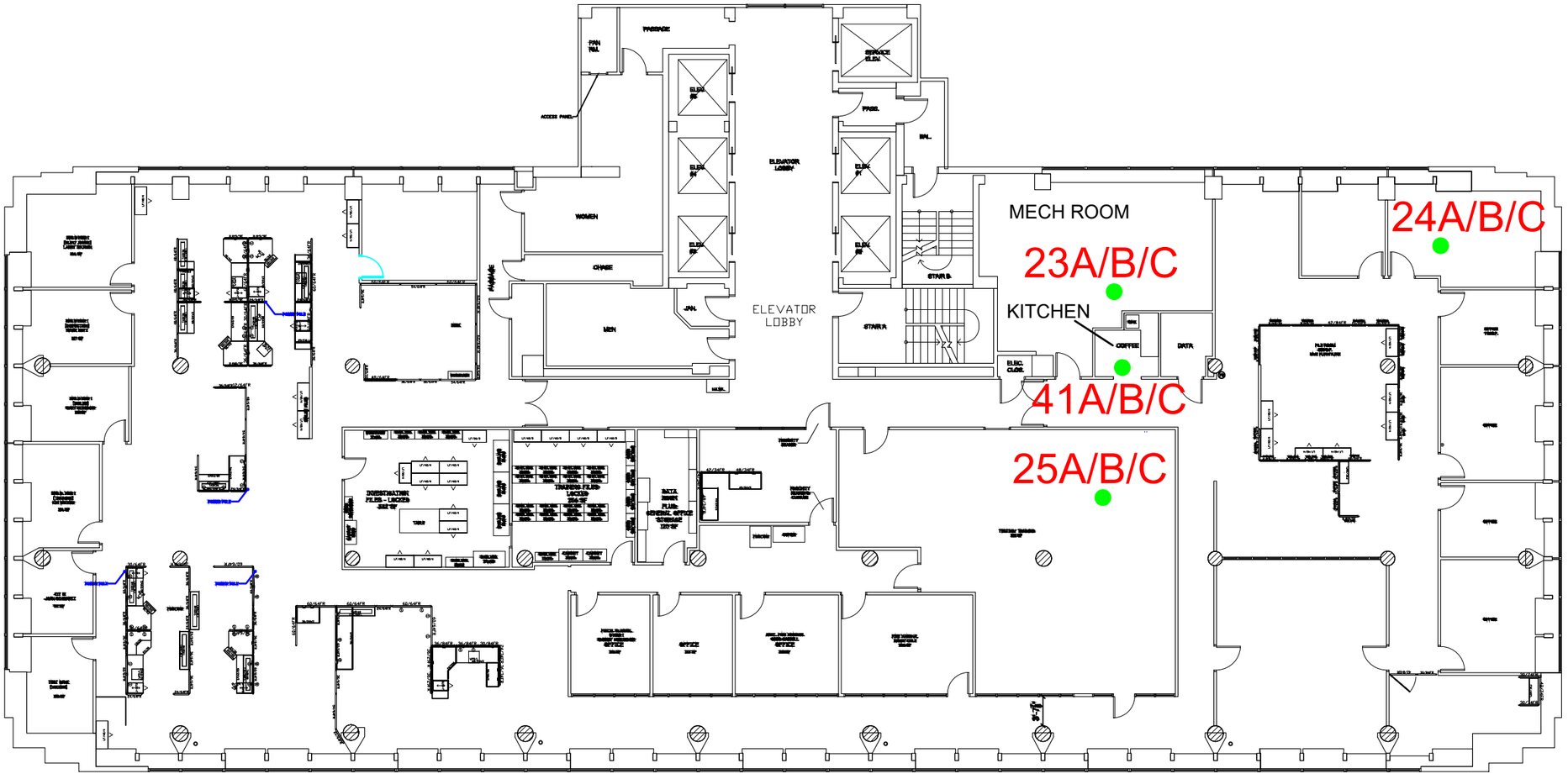
- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	12th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

13th Floor | Date: 8/30/21

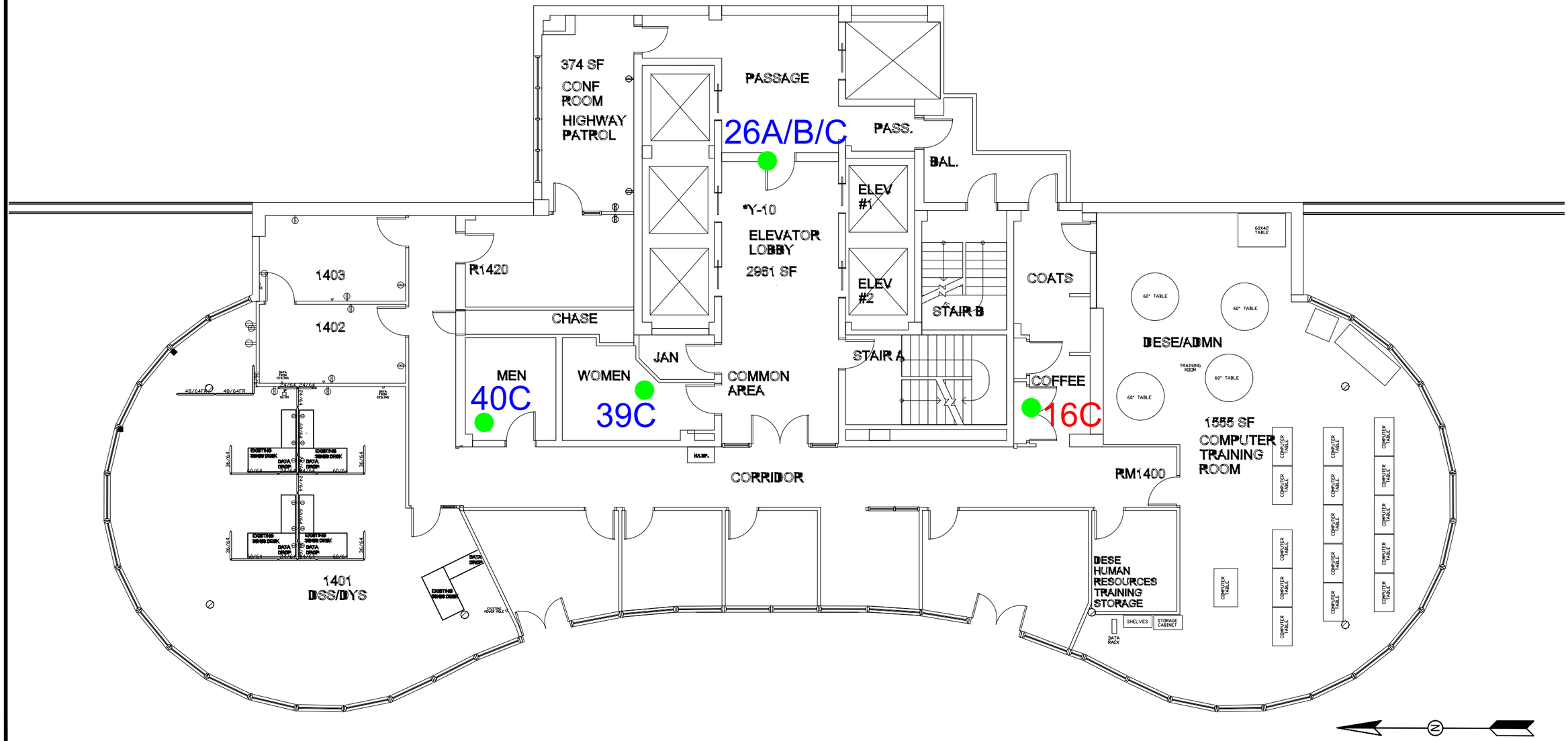
Project No. 238.01.003 | Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

1A Positive Asbestos Sample Location/Number

1A Negative Asbestos Sample Location/Number



Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

14th Floor		Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
Project No.	238.01.003	Drawn By: GW	

Legend

- 1A Positive Asbestos Sample Location/Number
- 1A Negative Asbestos Sample Location/Number

Asbestos Sample Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

Basement Floor | Date: 8/30/21

Project No. 238.01.003 | Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

APPENDIX E
Asbestos Location Maps

Legend

- 12" Brown Floor Tile Mastic (Sample Group 1)
- Flooring Beneath Carpet Squares (Sample Group 2) - Assumed Locations
- Mastic Beneath Carpet (Sample Group 4)
- Mastic Beneath Carpet Squares (Sample Group 10)
- 12" White Pattern Floor Tile Mastic (Sample Group 12)
- Mastic Beneath Carpet Squares Sample Group 15)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls

Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	1st Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic
(Sample Group 5)

Mastic Beneath Carpet
(Sample Group 6)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls

