PROJECT SPECIFICATIONS

ELIZABETH SQUARE, PHASE 1
SILVER SPRING, MARYLAND

ELIZABETH HOUSE III (EH3) AND SOUTH COUNTY REGIONAL RECREATION AND AQUATICS CENTER (SCRRAC)

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Prepared By

KGD Architecture
1101 15th Street NW
Suite 200
Washington, DC 20005

Prepared For

Housing Opportunities Commission of Montgomery County
10400 Detrick Avenue
Kensington, MD 20895

SECTION 00 0111

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SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

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

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

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, Type AC metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

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

2.3 SYSTEM DESCRIPTION

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

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. All conductors in SCRRAC area shall be copper. Aluminum conductors allowed only in HOC and Holy Cross spaces.

B. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

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

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway, Armored cable, Type AC, and Metal-clad cable, Type MC.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway, Armored cable, Type AC, and Metal-clad cable, Type MC.

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

E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway, Armored cable, Type AC, and Metal-clad cable, Type MC.

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

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway and Type XHHW-2, single conductors in raceway.

H. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway, Armored cable, Type AC, and Metal-clad cable, Type MC.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

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

B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

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

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

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

F. Support cables according to Section 26 0529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

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

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

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

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

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 0553 "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 26 0544 "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 07 8413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections :

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Electrical Contractor to perform visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for conductors and cables 100A and larger. Certify compliance with test parameters.

B. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL 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 grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1. In addition, include the following:

a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

2.2 SYSTEM DESCRIPTION

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

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

2.3 CONDUCTORS

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

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).

PART 3 - EXECUTION

3.1 APPLICATIONS

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

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. 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.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

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

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and

fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.5 EQUIPMENT GROUNDING

A. 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. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

B. 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.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

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

B. 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.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) 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. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 0543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

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

F. 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 a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a 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 a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

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

H. Grounding for Steel Building Structure: Install a Ufer Ground at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of area or item indicated.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.7 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform test and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. The exterior grounding system shall be tested after the exterior building grounding electrode system is assembled but before connection to the building equipment and grounding system. The test shall include the ground rod test, exterior ground loop and ufer grounds.

    b. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    c. Perform tests by fall-of-potential method according to IEEE 81.
    d. The Building grounding system resistance must not exceed 5 ohms.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order,

and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

D. Prepare test and inspection reports.

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

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL 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. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 26 0548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. IMC: Intermediate Metal Conduit.

C. RMC: Rigid Metal Conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. The natatorium, pool equipment room and locker room, and all directly communicating spaces to the pool areas shall be classified as “corrosive environment”. All materials specified including hangers and supports shall be suitable for installation in a corrosive environment.

C. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

D. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

E. Electrical conduits shall not be hung on hangers with any other service pipes.

F. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 7200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Atkore International.
    g. Wesanco, Inc.

2. Use stainless-steel conduit hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications (pools, pool equipment rooms, and locker room areas).
3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Channel Dimensions: Selected for applicable load criteria.

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

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

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

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

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

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

1) Hilti, Inc.
2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.

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

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

1) Cooper B-Line, Inc.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti, Inc.
4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

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

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

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

B. Materials: Comply with requirements in Section 05 5000 "Metal Fabrications" for steel shapes and plates.

2.3 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated conduit-support assembly similar to MFMA-4 for supporting multiple parallel conduits.

1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass

PART 3 - EXECUTION

3.1 APPLICATION

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

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

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

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

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

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

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

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.

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

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

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 3000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 09 9100 " Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION

SECTION 26 0533

RACEWAYS AND BOXES FOR ELECTRICAL 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, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. ARC: Aluminum Rigid Conduit.

B. GRC: Galvanized Rigid Steel Conduit.

C. IMC: Intermediate Metal Conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney.
6. Picoma Industries.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

D. ARC: Comply with ANSI C80.5 and UL 6A.

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

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

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

H. FMC: Comply with UL 1; zinc-coated steel.

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

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Setscrew.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

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

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; Hubbell.
12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. RTRC: Comply with UL 1684A and NEMA TC 14.

G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Fittings for LFNC: Comply with UL 514B.

I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, or Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

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

1. Allied Moulded Products, Inc.
2. Hoffman.
3. Lamson & Sessions; Carlon Electrical Products.
4. Niedax-Kleinhuis USA, Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

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

    a. Mono-Systems, Inc.
    b. Panduit Corp.
    c. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

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

    a. Hubbell Incorporated.
    b. Mono-Systems, Inc.
    c. Panduit Corp.
    d. Wiremold / Legrand.

2.6 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman.
7. Hubbell Incorporated.

8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

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

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

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

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round and rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

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, cast aluminum with gasketed cover.

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

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

M. Gangable boxes are allowed.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

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

O. Cabinets:

1. NEMA 250, Type 1 or Type 3R 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.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. NewBasis.
d. Oldcastle Precast, Inc.
e. Quazite: Hubbell Power System, Inc.
f. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

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

1. Exposed Conduit: GRC, IMC, RNC, Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: GRC, IMC, EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

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

1. Exposed, Not Subject to Physical Damage: EMT, ENT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT RNC identified for such use.
3. Electrical wiring methods including but not limited to conduits, fittings, j-boxes, supports, etc., in natatorium area shall be in compliance with NEC, article 680. All conductors shall be copper and installed in PVC conduit as approved by the AHJ. Exposed PVC conduit shall be painted to match the surrounding structure.
4. Exposed and Subject to Severe Physical Damage: GRC, IMC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT, ENT, or RNC, Type EPC-40-PVC.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Non-corrosive GRC,IMC or PVC. U.L. listed for intended use and approved by AHJ. Provide UL standards required threads cut after protective coatings are applied be treated to keep corrosion from taking place before the conduit is installed.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (19-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Where corrosion protection is necessary, the threads must be coated with an approved electrical conductive, corrosion-resistant compound. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

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

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

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.

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

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

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

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

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m)intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor. Coordinate use of nonmetallic conduit tubing in fire rated slabs with authorities having jurisdiction.

J. Stub-ups to Above Recessed Ceilings:

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

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

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

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

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

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

P. 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.

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

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

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm)radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

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

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

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

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

Y. 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 top of box unless otherwise indicated.

Z. 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.

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

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

CC. 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.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.5 PROTECTION

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

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

END OF SECTION

SECTION 26 0543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL 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. Direct-buried conduit, ducts, and duct accessories.
2. Concrete-encased conduit, ducts, and duct accessories.
3. Handholes and boxes.
4. Manholes.