Asbestos Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

2nd Floor | Date: 8/30/21

Project No. 238.01.003 | Drawn By: GW

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

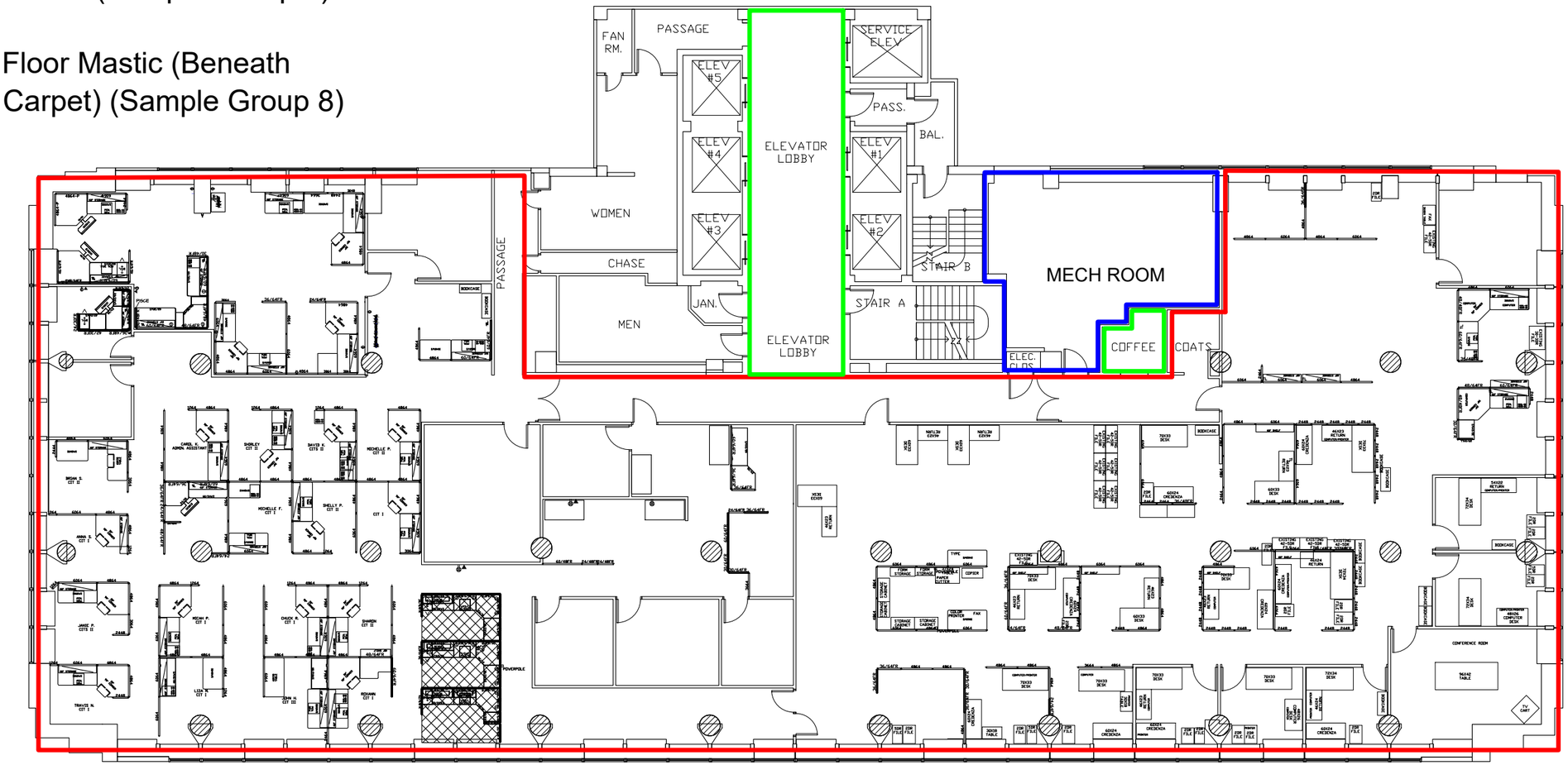
Legend

12" Brown Floor Tile Mastic

12" Beige Pattern Floor Tile Mastic (Sample Group 7)

Floor Mastic (Beneath Carpet) (Sample Group 8)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



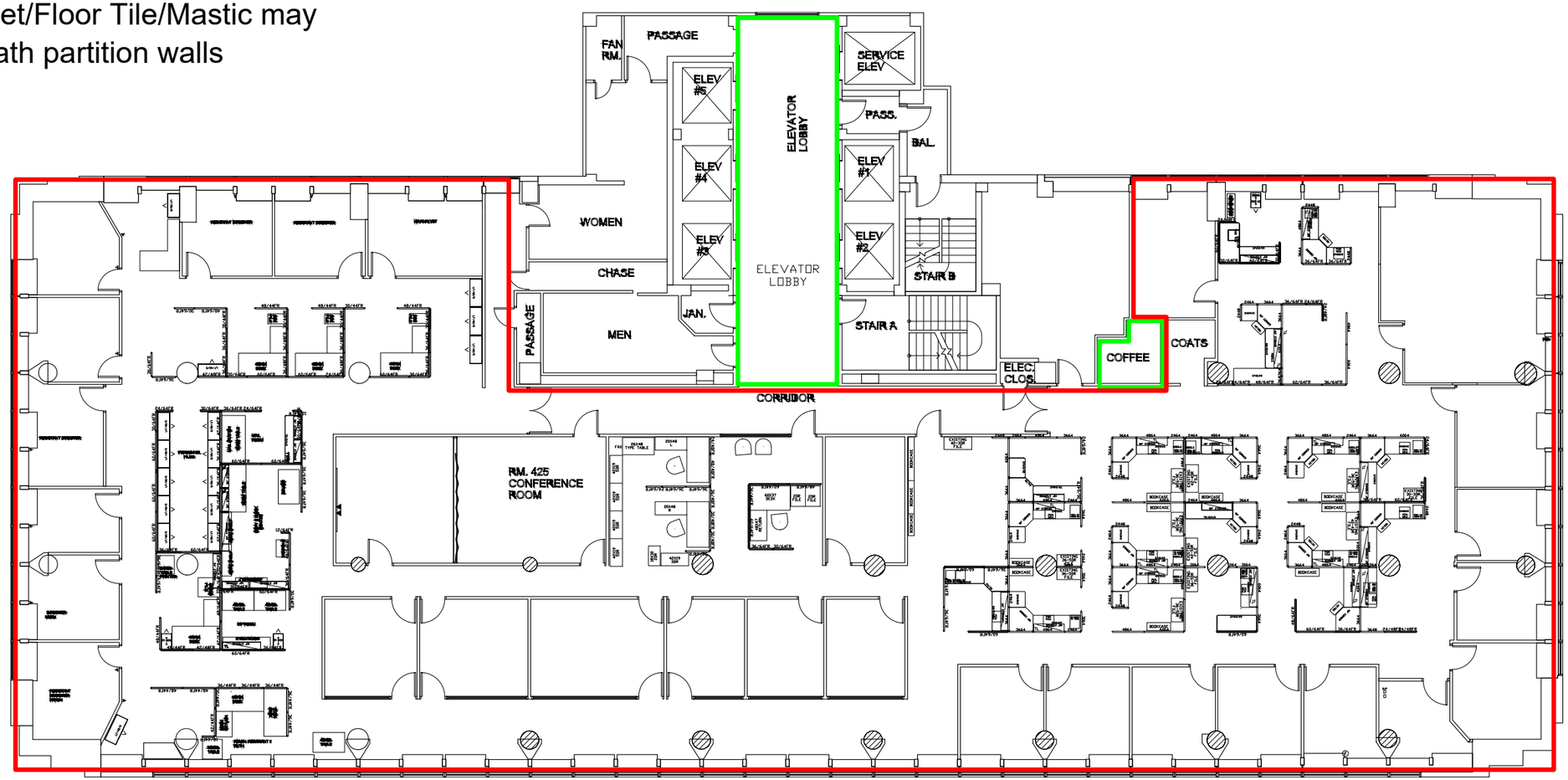
Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	3rd Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic

Floor Mastic (Beneath Carpet) (Sample Group 9)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



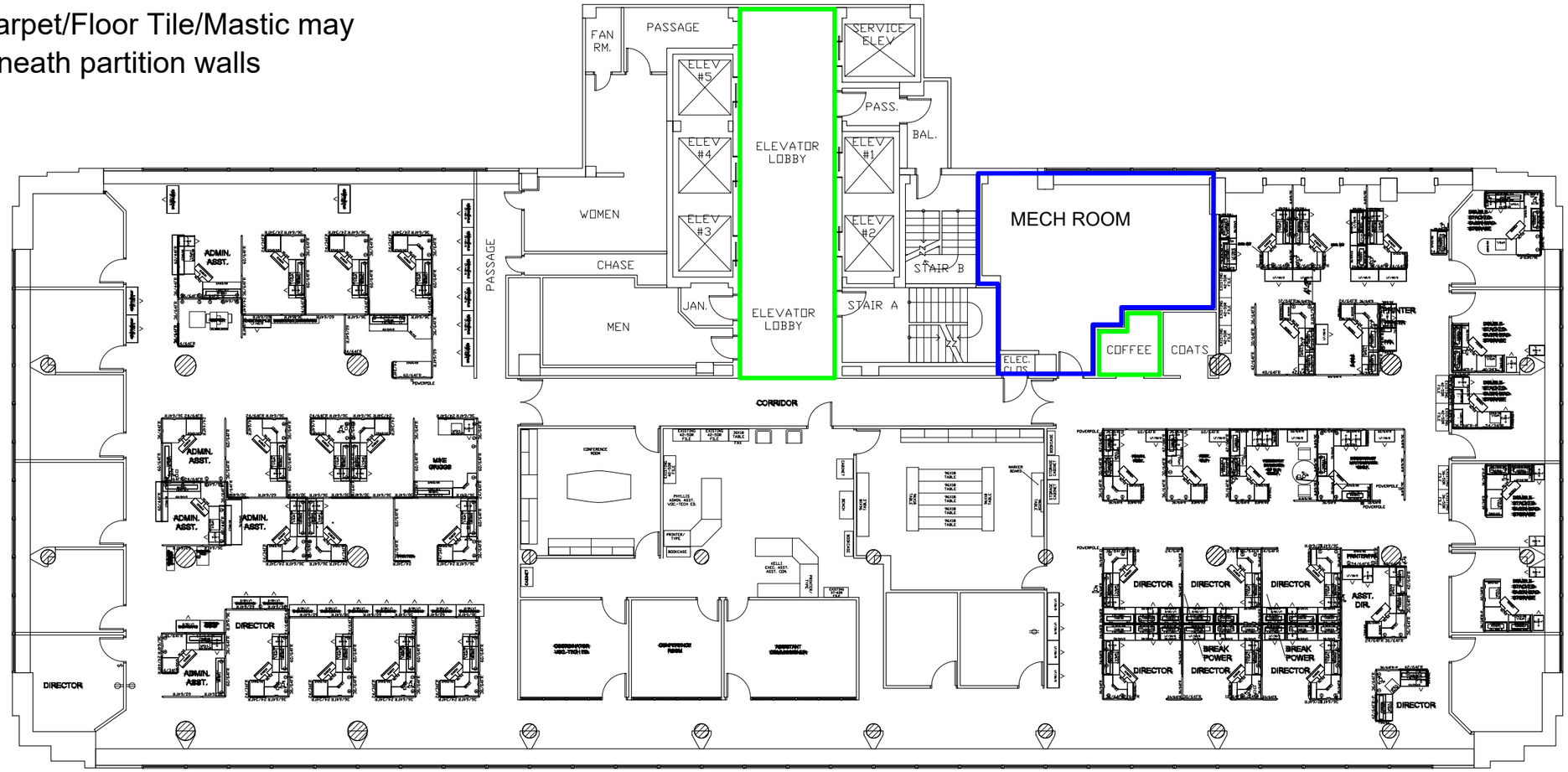
Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	4th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic

12" Beige Pattern Floor Tile Mastic (Sample Group 14)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	5th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

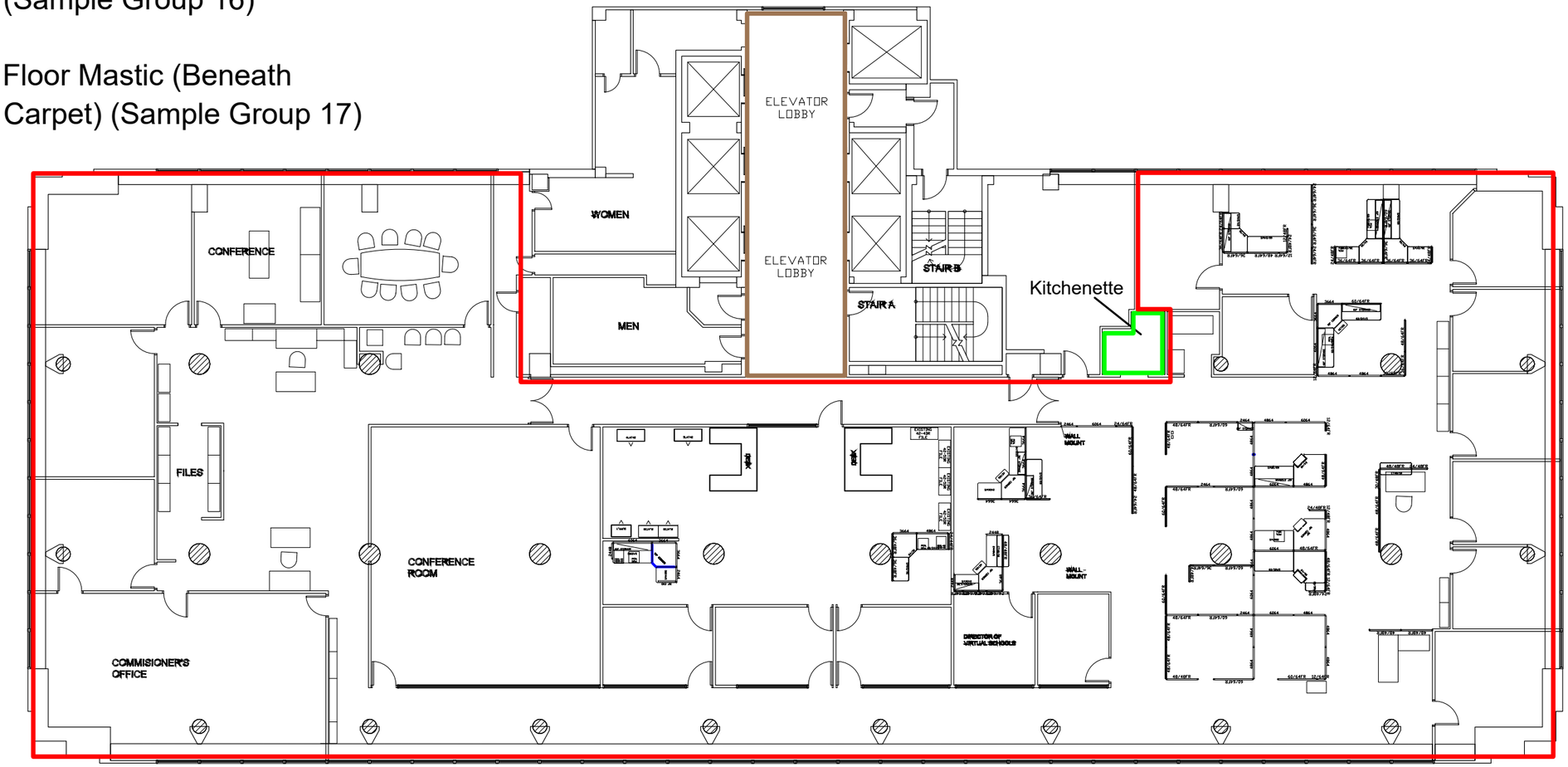
Legend

12" Brown Floor Tile Mastic (Sample Group 5)

12" Brown Floor Tile Mastic (Sample Group 16)

Floor Mastic (Beneath Carpet) (Sample Group 17)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



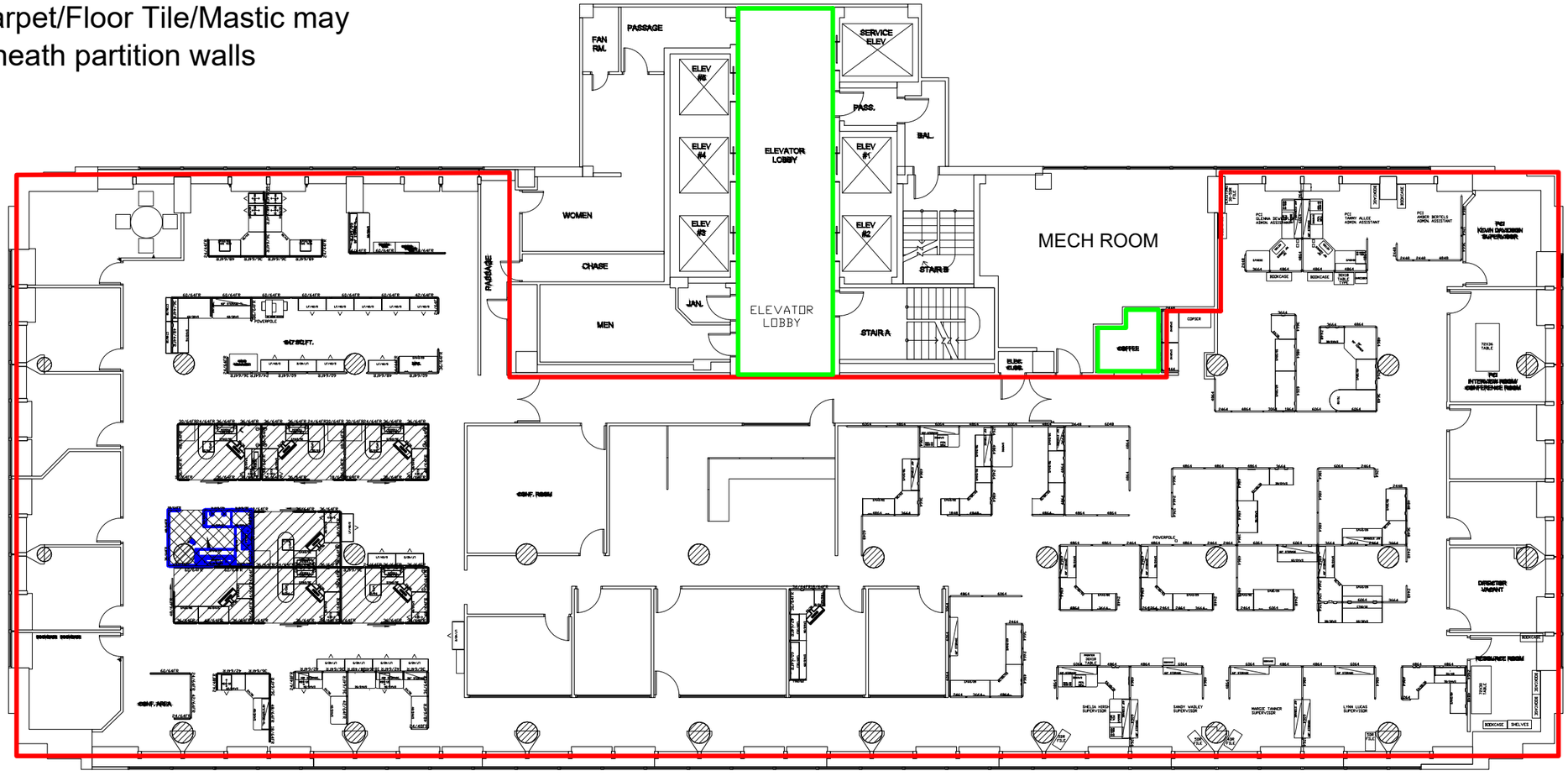
Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	6th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic

Floor Mastic (Beneath Carpet)
(Sample Group 18)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



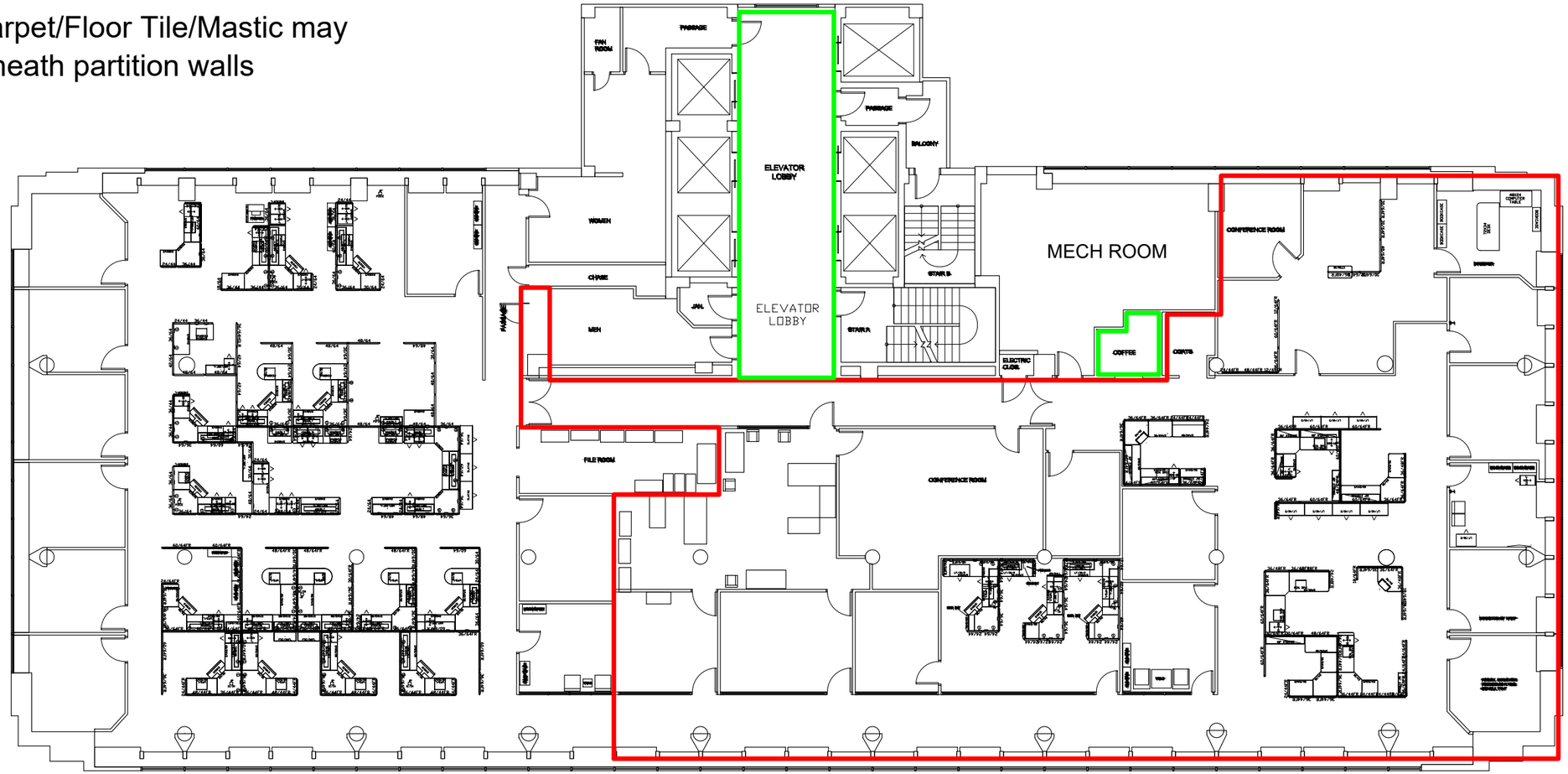
Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	7th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic

Mastic Beneath Carpet
(Sample Group 19)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	8th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

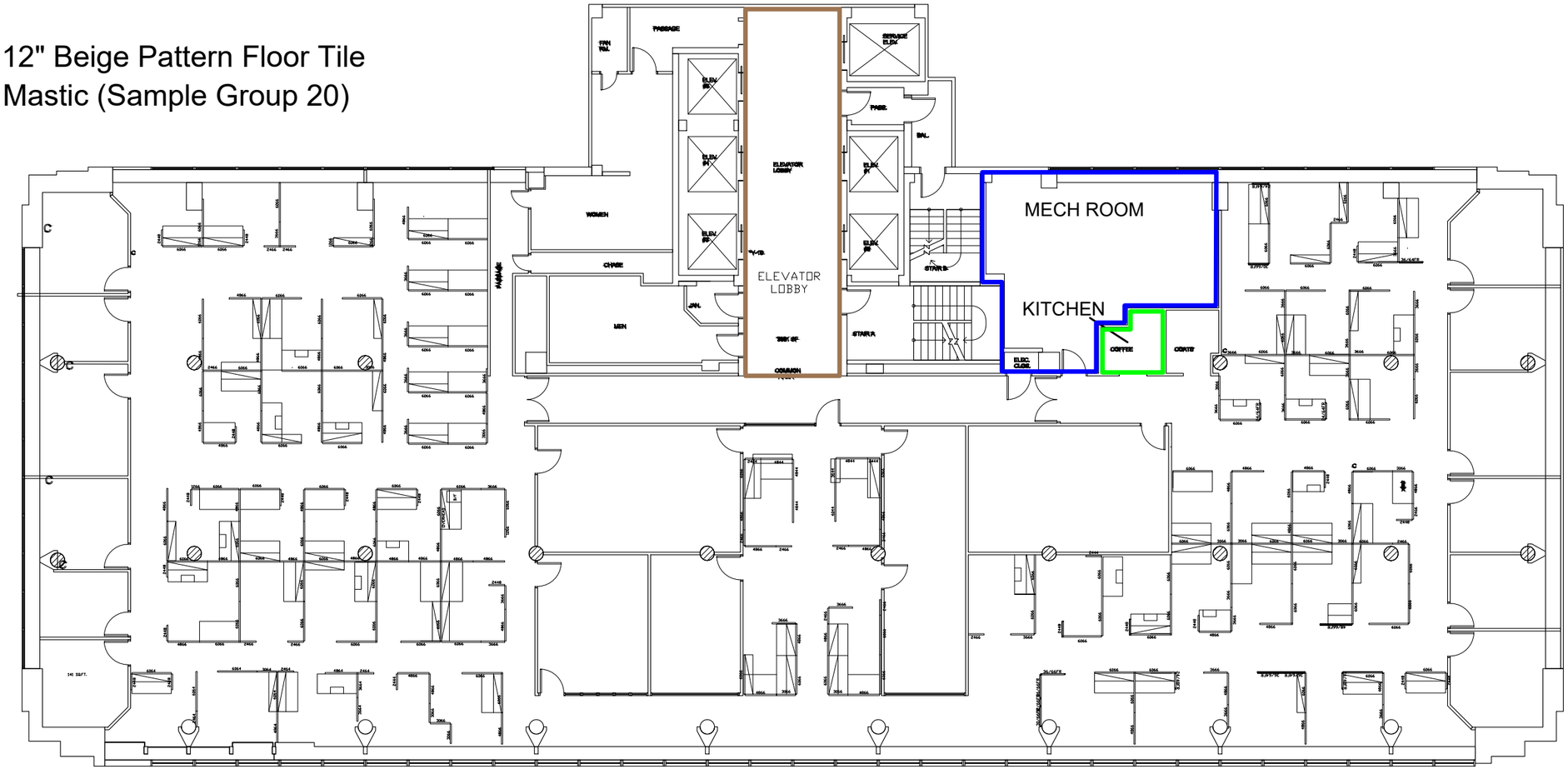
Legend

12" Brown Floor Tile Mastic (Sample Group 5)

12" Brown Floor Tile Mastic (Sample Group 16)

12" Beige Pattern Floor Tile Mastic (Sample Group 20)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