1.3 DEFINITIONS

A. Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including separators and miscellaneous components.
2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes
4. Include warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole frame support rings.
e. Include Ladder] details.

f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete manholes] and handholes, as required by ASTM C 858.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.2 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Section 26 0553 "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast Group.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC."
4. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches (300 mm) Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

1. Color: Gray].
2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. NewBasis.
    d. Quazite: Hubbell Power System, Inc.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 1000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 31 1000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

C. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 2000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 9200 "Turf and Grasses" and Section 32 9300 "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 01 7300 "Execution."

3.4 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm)], both horizontally and vertically, at other locations unless otherwise indicated.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
   1. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in empty ducts.

H. Concrete-Encased Ducts: Support ducts on duct separators.

   1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 31 2000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
   2. Width: Excavate trench 12 inches (300 mm) wider than duct bank on each side.
   3. Width: Excavate trench 3 inches (75 mm) wider than duct bank on each side.
   4. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
   5. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   6. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four] spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using

fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

7. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
8. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
11. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 2 inches (50 mm) on each side of duct bank.
12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 3000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

I. Direct-Buried Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 31 2000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four] spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to

expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

4. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

7. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 2000 "Earth Moving" for installation of backfill materials.

    a. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct bank.

J. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

K. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Comply with requirements in Section 03 3000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving] and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 03 3000 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep)].

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

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

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- (150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 0544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS 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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 8413 "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.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

1.4 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

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

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

1.5 SLEEVE-SEAL SYSTEMS

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

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

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

1.6 SLEEVE-SEAL FITTINGS

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

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

a. Presealed Systems.

1.7 GROUT

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

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

1.8 SILICONE SEALANTS

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

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 150 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

PART 2 - EXECUTION

2.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

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

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

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

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 9200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

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

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 6 inches (152 mm) above finished floor level. Install sleeves during erection of floors. Sleeves must be waterproofed and sealed to maintain the fire rating of the structure.

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

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

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

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

2.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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.

2.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 0548.16

SEISMIC CONTROLS FOR ELECTRICAL 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. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

B. Related Requirements:

1. Section 26 0529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.

1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Seismic- and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the 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.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    d. 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).

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class C as Defined in the IBC.
2. Assigned Seismic Use Group or Building Category III as Defined in the IBC.

    a. Component Importance Factor: 1.25.
    b. Component Response Modification Factor: 1.5.
    c. Component Amplification Factor: 1.0.

2.2 RESTRAINT CHANNEL BRACINGS

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

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

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

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

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

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO; a brand of NIBCO INC.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

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

D. 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.

E. 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.

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

2.5 MECHANICAL ANCHOR BOLTS

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

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and 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 present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

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

C. 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.

D. 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.

E. Drilled-in 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 the 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. Wedge Anchors: 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 Anchors: 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.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

C. Seismic controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 26 0553

IDENTIFICATION FOR ELECTRICAL 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. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

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

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

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

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

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

1.5 COORDINATION

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

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

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

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

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

G. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Colors for Cables Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Write-on, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

G. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

H. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

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

B. Self-Adhesive, Self-Laminating Polyester Labels: Write-on, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

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

G. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.5 FLOOR MARKING TAPE

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

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

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

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

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

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

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

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

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

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

2.10 MECHANICAL AND ELECTRICAL PAINTING (Applies to SCRRAC MEP Rooms and Shared MEP Rooms)

A. When covered and uncovered pipes, conduits, hangers and rods pass through finished room or space, paint with type of undercoat materials consistent with material to be painted and with same type and color of finish coat as used on immediately adjacent walls or ceiling surfaces, whichever surface is most appropriate to be matched, or color code provided in specification section 230553, paragraph 2.4.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

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

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

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

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

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

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot (3-m) maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.

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

1. Emergency Power.
2. Power.
3. UPS.

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

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

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

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

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

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

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

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

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

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless

otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels or Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

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

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

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

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

d. Switchboards.
e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
f. Emergency system boxes and enclosures.
g. Enclosed switches.
h. Enclosed circuit breakers.
i. Enclosed controllers.
j. Variable-speed controllers.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Power-generating units.
p. Monitoring and control equipment.
q. UPS equipment.

END OF SECTION

SECTION 26 0572

OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 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 which 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. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

a. Submit study report for action prior to receiving final approval of the 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 the selection of devices and associated characteristics is satisfactory.
b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

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

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551 and IEEE 730.1.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

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

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

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

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
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 the 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: As described in "Power System Data" Article in the Evaluations.

G. Short-Circuit Study Output:

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 a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
2. For equipment provided that is Work of this Project, use characteristics submitted under the 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. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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 the 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. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

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

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

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

D. The extent of the electrical power system to be studied is indicated on Drawings.

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

1. To normal system low-voltage load buses where fault current is 10 kA or less.

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

G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

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

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.

2. Incoming switchgears and switchboards.
3. Low-voltage switchgears and switchboards.
4. Busways and busplugs
5. Control panels.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 26 0573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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

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

1.3 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 which 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. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the 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 the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Software Developer.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. In addition, include the following:

    a. The following parts from the Protective Device Coordination Study Report:

        1) One-line diagram.
        2) Protective device coordination study.
        3) Time-current coordination curves.

    b. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All

elements of the study shall be performed under the direct supervision and control of this professional engineer.

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

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.
5. ETAP Automation, Inc.

B. Comply with IEEE 242 and IEEE 399.

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

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

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

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

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

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

E. Short-Circuit Study:

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 a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Protective Device Coordination Study:

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

G. 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 the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the 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. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. 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. 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 PROTECTIVE DEVICE 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. The study shall be based on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

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

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

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

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall 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 shall protect transformers according to IEEE C57.12.00, for fault currents.

H. 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.

I. 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 the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

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

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Low-voltage switchgear and switchboards.
4. Standby generators and automatic transfer switches.
5. Branch circuit panelboards.

M. 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. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the 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 the design capacity of the load buses.

3. Prepare the 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.

3.4 MOTOR-STARTING STUDY

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

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and , and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA

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

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the 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. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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 the 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 all 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, 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, and cable construction and metallic shield performance parameters.
17. Data sheets to supplement electrical distribution system 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 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. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes RMS symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by an independent NETA testing agency and the engineering service division of the equipment manufacturer under the 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 shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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

3.7 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 26 0574

OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

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

1.3 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 which 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. SCCR: Short-circuit current rating.

E. Arc Flash Hazard – A dangerous condition associated with the possible release of energy caused by an electric arc.

F. Arc Flash Hazard Analysis – A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash boundary, and the appropriate levels of personal protective equipment (PPE).

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

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

a. Submit study report for action prior to receiving final approval of the 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 the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Software Developer.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

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

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.
5. ETAP Automation, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

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

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

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

E. Short-Circuit Study Output:

1. 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 a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

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

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

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.

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

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall 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 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399 and as specified in section 260572.

3.3 ARC-FLASH HAZARD ANALYSIS

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

B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

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

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

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

E. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

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

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the 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.

3.4 POWER SYSTEM DATA

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

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the 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. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

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 at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, 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 and available range of settings, 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. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.5 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Low-voltage switchgear.

2. Low voltage switchboards.
3. Control panels.
4. Busway taps.
5. Transfer switches.
6. Transformers.
7. Panelboards.

3.6 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.7 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION

SECTION 26 0800

COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 01 9113.14 – General Commissioning Requirements – SCRRAC

C. Section 01 9113 – General Commissioning Requirements – EH3

D. Section 23 0800 – Commissioning of Mechanical

E. Commissioning Plan

1.2 SCOPE

A. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning verifies that systems are operating in a manner consistent with the Contract Documents.

B. Refer to Part 3 of this section and sections 019113 and 01911.14 for detailed lists of equipment included in each commissioning activity.

1.3 RESPONSIBILITIES

A. The Contractor shall be responsible for adhering to applicable code required procedures, standards and industry practices to ensure personal safety, the safety of others, and facility safety with regard to electrical equipment operation and testing. If there are procedures in the checklists or the functional performance tests which conflict with safety, the Contractor shall not proceed and shall notify the CxA immediately.

1.4 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.
2. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

3. Certificate of readiness certifying that Electrical systems, subsystems, equipment, and associated controls are ready for testing.
4. Test and inspection reports and certificates.
5. Corrective action documents.

PART 2 - PRODUCTS

2.1 MEANS OF ACCESS

A. The Contractor shall provide means for the CxA to access, observe and visually confirm proper operation of all equipment and systems. These means shall be in compliance with all OSHA and job-site safety regulations.

2.2 TEST EQUIPMENT

A. The Contractor shall provide the necessary equipment to fully test the commissioned systems as defined in the Contract Documents and as defined in the functional performance test procedures to be provided by the CxA.

PART 3 - EXECUTION

3.1 COMPONENT LEVEL TESTS

A. Component level tests shall be those tests, both factory and field, defined in the Contract Documents under “Tests” subsections in other Electrical sections.

B. The Contractor shall provide a report to the owner and the CxA of the results of all component level tests. The report shall contain at a minimum the following information.

1. Project Name
2. Name of person and organization conducting the test
3. Name(s) of person(s) present for the test
4. Date of test
5. Description of equipment or system tested or calibrated, including equipment identification label
6. Description of test or calibration, including test or calibration procedures
7. Environmental conditions (temperature, humidity, other) that may affect the results of the test or calibration
8. Test results
9. Description of “as-found” and “as-left” results, as applicable
10. Analysis and recommendations, as applicable
11. Other comments related to the test or calibration

3.2 EQUIPMENT PRE-FUNCTIONAL CHECKLISTS

A. Equipment Pre-functional Checklists, provided by the CxA, shall be completed by the Contractor on the following systems in addition to systems listed in sections 019113 and 019113.14:

1. Emergency Generator
2. Automatic Transfer Switches
3. Exterior Lighting Controls
4. Interior Lighting Controls
5. Occupancy Sensors

3.3 FUNCTIONAL PERFORMANCE TESTS

A. The Contractor shall provide all documentation as requested to the CxA for development of functional performance testing procedures. This documentation shall include, at a minimum, manufacturer installation, start-up, operation and maintenance procedures. The CxA may request further documentation as necessary for the development of functional performance tests.

B. Functional Performance Tests, provided by the CxA, shall be performed on the following system in addition to systems listed in sections 019113 and 019113.14:

1. Emergency Generator
2. Automatic Transfer Switches
3. Exterior Lighting Controls
4. Interior Lighting Controls
5. Occupancy Sensors

C. The Contractor shall review the functional performance test procedures developed by the CxA.

1. The Contractor shall respond in writing to the CxA regarding the acceptability of the proposed test procedures.
2. The Contractor shall note any necessary modifications to the procedures due to the actual equipment/systems or safety concerns and shall submit these to the CxA for consideration.

D. The Contractor shall place equipment and systems into operation and continue the operation as required during each working day of the testing activities.

E. The Contractor shall accomplish the functional performance testing of equipment based on procedures developed by the CxA and as reviewed by the Contractor.

1. The Contractor shall provide skilled technicians to operate the systems during functional performance testing.
2. The Contractor shall correct any deficiencies as identified during testing and retest equipment as required.

F. Functional performance testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of the system at the discretion of the CxA and the Contractor.

3.4 DEFERRED FUNCTIONAL PERFORMANCE TESTING

A. The Contractor shall perform any deferred testing as required to properly demonstrate successful operation to the owner.

1. Some test conditions may not be able to be simulated and thus require these actual conditions to be present to implement the test.
2. A mutually convenient time to the owner, CxA and Contractor will be scheduled when these test conditions will be present to conduct this deferred testing.

B. The Contractor shall perform these tests as indicated in the functional performance test procedures.

C. The Contractor shall correct any deficiencies or failures identified in the process of performing these tests.

END OF SECTION

SECTION 26 0913

ELECTRICAL POWER MONITORING AND CONTROL

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 the following for monitoring of electrical power system:

1. PC-based workstation(s) and software.
2. Communication network and interface modules for RS-232 RS-485, Modbus TCP/IP IEEE 802.3 data transmission protocols.
3. The EPMCS shall comply with new construction installations and shall be approved by the County prior to commencing submittal process.

B. Related Sections:

1. Section 26 2713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant sub-metering.

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

C. HTML: Hypertext markup language.

D. I/O: Input/output.

E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.

F. LAN: Local area network; sometimes plural as "LANs."

G. LCD: Liquid crystal display.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

I. Modbus TCP/IP: An open protocol for exchange of process data.

J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

K. PC: Personal computer; sometimes plural as "PCs."

L. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. THD: Total harmonic distortion.