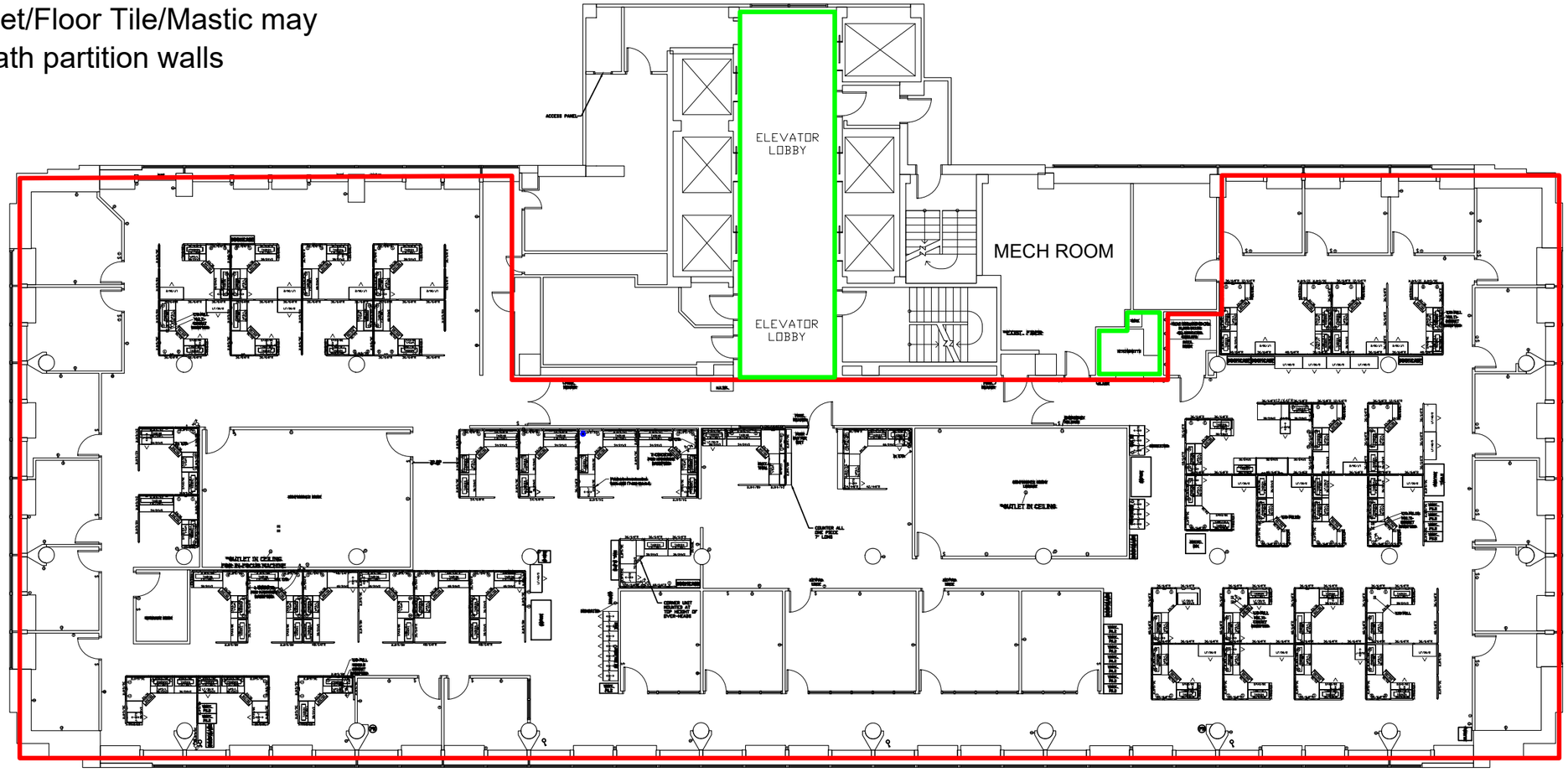
Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	9th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

12" Brown Floor Tile Mastic

Mastic Beneath Carpet Squares (Sample Group 21)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	10th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

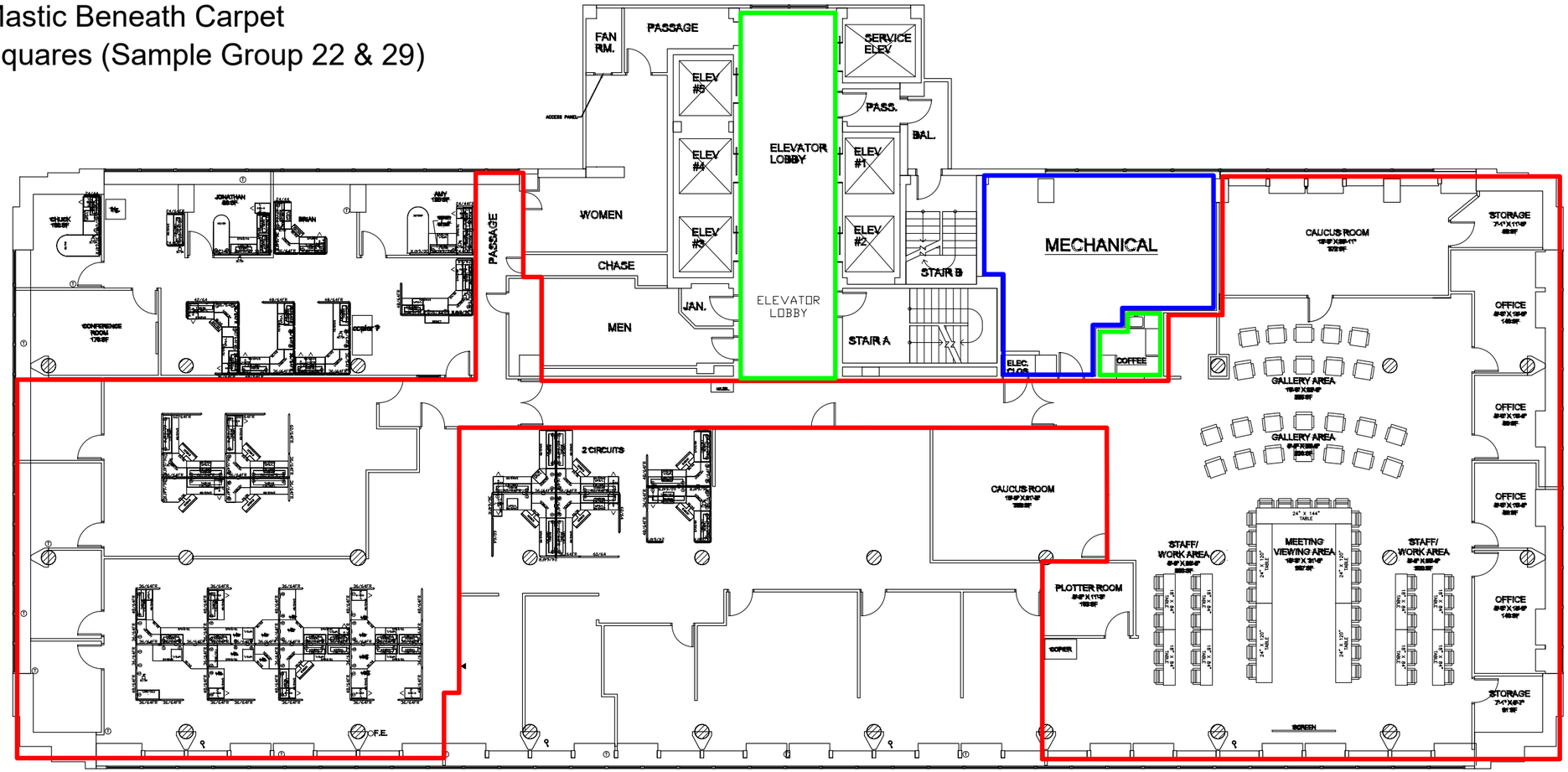
Legend

12" Brown Floor Tile Mastic

12" Beige Pattern Floor Tile Mastic (Sample Group 27)

Mastic Beneath Carpet Squares (Sample Group 22 & 29)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

11th Floor		Date: 8/30/21
Project No. 238.01.003	Drawn By: GW	

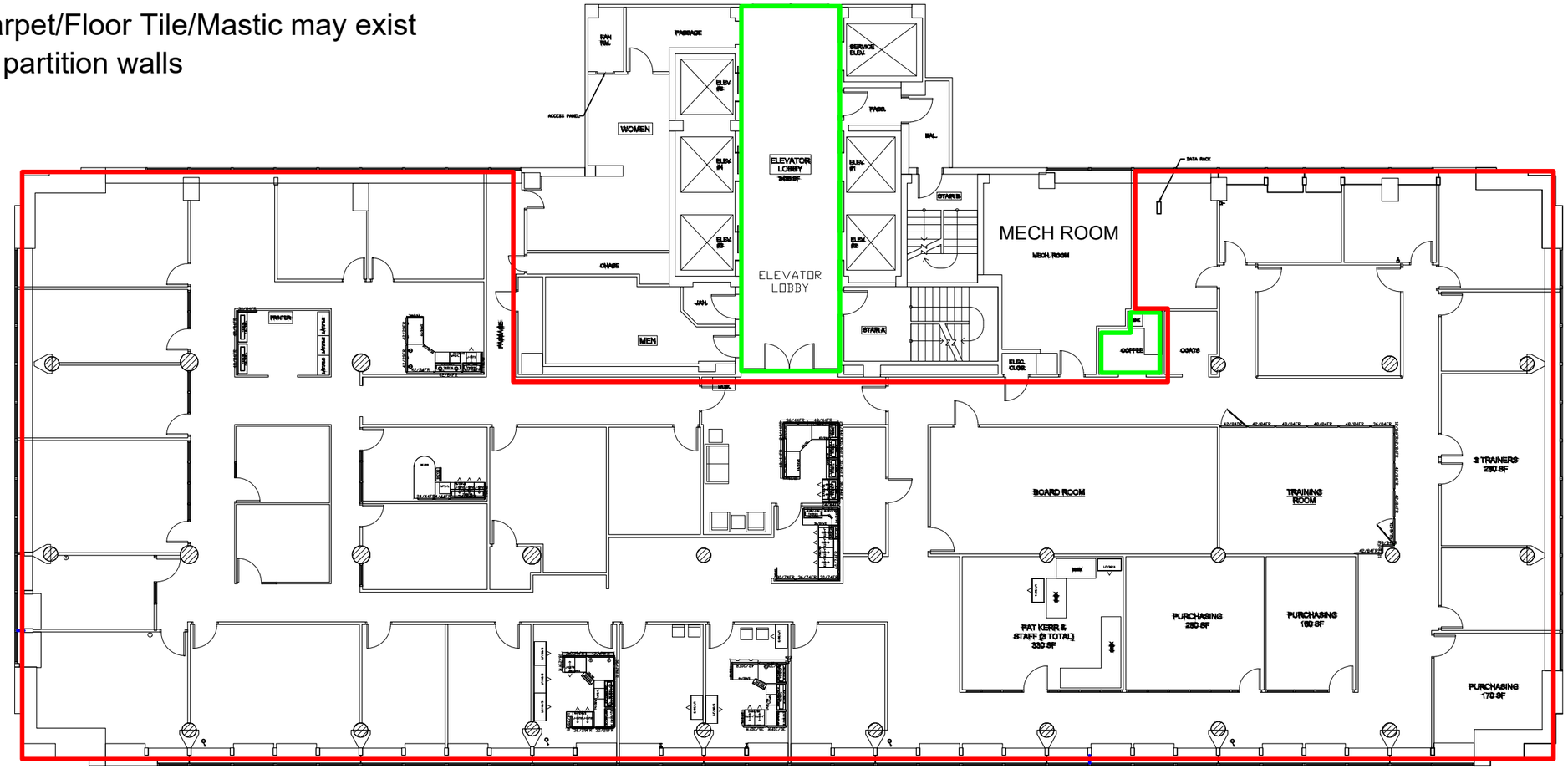
PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