Q. UPS: Uninterruptible power supply; used both in singular and plural context.

R. WAN: Wide area network.

1.4 ACTION SUBMITTALS

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

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

C. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data

communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram. Location of the meters and gateways, and routing of the connecting wiring.
5. UPS sizing calculations for workstation.
6. Surge Suppressors: Data for each device used and where applied.
7. Electrical monitoring/control system's graphic screens and navigation scheme. Generic screen examples are not acceptable.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified manufacturer.

B. Field quality-control reports.

C. Other Informational Submittals:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. Include the following:

1. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:

1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
2. Software operating and upgrade manuals.
3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.

4. Device address list and the set point of each device and operator option, as set in applications software.
5. Graphic file and printout of graphic screens and related icons, with legend.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.

D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. 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.

1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Siemens Industry, Inc.
2. SCRRAC-Energy Metering shall be by Siemens and equal to MD-P1 and MD-P1D power meters and shall integrate into the BAS.

2.2 FUNCTIONAL DESCRIPTION

A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.

1. Calculate and Record the Following:

a. Load factor.
b. Peak demand periods.

2. Measure and Record Metering Data for the Following:

a. Electricity.
b. Domestic water.
c. Natural gas.

B. Software: Calculate allocation of utility costs.

1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:

a. At least 15 departments.
b. At least 30 tenants.
c. At least five processes.

C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

1. Voltage regulation and unbalance.
2. Continuous three-phase RMS voltage.

3. Periodic max./min./avg. voltage samples.
4. Harmonics.
5. Voltage excursions.

D. System: Report equipment status and power system control.

2.3 SYSTEM REQUIREMENTS

A. Monitoring and Control System: Include PC-based workstation, with its operating system and application software, connected to data transmission network.

B. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 4313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

D. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
2. ASHRAE 135 (BACnet)and Modbus Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.4 OPERATING SYSTEM

A. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Modbus TCP/IP, RS-232, and RS-485 digital communications.

B. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.

C. Operating System Software: Based on 32-bit, Microsoft Windows Insert name of operating system workstation operating system. Software shall have the following features:

1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu tree format.
3. Capability for future additions within the indicated system size limits.

D. Peer Computer Control Software: Shall detect a failure of workstation and associated server and shall cause other workstation and associated server to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

2.5 APPLICATIONS SOFTWARE

A. Basic Requirements:

1. Fully compatible with and based on the approved operating system.
2. Password-protected operator login and access; three levels, minimum.
3. Password-protected setup functions.
4. Context-sensitive online help.
5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
7. Automatic and encrypted backups for database and history; automatically stored at central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
8. Operator audit trail for recording and reporting all changes made to user-defined system options.

B. Workstation Server Functions:

1. Support other client PCs on the LAN and WAN.
2. Maintain recorded data in databases accessible from other PCs on the LAN and WAN.

C. Data Formats:

1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
2. Option to convert reports and graphics to HTML format.
3. Interactive graphics.
4. Option to send preprogrammed or operator designed e-mail reports.

D. Metered Data: Display metered values in real time.

E. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.

F. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:

1. Site plan.
2. Floor plans.
3. Equipment elevations.
4. Single-line diagrams.

G. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:

1. Operator log on/off.
2. Attempted operator log on/off.
3. All alarms.
4. Equipment operation counters.
5. Out-of-limit, pickup, trip, and no-response events.

H. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.

1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
2. Charting, statistical, and display functions of standard Windows-based spreadsheet.

I. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.

1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.

J. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event. Include the graphic displays of the following, based on user-specified criteria:

1. Phase voltages, phase currents, and residual current.
2. Overlay of three-phase currents, and overlay each phase voltage and current.
3. Waveforms ranging in length from 2 cycles to 5 minutes.
4. Disturbance and steady-state waveforms up to 512 points per cycle.
5. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
6. Calculated waveform, based on recorded data, on a minimum of four cycles of data of the following:

a. THD.
b. RMS magnitudes.
c. Peak values.
d. Crest factors.

e. Magnitude of individual harmonics.

K. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.

1. Tabular data shall be in the comma-separated values.

L. Activity Billing Software:

1. Automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand integrated over user-defined interval.
2. Intervals shall be same as used by electric utilities, including current vendor.
3. Import metered data from saved records that were generated by metering and monitoring software.
4. Maintain separate directory for each activity's historical billing information.
5. Prepare summary reports in user-defined formats and time intervals.

M. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
2. Sort and report by device name and by function.
3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
4. Differentiate alarm signals from other indications.
5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.6 COMMUNICATION COMPONENTS AND NETWORKS

A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.7 POWER MONITORS

A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.

1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. RMS Real-Time Measurements:

1. Current: Each phase, neutral, average of three phases, percent unbalance.
2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
3. Power: Per phase and three-phase total.
4. Reactive Power: Per phase and three-phase total.
5. Apparent Power: Per phase and three-phase total.
6. Power Factor: Per phase and three-phase total.
7. Displacement Power Factor: Per phase and three-phase total.
8. Frequency.
9. THD: Current and voltage.
10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:

1. Present.
2. Running average.
3. Last completed interval.
4. Peak.

E. Demand Real Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

F. Demand Reactive Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

G. Demand Apparent Power Calculations, Three-Phase Total:

1. Present.

2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

H. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.

I. Power Analysis Values:

1. THD, Voltage and Current: Per phase, three phase, and neutral.
2. Displacement Power Factor: Per phase, three phase.
3. Fundamental Voltage, Magnitude and Angle: Per phase.
4. Fundamental Currents, Magnitude and Angle: Per phase.
5. Fundamental Real Power: Per phase, three phase.
6. Fundamental Reactive Power: Per phase.
7. Harmonic Power: Per phase, three phase.
8. Phase rotation.
9. Unbalance: Current and voltage.
10. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.

J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    b. Fixed block that calculates demand at end of the interval.
    c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

    a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
    b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
    c. Demand can be synchronized with clock in the power meter.

K. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.

L. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Current per phase.
4. Line-to-line voltage unbalance.
5. Line-to-neutral voltage unbalance.
6. Power factor.
7. Displacement power factor.
8. Total power.
9. Total reactive power.
10. Total apparent power.
11. THD voltage L-L.
12. THD voltage L-N.
13. THD current.
14. Frequency.