12" Brown Floor Tile Mastic

Floor Mastic Beneath Carpet Squares (Sample Group 30)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	12th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

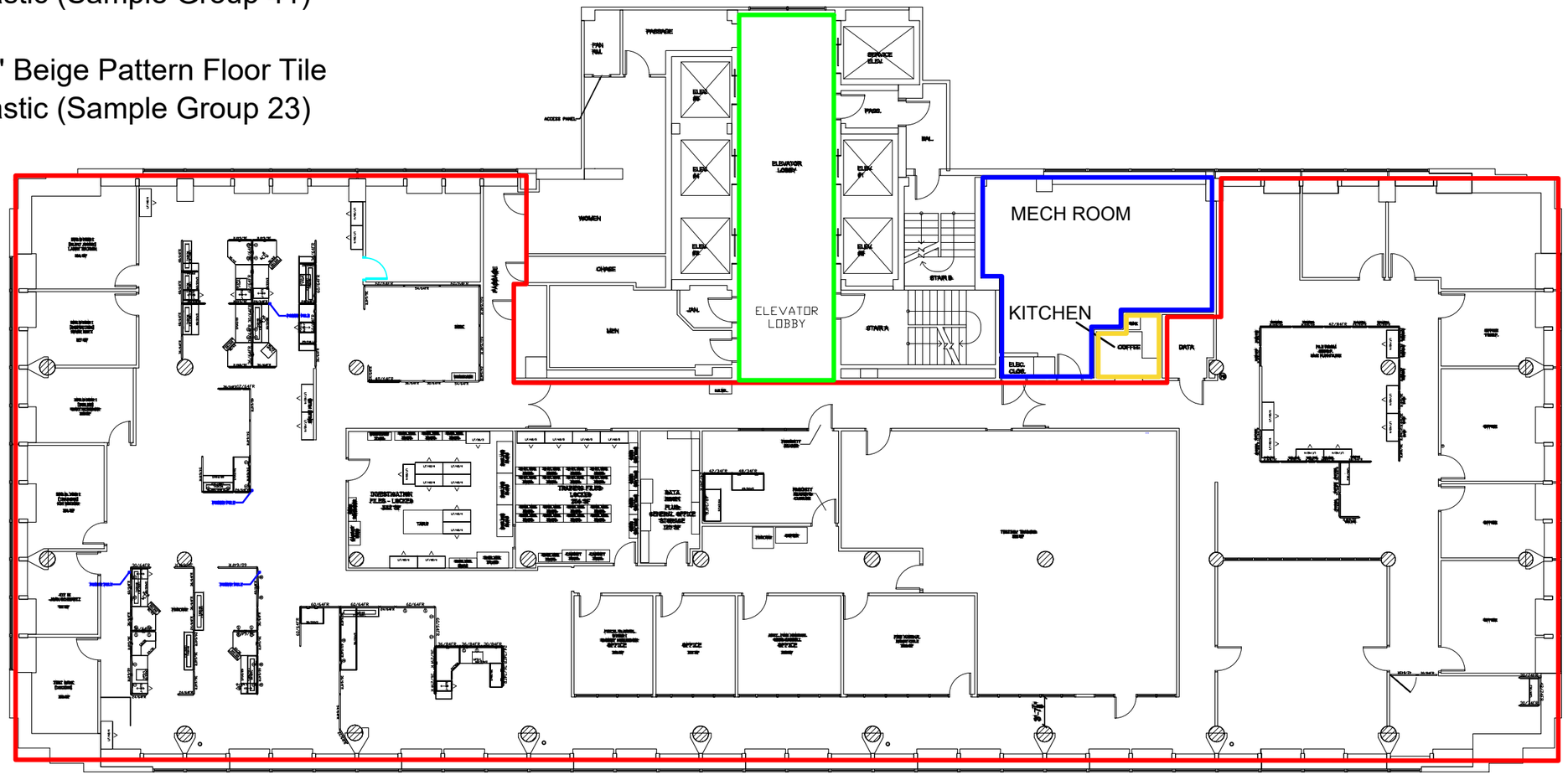
12" Brown Floor Tile Mastic

12" White Pattern Floor Tile Mastic (Sample Group 41)

12" Beige Pattern Floor Tile Mastic (Sample Group 23)

Mastic Beneath Carpet Squares (Sample Group 25)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

13th Floor

Date: 8/30/21

Project No. 238.01.003

Drawn By: GW

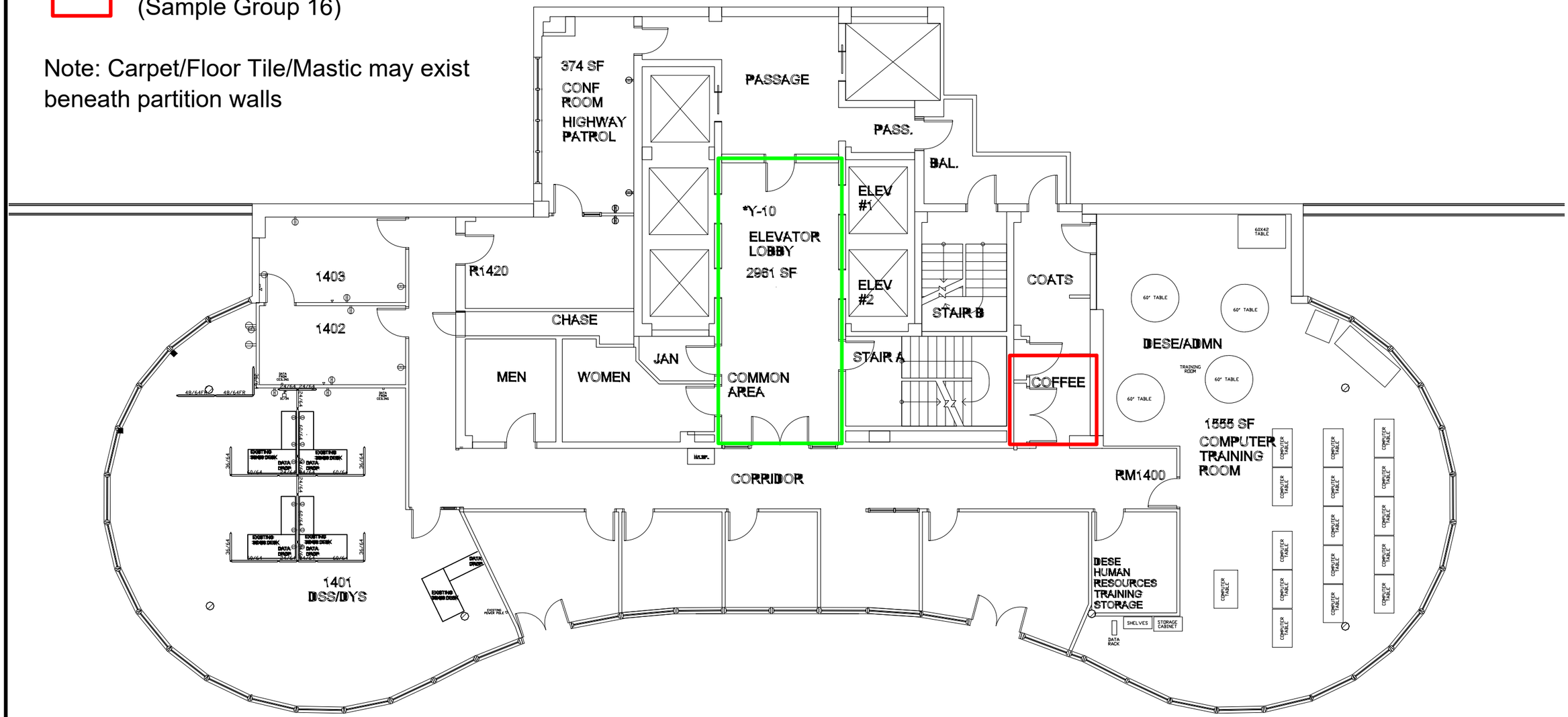
PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

Legend

12" Brown Floor Tile Mastic
(Sample Group 26)

12" Brown Floor Tile Mastic
(Sample Group 16)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls



Asbestos Location Map Jefferson State Office Building 205 Jefferson Street, Jefferson City, Missouri 65101	14th Floor	Date: 8/30/21	PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.
	Project No. 238.01.003	Drawn By: GW	

Legend

- 12" Brown Floor Tile Mastic (Sample Group 31)
- 12" White/Brown Pattern Floor Tile Mastic (Sample Group 33)
- 12" White Pattern Floor Tile Mastic (Sample Group 37)

Note: Carpet/Floor Tile/Mastic may exist beneath partition walls

Asbestos Location Map
Jefferson State Office Building
205 Jefferson Street, Jefferson City, Missouri 65101

Basement Floor		Date: 8/30/21
Project No. 238.01.003	Drawn By: GW	

PROFESSIONAL ENVIRONMENTAL ENGINEERS, INC.