M. Harmonic Calculation: Display and record the following:

1. Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of RMS values, as selected by user.

N. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

O. Accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:

a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:

a. Current: Plus or minus 2.5 percent.
b. Voltage: Plus or minus 1.5 percent.
c. Energy, Demand, and Power: Plus or minus 4.0 percent.
d. Frequency: Plus or minus 1 Hz.

P. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

Q. Input: One digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

R. Outputs:

1. Operated either by user command sent via communication link or set to operate in response to user-defined alarm or event.
2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V RMS isolation.
5. One] relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
6. Output Relay Control:

a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
b. Normally open and normally closed contacts, field configured to operate as follows:

1) Normal contact closure where contacts change state for as long as signal exists.

2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
4) End of power demand interval when relay operates as synchronization pulse for other devices.
5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
6) Output controlled by multiple alarms using Boolean-type logic.

S. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 80 KB of onboard nonvolatile memory.
2. Stored Data:

a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 and 52 days of 15-minute interval data, depending on number of quantities selected.
b. Custom Data Logs: Three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:

1) Schedule interval.
2) Event definition.
3) Configured as "fill-and-hold" or "circular, first-in first-out."

c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

T. Alarms.

1. User Options:

a. Define pickup, dropout, and delay.
b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:

a. Over/undercurrent.
b. Over/undervoltage.
c. Current imbalance.

d. Phase loss, current.
e. Phase loss, voltage.
f. Voltage imbalance.
g. Over kW demand.
h. Phase reversal.
i. Digital input off/on.
j. End of incremental energy interval.
k. End of demand interval.

U. Control Power: 90- to 457-V ac or 100- to 300-V dc.

V. Communications:

1. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet or RS-485 Modbus TCP/IP.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

W. Display Monitor:

1. Backlighted LCD to display metered data with selecting device.
2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
3. Display four values on one screen at same time.

a. Current, per phase RMS, three-phase average and neutral.
b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
c. Real power, per phase and three-phase total.
d. Reactive power, per phase and three-phase total.
e. Apparent power, per phase and three-phase total.
f. Power factor, per phase and three-phase total.
g. Frequency.
h. Demand current, per phase and three-phase average.
i. Demand real power, three-phase total.
j. Demand apparent power, three-phase total.
k. Accumulated energy (MWh and MVARh).
l. THD, current and voltage, per phase.

4. Reset: Allow reset of the following parameters at the display:

a. Peak demand current.
b. Peak demand power (kW) and peak demand apparent power (kVA).
c. Energy (MWh) and reactive energy (MVARh).

2.8 STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT

A. Separately mounted, permanently installed instrument for power monitoring and control.

1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.

1. Indoor installation in nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) Insert temperature range dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.

D. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via 10 Base-T LAN.

E. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.

F. Server Configuration:

1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
4. Operating Software: Suitable for local access; firewall protected.

G. Data Access:

1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.

H. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.

I. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:

1. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values.
2. Circuit Summary Page: Circuit name, three-phase average RMS current, power (kW), power factor, and breaker status.
3. Load Current Summary Page: Circuit name, Phase A, B, and C RMS current values.

4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
7. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
8. Motor-Control Center Status Page: Circuit name, three-phase average RMS current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
9. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.

    a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
    b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.

10. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.

J. Communications:

1. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP and Modbus TCP via a 100 Base-T Ethernet.
2. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.
3. Monitor Display: Backlighted LCD to display metered data with touch-screen selecting device.

2.9 WORKSTATION HARDWARE

A. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 122 deg F (2 to 50 deg C)] dry bulb and 20 to 90 percent relative humidity, noncondensing.

B. Computer: Standard unmodified PC of modular design, designed for the latest version of Windows operating system.

1. Memory: 16MB of usable installed memory.
2. Real-Time Clock. Automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
3. Ports: Two RS-232-F serial ports for general use; one parallel port; four USB ports
4. Replaceable graphics board.
5. LAN Adapter Card.

6. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
7. Color Monitor: WXGA TFT, not less than 24 inches, LCD type.
8. Keyboard: US English.
9. Mouse: Standard.
10. Minimum Disk Storage: 1TB, 7200 rpm hard drive.
11. CD-RW/DVD-ROM Drive.
12. Report Printer: Minimum resolution 600 dpi laser printer.

    a. Connected to central station and designated workstations.
    b. RAM: 16 MB, minimum.
    c. Printing Speed: Minimum 12 pages per minute.

C. UPS: Provide a minimum of 6 hours of operation of workstation station equipment

2.10 LAN CABLES

A. Comply with Section 27 1500 "Communications Horizontal Cabling."

B. RS-485 Cable:

1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.

C. Unshielded Twisted Pair Cables: Category 5eor 6 as specified for horizontal cable for data service in Section 27 1500 "Communications Horizontal Cabling."

2.11 LOW-VOLTAGE WIRING

A. Comply with Section 26 0523 "Control-Voltage Electrical Power Cables."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

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

2. Install Power Management Engineering Station in a secure location per the County's directions and connect all appropriate communication cables.

3.2 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Section 27 1500 "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray 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. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces. All communication conductor wiring, and routing shall be per the manufacturer's recommendations.

D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 0553 "Identification for Electrical Systems."

B. Label each power monitoring and control module with a unique designation.

3.4 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

    a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    b. Test LANs according to requirements in Section 27 1500 "Communications Horizontal Cabling."
    c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
    d. Verify accuracy of graphic screens, icons, and navigation links.
    e. Metering Test: Load feeders, measure loads on feeder conductor with an RMS reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Load must be equal or larger than the meter manufacturer’s minimum accurate load for metering device. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
    f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

G. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

H. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.6 DEMONSTRATION

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

1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.7 ON-SITE ASSISTANCE

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

END OF SECTION

SECTION 26 0923

LIGHTING CONTROLS - LUTRON

PART 1-GENERAL

1.01 SECTION INCLUDES

A. Digital-network lighting control system and associated components:
   1. Main units (Lutron Grafik Eye QS).
   2. Lighting control modules (Lutron Energi Savr Node).
   3. Control stations.
   4. Low-voltage control interfaces.
   5. Wireless sensors.
   6. Accessories.