VSW-1

VERSICO TOTAL ROOFING SYSTEM WARRANTY

Versico Roofing Systems, Inc. (VERSICO) warrants to the Building Owner (OWNER) of the building described below, that subject to the terms, conditions and limitations stated in this warranty, Versico will repair any leak in the Versico Roofing System (VERSICO ROOFING SYSTEM)installed by a Versico Authorized Roofing Contractor for a period of 15 years commencing with the date of Versico's acceptance of the Versico Roofing System installation. However, in no event shall Versico's obligations extend beyond 15 1/2) years subsequent to the date of substantial completion of the Versico Total Roofing System. See below for exact date of warranty expiration.

The Versico Roofing System is defined as the following Versico Materials: Membrane, Flashings, Adhesives and Sealants, Fastener Assemblies, Metal Edging, Insulation and any other Versico brand products utilized in this installation.

TERMS, CONDITIONS, LIMITATIONS

1. Owner shall provide Versico with written notice to the address printed below within thirty (30) days of the discovery of any leaks in the Roofing System. By so notifying Versico, the Owner authorizes Versico to investigate the cause of the leak. Should the investigation reveal the cause of the leak to be outside the scope of this warranty, investigation and repair costs for this service shall be paid by the Owner.

2. If, upon inspection, Versico determines that the leaks in the Roofing System are caused by defects in the Roofing System's material or workmanship of the Versico Authorized Roofing Contractor in installing the same, Owner's remedies and Versico's liability shall be limited to Versico's repair of the leak in the Roofing System.

3. This Warranty shall not be applicable if Versico determines that any of the following has occurred:

(a) The Roofing System is damaged by natural disasters, including, but not limited to, lightning, insects, winds in excess of 55 mph measured at roof level, earthquakes, fire, tornado, and hail; or

(b) The Roofing System is damaged by any acts of negligence, accidents, or misuse, including but not limited to, excessive traffic, recreational activities, storage of materials on the roof, vandalism, or civil disobedience; or

(c) The Roofing System is damaged by infiltration of moisture in, through, or around walls, skylights, vents, copings, HVAC units, building structures, or underlying or surrounding areas; or

(d) The Roofing System is damaged by the building structure failing to have adequate strength to support all live and dead loads, including water and snow loads, or by any other structural defects or failures; or

(e) The Roofing System is damaged by settlement, distortion, cracking, movement or failure of the roof substrate, coping, walls, structural members or components adjacent to the roof or foundation of said building; or

(f) The Roofing System is damaged as a result of attack by roof top contaminants such as solvents, petroleum, oil products, acids, or other harmful chemicals.

4. This Warranty shall be null and void if Versico determines that any of the following has occurred:

(a) If, after installation of the Roofing System by a Versico Authorized Roofing Contractor, there are any alterations, test cuts, or repairs made on or through the roof, or objects such as, but not limited to, structures, fixtures, or utilities are placed upon or attached to the roof without first obtaining written authorization from Versico, or

(b) Failure by the Owner to use reasonable care in maintaining the roof, including, but not limited to periodic cleaning of drains and removal of harmful debris from the roof, or

(c) Owner fails to comply with every term and/or condition stated herein.

5. During the term of this Warranty, Versico shall have free access to the roof during regular business hours.

6. Versico shall have no obligation under this Warranty while any bills for installation, supplies, services and warranty charges have not been paid in full to the Versico Authorized Roofing Contractor, Versico, or material suppliers.

7. Versico's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.

8. This warranty is not assignable by operation of law or otherwise. Application may be made by a new building owner for reissuance of the warranty during the original warranty period. Certain procedures, including an inspection of the Roofing System by a Versico representative, and fees will apply to any reissuance. Versico reserves the right, in its sole discretion, to refuse to reissue this warranty.

9. Only Versico brand insulations are covered by this warranty. Versico specifically disclaims liability, under any theory of law, for damages sustained by or caused by non-Versico brand insulation products.

10. Versico shall not be responsible for the cleanliness or discoloration of the Versico Roofing System caused by environmental conditions including, but not limited to, dirt pollutants or biological agents.

VERSICO DOES NOT WARRANT PRODUCTS UTILIZED IN THIS INSTALLATION WHICH IT HAS NOT FURNISHED; AND SPECIFICALLY DISCLAIMS LIABILITY, UNDER ANY THEORY OF LAW, ARISING OUT OF THE INSTALLATION AND PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY VERSICO.

THE REMEDIES STATED HEREIN ARE THE SOLE AND EXCLUSIVE REMEDIES FOR FAILURE OF THE ROOFING SYSTEM OR ITS COMPONENTS. THERE ARE NO WARRANTIES EITHER EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, WHICH EXTEND BEYOND THE FACE HEREOF. VERSICO SHALL NOT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED, TO, LOSS OF PROFITS OR DAMAGE TO THE BUILDING OR ITS CONTENTS UNDER ANY THEORY OF LAW.

OWNER: STATE OF MISSOURI

BUILDING: JEFFERSON STATE OFC BLDG PENTHOUSE
JEFFERSON ST
JEFFERSON CITY, MO

DATE INSTALLATION COMPLETED: 02/22/02

WARRANTY EXPIRATION DATE: 02/22/17

LENGTH OF WARRANTY: 15 YEARS

ROOF AREA COVERED: 276 SQ FT

ROOFER: WEATHERCRAFT, INC
P O BOX 105108
JEFFERSON CITY, MO 651105108

PHONE: 573-635-0141

SERIAL NUMBER: 063098

VERSICO INCORPORATED

A subsidiary of Carlisle SynTec Incorporated

3485 Fortuna Drive
Akron, Ohio 44312
(800) 992-7663
(330) 644-2613 FAX

VERSICO INCORPORATED

By _____

CARE & MAINTENANCE INFORMATION

Your building is now covered by one of the finest single ply roofing materials and warranties in the market today.

The following items of maintenance information are recommended for the Roofing System.

1) Clogged drains should be avoided to insure equal load across your structure.

2) Ponding water that does not dry in 48 hours after a rain causes damage to roofing systems. The building owner is responsible for roof drains that meet this requirement. This includes new construction, reroofing, and structural distortion or sag requiring drain addition, relocation, or addition of tapered insulation, crickets, etc.

3) Petroleum products, if left to stand on the membrane, will have an adverse effect and may degrade the surface of the membrane. Keep all petroleum products off the membrane (solvents, greases, oils, or any other liquid containing petroleum products should be kept off the membrane).

4) Kitchen waste should not be exhausted onto the roof surface. They could reduce the life of your roof.

5) If your roof is to come in contact with any type of contaminant, please contact Versico; we have the means of analyzing any material and will advise its effect on the membrane and its components.

6) Foot traffic should be kept to a minimum. Any areas which require normal maintenance within a 30-day period should have walkways to and from, as well as in, the work area. PROTECT YOUR ROOF!

7) Roofing cements under no circumstances shall be used in conjunction with the Versigard System.

8) Areas such as counterflashings, curbs, and pipes should be kept sealed watertight at all times.

9) If a leak occurs, don't assume that it is the membrane. Too often most leaks are curb skylights, hatches, metal work, or plumbing problems. Survey the problem first.

10) If any new installation is required on your roof, contact Versico for a recommendation as to how the unit is to be tied in to your existing roof. New work shall be done by a roofing contractor approved to install the roofing system in compliance to Versico's specifications and warranty.

General maintenance trades working on your rooftop units, doing plumbing, welding, soldering, and other work must use care and protection or they will cut and abuse your roof. This type of damage is the owner's responsibility and not covered by the Verisco warranty.

VERSICO
INCORPORATED

A subsidiary of Carlisle Corporation.

CARLISLE

GOLDEN SEAL TOTAL ROOFING SYSTEM WARRANTY

SERIAL NO. 10093215 **919** **DATE OF ISSUE: July 17, 2013**

BUILDING OWNER: STATE OF MISSOURI OFFICE OF ADMINISTRATION
NAME OF BUILDING: JEFFERSON STATE OFFICE BUILDING
BUILDING ADDRESS: 205 JEFFERSON STREET, JEFFERSON CITY, MO
DATE OF COMPLETION OF THE CARLISLE TOTAL ROOFING SYSTEM: 07/16/2013
DATE OF ACCEPTANCE BY CARLISLE: 07/17/2013 **(EB Warranty)** **AB#1132890**

Carlisle Roofing Systems, Inc., (Carlisle) warrants to the Building Owner (Owner) of the above described building, that; subject to the terms, conditions, and limitations stated in this warranty, Carlisle will repair any leak in the Carlisle Golden Seal™Total Roofing System (Carlisle Total Roofing System) installed by a Carlisle Authorized Roofing applicator for a period of 20 years commencing with the date of Carlisle's acceptance of the Carlisle Total Roofing System installation. However, in no event shall Carlisle's obligations extend beyond 20.5 years subsequent to the date of substantial completion of the Carlisle Total Roofing System. See below for exact date of warranty expiration.

The Carlisle Total Roofing System is defined as the following Carlisle brand materials: Membrane, Flashings, Counterflashings, Adhesives and Sealants, Insulation, Cover Boards, Fasteners, Fastener Plates, Fastening Bars, Metal Work, Insulation Adhesives, and any other Carlisle brand products utilized in this installation.

TERMS, CONDITIONS, LIMITATIONS

1. Owner shall provide Carlisle with written notice via letter, fax or email within thirty (30) days of the discovery of any leak in the Carlisle Total Roofing System. Owner should send written notice of a leak to Carlisle's Warranty Services Department at the address set forth at the bottom of this warranty. By so notifying Carlisle, the Owner authorizes Carlisle or its designee to investigate the cause of the leak. Should the investigation reveal the cause of the leak to be outside the scope of this Warranty, investigation and repair costs for this service shall be paid by the Owner.
2. If, upon inspection, Carlisle determines that the leak is caused by a defect in the Carlisle Total Roofing System's materials, or workmanship of the Carlisle Authorized Roofing Applicator in installing the same, Owner's remedies and Carlisle's liability shall be limited to Carlisle's repair of the leak.
3. This warranty shall not be applicable if, upon Carlisle's inspection, Carlisle determines that any of the following has occurred:
   (a) The Carlisle Total Roofing System (Membrane, Insulation or Accessory) is damaged by natural disasters, including, but not limited to, lightning, fire, insect infestations, earthquake, tornado, hail, hurricanes, and winds of (3 second) peak gust speeds of seventy-two mph or higher measured at 10 meters above ground; or
   (b) Loss of integrity of the building envelope and, or structure including, but not limited to partial or complete loss of roof decking, wall siding, windows, doors or other envelope components or from roof damage by wind-blown objects, or:
   (c) The Carlisle Total Roofing System is damaged by any intentional or negligent acts, accidents, misuse, abuse, vandalism, civil disobedience, or the like.
   (d) Deterioration or failure of building components, including, but not limited to, the roof substrate, walls, mortar, HVAC units, non-Carlisle brand metal work, etc., occurs and causes a leak, or otherwise damages the Carlisle Total Roofing System; or
   (e) Acids, oils, harmful chemicals and the like come in contact with the Carlisle Total Roofing System and cause a leak, or otherwise damage the Carlisle Total Roofing System.
   (f) The Carlisle Total Roofing System encounters leaks or is otherwise damaged by condensation resulting from any condition within the building that may generate moisture.
4. This Warranty shall be null and void if any of the following shall occur:
   (a) If, after installation of the Carlisle Total Roofing System by a Carlisle Authorized Roofing Applicator there are any alterations or repairs made on or through the roof or objects such as, but not limited to, structures, fixtures, solar panels, wind turbines, roof gardens or utilities are placed upon or attached to the roof without first obtaining written authorization from Carlisle; or
   (b) Failure by the Owner to use reasonable care in maintaining the roof, said maintenance to include, but not be limited to, those items listed on Carlisle's Care & Maintenance Information sheet which accompanies this Warranty.
5. Only Carlisle brand insulation products are covered by this warranty. Carlisle specifically disclaims liability, under any theory of law, for damages sustained by or caused by non-Carlisle brand insulation products.
6. During the term of this Warranty, Carlisle shall have free access to the roof during regular business hours.
7. Carlisle shall have no obligation under this Warranty while any bills for installation, supplies, service, and warranty charges have not been paid in full to the Carlisle Authorized Roofing Applicator, Carlisle, or material suppliers.
8. Carlisle's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.
9. Carlisle shall not be responsible for the cleanliness or discoloration of the Carlisle Total Roofing System caused by environmental conditions including, but not limited to, dirt, pollutants, or biological agents.
10. Carlisle shall have no liability under any theory of law for any claims, repairs, restoration, or other damages including, but not limited to, consequential or incidental damages relating, directly or indirectly, to the presence of any irritants, contaminants, vapors, fumes, molds, fungi, bacteria, spores, mycotoxins, or the like in the building or in the air, land, or water serving the building.
11. This warranty is not assignable by operation of law or otherwise. Application may be made by a new building owner for reissuance of the warranty during the original warranty period. Certain procedures including, but not limited to, an inspection of the Roofing System by a Carlisle representative and fees will apply to any reissuance. Carlisle reserves the right, in its sole discretion, to refuse to reissue this warranty.

CARLISLE DOES NOT WARRANT PRODUCTS UTILIZED IN THIS INSTALLATION WHICH IT HAS NOT FURNISHED; AND SPECIFICALLY DISCLAIMS LIABILITY, UNDER ANY THEORY OF LAW, ARISING OUT OF THE INSTALLATION AND PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY CARLISLE OR THE PRIOR EXISTING ROOFING MATERIAL OVER WHICH THE CARLISLE ROOFING SYSTEM HAS BEEN INSTALLED

THE REMEDIES STATED HEREIN ARE THE SOLE AND EXCLUSIVE REMEDIES FOR FAILURE OF THE CARLISLE TOTAL ROOFING SYSTEM OR ITS COMPONENTS. THERE ARE NO WARRANTIES EITHER EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, WHICH EXTEND BEYOND THE FACE HEREOF. CARLISLE SHALL NOT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR DAMAGE TO THE BUILDING OR ITS CONTENTS UNDER ANY THEORY OF LAW.

BY: Robert H. McNeill Robert H. McNeill /mdf
AUTHORIZED SIGNATURE
TITLE: Director, Technical and Warranty Services
This Warranty Expires: July 16, 2033

P.O. Box 7000 Carlisle, PA 17013 Phone: 800.233.0551 Fax: 717.245.7121 www.carlislesyntec.com

CARLISLE
SYNTEC SYSTEMS

Thank you for selecting Carlisle SynTec Systems as the provider of your new roofing system. We are confident you've purchased a roof that will protect your building and its assets for years to come.

Enclosed is the owner's manual for your new roof. The manual includes your roofing system warranty, along with care and maintenance information that will ensure long-term system performance.

Carlisle SynTec Systems is unsurpassed in its commitment to providing quality commercial roofing systems, products and services. These services include:

- **Carlisle authorized applicators** - This network of professionally trained roofing contractors ensures quality installation of our products and systems. In addition, they are a valuable resource if rooftop conditions change and modifications or revisions to your roofing system are required.
- **No-dollar-limit warranty** - The warranty issued for your roofing project includes both labor and material coverage as outlined in the enclosed warranty document.
- **Service departments** - There are several departments within Carlisle SynTec Systems available to answer questions and provide information regarding:
    - Roof maintenance programs
    - Revisions, alterations and/or modifications to your roof
    - Roof restoration
    - Warranty service

To properly safeguard your roof – and your warranty – please consult the enclosed care and maintenance information prior to making any changes to your roofing system. For questions regarding your warranty, or to report a roof leak, please call us at 1-800-233-0551.

If you wish to see the latest innovations in commercial roofing, please visit www.carlislesyntec.com. Once again, thank you for choosing Carlisle SynTec Systems.

Sincerely,

Robert H. McNeill
Director, Technical & Warranty Services

Carlisle SynTec Incorporated
P.O. Box 7000
Carlisle, PA 17013
(717)245-7000 FAX (717)245-7121

TECHNICAL ASSISTANCE REPORT

TO: Missouri Builders Service

DATE: 11/12/13

Check Appropriate Assistance: x Spot Check

Project: Jefferson State Office Building
Tech Rep Name/No.: #426 Kevin Schmitt
Applicator: Mo Bldgs Service
AB#: 1132890

Location: Jefferson City Mo

Attendee: Dan Henley
System: S-Weld A

Sq. Ft: 8,904
Date: 11/12/13

REPAIRS REQUIRED/DETAILS DISCUSSED

On Nov 12 2013 a re-inspect/spot check was performed on the above referenced project due to some alteration. The repairs have been completed as per Carlisle spec and detail. Therefore the Warranty will continue.

Sincerely
Kevin Schmitt
Kevin Schmitt
Field Service Rep

NOTE: The above Technical Assistance Report is **not** an Inspection for Warranty. At the time of the technical assistance, this project was % complete. Please check the entire project to ensure it meets Carlisle's Specification and Details. An Inspection for Warranty will be conducted when the Notice of Completion (NOC) is received by Carlisle. This information is for your reference and need not be returned to Carlisle SynTec Incorporated.

ATTENTION

THIS IS A CARLISLE ROOF SYSTEM

Use Walkways Where Provided

Physical damage to this roof is not covered by the warranty.

All repairs or alterations to the roof must be completed by a Carlisle authorized applicator to protect the warranty. For more information, review your warranty/owner's manual or contact Carlisle.

NO SMOKING

Installed by: _____

Contractor Name: _____

Contractor Phone: _____

System Type: _____

Date Installed: _____

CARLISLE
SYNTEC SYSTEMS

Carlisle SynTec Systems
P.O. Box 7000 • Carlisle, PA 17013
(USA) 800-233-0551
(CANADA) 800-387-4990
www.carlislesyntec.com

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