B. Lighting Scope Chart and Responsibility:

1. SCRAAC:

a. Front of House Lighting: CM Kling + Associates, Inc.

b. Back of House Lighting: Garage, etc. : AHA

2. Holy Cross Space:

a. AHA/KGD Architecture

C. Elizabeth House III Residential:

a. Lobby: CM Kling + Associates, Inc.

b. Levels 4-~~12~~Roof: AHA/KGD Architecture

D. Exterior Façade Lighting + Courtyard Lighting + Site Lighting:

a. CM Kling + Associates, Inc.

b. Egress Lighting: AHA

1.02 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments; 2002a (Reapproved 2010).

B. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements; 2015.

C. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2008.

D. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2014.

E. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

F. ISO 9001 - Quality Management Systems-Requirements; 2008.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

H. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

I. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

L. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
   4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
   5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
   5. Control locations.
   6. Load circuit wiring.
   7. Connections to other equipment and other Lutron equipment.
   8. Installer responsibilities.

C. Sequencing:
   1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations.

C. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy/Vacancy Sensors: Include detailed basic motion detection coverage range diagrams.

D. Shop Drawings:
   1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications:
   1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
   2. Registered to ISO 9001, including in-house engineering for product design activities.
   3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.
   1. System Requirements - Lutron, Unless Otherwise Indicated:
      a. Ambient Temperature:
         1) Lighting Control System Components, Except Those Listed Below: Between 32 and 104 degrees F (0 and 40 degrees C).
         2) Lighting Management System Computer: Between 50 and 90 degrees F (10 and 35 degrees C).

3) Fluorescent Electronic Dimming Ballasts: Between 50 and 140 degrees F (10 and 60 degrees C).

b. Relative Humidity: Less than 90 percent, non-condensing.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Standard Warranty, With Manufacturer Start-Up; Lutron Standard 2-Year Warranty; Lutron LSC-B2:
   1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:
      a. First Two Years:
         1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
         2) First-available on-site or remote response time.
         3) Remote diagnostics for applicable systems.
      b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
   2. Lighting Management System Computer: One year 100 percent parts coverage, one year 100 percent manufacturer labor coverage.
   3. Ballasts/Drivers and Ballast Modules: Five years 100 percent parts coverage, no manufacturer labor coverage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: Lutron Electronics Company, Inc; www.lutron.com.

2.02 DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Sensor Layout and Tuning: Include as part of the base bid additional costs for Lighting Control Manufacturer's Sensor Layout and Tuning service; Lutron LSC-SENS-LT:
   1. Lighting Control Manufacturer to take full responsibility for wired or wireless sensor layout and performance for sensors provided by Lighting Control Manufacturer.
   2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
   3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation should conditions require a deviation from locations specified in the drawings.
   4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from Date of Substantial Completion to fine-tune sensor calibration per the agreed upon sequence of operations.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.

D. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.

E. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

F. Dimming and Switching (Relay) Equipment:
   1. Designed so that electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under fully loaded conditions at maximum rated temperature.
   2. Inrush Tolerance:
      a. Utilize load-handling thyristors (SCRs and triacs), field effect transistors (FETs) and isolated gate bipolar transistors (IGBTs) with maximum current rating at least two times the rated operating current of the dimmer/relay.
      b. Capable of withstanding repetitive inrush current of 50 times the operating current without impacting lifetime of the dimmer/relay.
   3. Surge Tolerance:
      a. Panels: Designed and tested to withstand surges of 6,000 V, 3,000 amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance.
      b. Other Power Handling Devices: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
   4. Power Failure Recovery: When power is interrupted and subsequently restored, within 3 seconds lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
   5. Dimming Requirements:
      a. Line Noise Tolerance: Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage per cycle), frequency shifts (plus or minus 2 Hz change in frequency per second), dynamic harmonics, and line noise.
         1) Systems not providing integral cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
      b. Incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
      c. Utilize air gap off to disconnect the load from line supply.
      d. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
      e. Load Types:
         1) Assign a load type to each dimmer that will provide a proper dimming curve for the specific light source to be controlled.
         2) Provide capability of being field-configured to have load types assigned per circuit.
      f. Minimum and Maximum Light Levels: User adjustable on a circuit-by-circuit basis.
      g. Line Voltage Dimmers:
         1) Dimmers for Magnetic Low Voltage (MLV) Transformers:
            (a) Provide circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472.
            (b) Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
         2) Dimmers for Electronic Low Voltage (ELV) Transformers: Operate transformers via reverse phase control. Alternately, forward phase control

dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.

3) Dimmers for Neon and Cold Cathode Transformers:
   (a) Magnetic Transformers: Listed for use with normal (low) power factor magnetic transformers.
   (b) Electronic Transformers: Must be supported by the ballast equipment manufacturer for control of specific ballasts being provided.

h. Low Voltage Dimming Modules:
   1) Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to a single zone.
   2) Single low voltage dimming module; capable of controlling the following light sources:
      (a) 0-10V analog voltage signal.
         (1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         (2) Sink current according to IEC 60929.
         (3) Source current.
      (b) 10-0V reverse analog voltage signal.
      (c) DSI digital communication.
      (d) DALI broadcast communication per IEC 60929:
         (1) Logarithmic intensity values complying with IEC 60929.
         (2) Linear intensity values for use with LED color intensity control.
      (e) PWM per IEC 60929.

6. Switching Requirements:
   a. Rated Life of Relays: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
   b. Switch load in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
   c. Provide output fully rated for continuous duty for inductive, capacitive, and resistive loads.

G. Device Finishes:
   1. Standard Colors: Comply with NEMA WD1 where applicable.
   2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units.
   3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

2.03 MAIN UNITS (LUTRON GRAFIK EYE QS)

A. Product: Lutron GRAFIK Eye QS.

B. Provide main units with configuration and quantity of zones as indicated to control the loads as indicated.

C. Engrave units with button, zone, and scene descriptions as indicated on the drawings.

D. Integrated Wireless Capability:
   1. Provide wireless communication inputs for:
      a. Occupancy sensors.
      b. Daylight sensors.
      c. Wireless controller.
   2. RF Range: 30 feet (9 m) between sensor and compatible RF receiving device(s).

3. RF Frequency: 434 MHz; operate in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

E. Preset Lighting Control with Zone Override:
1. Intensity for each zone indicated by means of one illuminated bar graph per zone.
2. User-programmable zone and scene names.
3. Utilize air gap off to disconnect the load from line supply.
4. Astronomical time clock and programmer interface provides access to:
   a. Scene selections.
   b. Fade zone to a level.
   c. Fine-tuning of preset levels with scene raise/lower.
   d. Lock out scenes and zones.
   e. Fine-tuning of light levels with individual zone raise/lower.
   f. Terminal block for wired infrared signal input.
   g. Enable/disable wall station.
5. Light intensity with real time energy savings by digital display.
6. Fade time indicated by digital display for current scene while fading.
7. Integral wide angle infrared receiver.
8. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
9. Direct Low-Voltage Control of Digital Ballasts and LED drivers (120V, 220/240V, 277V and/or 347V Lighting):
   a. Electronically link a digital fluorescent lighting ballast to a zone for both dimming and turning on/off.
   b. Electronically assign daylight sensors to digital ballasts and line voltage dimmers for proportional daylight harvesting.
   c. Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
10. Creates daylighting rows independent of control zones.
11. Capable of re-zoning without re-wiring using programming display on unit.
12. Outputs can be virtually mapped to other device's outputs.
13. Zone raise/lower buttons capable of controlling local lighting loads connected to the main unit or remote lighting zones in the system.

F. Provides one direct-wired occupancy sensor connection without interface or power pack.

2.04 LIGHTING CONTROL MODULES (LUTRON ENERGI SAVR NODE)

A. Provide lighting control modules as indicated to control the loads as indicated.

B. General Requirements:
1. Listed to UL 508 as industrial control equipment.
2. Delivered and installed as a listed factory-assembled panel.
3. Passively cooled via free-convection, unaided by fans or other means.
4. Mounting: Surface.
5. Connection without interface to wired:
   a. Occupancy sensors.
   b. Daylight sensors.
   c. IR receivers for personal control.
6. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
7. Contact Closure Input:

a. Directly accept contact closure input from a dry contact closure or sold-state output without interface to:
   1) Activate scenes.
      (a) Scene activation from momentary or maintained closure.
   2) Enable or disable after hours.
      (a) Automatic sweep to user-specified level after user-specified time has elapsed.
      (b) System will provide occupants a visual warning prior to sweeping lights to user-specified level.
      (c) Occupant can reset timeout by interacting with the lighting system.
   3) Activate or deactivate demand response (load shed).
      (a) Load shed event will reduce lighting load by user-specified amount.

8. Emergency Contact Closure Input:
   a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 listed emergency lighting interface, security system or fire alarm system.
   b. Allow configurable zone response during emergency state.
   c. Disable control operation until emergency signal is cleared.
9. Supplies power for control link for keypads and control interfaces.
10. Distributes sensor data among multiple lighting control modules.
11. Capable of being controlled via wireless sensors and controls.

C. 0-10V Lighting Control Modules:
   1. Product(s):
      a. Lutron 0-10V Energi Savr Node; Model QSN-4T16-S: 16 A continuous-use per channel.
   2. Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to single zone.
   3. Single low voltage dimming module; capable of controlling following light sources:
      a. 0-10V analog voltage signal.
         1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         2) Sink current per IEC 60929.
      b. 10V-0V analog voltage signal.
         1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         2) Sink current per IEC 60929.
   4. Switching:
      a. Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
      b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
      c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
      d. Module to integrate up to four individually controlled zones.
      e. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

2.05 CONTROL STATIONS

A. Provide control stations with configuration as indicated to control the loads as indicated.

B. Wired Control Stations:
   1. General Requirements:
      a. Power: Class 2 (low voltage).

b. UL listed.
c. Provide faceplates with concealed mounting hardware.
d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
e. Finish: As specified for wall controls in "Device Finishes" under DIGITAL NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS article above.

2. Multi-Scene Wired Control:
   a. General Requirements:
      1) Allows control of any devices part of the lighting control system.
      2) Allows for easy reprogramming without replacing unit.
      3) Replacement of units does not require reprogramming.
      4) Communications: Utilize RS485 wiring for low-voltage communications link.
      5) Engrave keypads with button, zone, and scene descriptions as indicated on the drawings.
      6) Software Configuration:
         (a) Customizable control station device button functionality:
            (1) Buttons can be programmed to perform single defined action.
            (2) Buttons can be programmed to perform defined action on press and defined action on release.
            (3) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
            (4) Buttons can be programmed to perform automatic sequence of defined actions.
            (5) Capable of deactivating select keypads to prevent accidental changes to light levels.
            (6) Buttons can be programmed for raise/lower of defined loads.
            (7) Buttons can be programmed to toggle defined set of loads on/off.
      7) Status LEDs:
         (a) Upon button press, LEDs to immediately illuminate.
         (b) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
         (c) Support logic that defines when LED is illuminated:
            (1) Scene logic (logic is true when all zones are at defined levels).
            (2) Room logic (logic is true when at least one zone is on).
            (3) Pathway logic (logic is true when at least one zone is on).
            (4) Last scene (logic is true when spaces are in defined scenes).
   b. Wired Keypads; Lutron seeTouch QS Wallstations:
      1) Style: Architectural Insert Style.
      2) Mounting: Wallbox or low-voltage mounting bracket; provide wall plates with concealed mounting hardware.
      3) Button/Engraving Backlighting:
         (a) Utilize backlighting for buttons and associated engraving to provide readability under all light conditions.
         (b) Backlight intensity adjustable via programming software.
      4) Design keypads to allow field-customization of button color, configuration, and engraving using field-changeable replacement kits.

5) Contact Closure Interface: Provide two contact closure inputs on back of unit which provide independent functions from front buttons; accepts both momentary and maintained contact closures.
6) Terminal block inputs to be over-voltage and miswire-protected against reversals and shorts.

C. Wireless (Radio Frequency) Controls:
1. Product(s):
a. Type _____ - 2-Button with Raise/Lower Control; Lutron Pico Wireless Control Model PJ2-2BRL.
b. Screw Mounting Kit; Lutron Model PICO-SM-KIT.
c. Wallbox Adapter; Lutron Model PICO-WBX-ADAPT.
2. Quantity: As indicated on the drawings.
3. Communicates via radio frequency to compatible dimmers, switches, and plug-in modules.
4. Does not require external power packs, power or communication wiring.
5. Allows for easy reprogramming without replacing unit.
6. Button Programming:
a. Single action.
b. Toggle action.
c. Defined action on press and defined action on release.
7. Includes LED to indicate button press or programming mode status.
8. Mounting:
a. Capable of being mounted with a table stand or directly to a wall under a faceplate.
b. Faceplates: Provide concealed mounting hardware.
9. Power: Battery-operated with minimum ten-year battery life.
10. Finish: As specified for wall controls in "Device Finishes" under DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS article above.

2.06 LOW-VOLTAGE CONTROL INTERFACES

A. Provide low-voltage control interfaces as indicated to control the loads as indicated.

B. UL listed.

C. RS232 and Ethernet Interface:
1. Product: Lutron Model QSE-CI-NWK-E.
2. Provide ability to communicate via Ethernet or RS232 to audiovisual equipment, touchscreens, etc.
3. Provide control of:
a. Light scene selections.
b. Fine-tuning of light scene levels with raise/lower.
c. Simulate system wall station button presses and releases.
4. Provide status monitoring of:
a. Light scene status.
b. Wall station button presses and releases.
c. Wall station LEDs.
5. Provide ability to send custom output strings.

D. Sensor Modules:
1. Products:
a. Sensor module with both wired and wireless inputs; Lutron Model QSM2-4W-C.
2. Wired Modules:

a. Provide wired inputs for:
   1) Occupancy sensors.
   2) Daylight sensors.
   3) IR receivers for personal control.
   4) Digital ballast wall stations.

3. Wireless Modules:
   a. Provide wireless communication inputs for:
      1) Occupancy sensors.
      2) Daylight sensors.
      3) Wireless controller.
   b. RF Range: 30 feet (9 m) between sensor and compatible RF receiving devices.
   c. RF Frequency: 434 MHz; operates in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
4. Communicate sensor information to wired low-voltage digital link for use by compatible devices.

2.07 WIRELESS SENSORS

A. General Requirements:
   1. Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.
   2. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
   3. Does not require external power packs, power wiring, or communication wiring.
   4. Capable of being placed in test mode to verify correct operation from the face of the unit.
   5. RF Range: 30 feet (9 m) between sensor and compatible RF receiving device(s).
   6. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.

B. Wireless Occupancy/Vacancy Sensors:
   1. General Requirements:
      a. Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
      b. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
      c. Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions; Lutron XCT Technology. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
      d. Provide optional, readily accessible, user-adjustable controls for timeout, automatic/manual-on, and sensitivity.
      e. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
      f. Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
      g. Color: White.
      h. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.

i. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
j. Sensor lens to illuminate during test mode when motion is detected to allow installer to verify coverage prior to permanent mounting.
k. Ceiling-Mounted Sensors:
1) Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
2) Provide recessed mounting bracket compatible with drywall and compressed fiber ceilings.
3) Provide customizable mask to block off unwanted viewing areas.

2. Wireless Combination Occupancy/Vacancy Sensors:
a. Ceiling-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), an occupancy sensor with low light feature (automatic-on when less than one footcandle of ambient light available and automatic-off), or a vacancy sensor (manual-on and automatic-off).
b. Product(s):
1) Type _____ - Ceiling-Mounted Occupancy/Vacancy Sensor; Lutron Model LFR2-OCR2B-P-WH: Coverage from 324 square feet (30.2 sq m) to 676 square feet (62.4 sq m) depending on ceiling height from 8 to 12 feet (2.4 to 3.7 m); 360 degree field of view.

C. Wireless Daylight Sensors:
1. Product: Lutron Model LFR2-DCRB.
2. Open-loop basis for daylight sensor control scheme.
3. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
4. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
5. Provide linear response from 0 to 10,000 footcandles.
6. Color: White.
7. Mounting:
a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
b. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
c. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

2.08 ACCESSORIES

A. Emergency Lighting Interface:
1. Product: Lutron Model LUT-ELI.
2. Provides total system listing to UL 924 when used with lighting control system.
3. Senses all three phases of building power.
4. Provides an output to power panels or digital ballast interfaces if power on any phase fails and sends all lights controlled by these devices to an emergency light level setting. Lights to return to their previous intensities when normal power is restored.
5. Accepts a contact closure input from a fire alarm control panel.

B. Provide power supplies as indicated to power system devices and accessories.

2.09 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Factory Testing; Lutron Standard Factory Testing:
   1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
   2. Perform factory audit burn-in of all dimming assemblies and panels at 104 degrees F (40 degrees C) at full load for two hours.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.

B. Install products in accordance with manufacturer's instructions.

C. Define each dimmer/relay load type, assign each load to a zone, and set control functions.

D. Sensor Locations:
   1. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", locate sensors in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, locate sensors in accordance with Drawings.
   2. Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.

E. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.

F. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

G. Identify system components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Manufacturer's Startup Services; Lutron Standard Startup Services:

1. Manufacturer's authorized Service Representative to conduct minimum of two site visits to ensure proper system installation and operation.
2. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
3. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
    a. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", authorized Service Representative to verify sensor locations, in accordance with layout provided by Lighting Control Manufacturer; Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
    b. Verify connection of power wiring and load circuits.
    c. Verify connection and location of controls.
    d. Address devices.
    e. Verify system operation control by control.
    f. Verify proper operation of manufacturer's interfacing equipment.
    g. Configure initial groupings of ballast for wall controls, daylight sensors and occupancy sensors.
    h. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS".
    i. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
    j. Obtain sign-off on system functions.
4. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 ADJUSTING

A. On-Site Scene and Level Tuning; Lutron LSC-AF-VISIT: Include as part of the base bid additional costs for Lighting Control Manufacturer to visit site to conduct meeting with Engineer to make required lighting adjustments to the system for conformance with original design intent.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 COMMISSIONING

A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.

3.07 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION

SECTION 26 2200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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. Qualification Data: For testing agency.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. 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.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D Co./Groupe Schneider NA; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Totally enclosed, nonventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Totally enclosed, nonventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 gray.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 15 kVA and Larger: Three 2.5 percent taps above and three 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

M. Wall Brackets: Manufacturer's standard brackets.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

O. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 45 dBA.
2. 30 to 50 kVA: 45 dBA.
3. 51 to 150 kVA: 50 dBA.
4. 151 to 300 kVA: 55 dBA.
5. 301 to 500 kVA: 60 dBA.
6. 501 to 750 kVA: 62 dBA.
7. 751 to 1000 kVA: 64 dBA.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written 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 26 0526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 0529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

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

C. Perform tests and inspections and prepare test reports.

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

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period no more than four months after substantial completion and building occupancy. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a 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.

END OF SECTION

SECTION 26 2413

SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. 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 NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit in PDF format; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

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.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition, include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. 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.

E. 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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.9 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

1.10 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. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V or 208Y/120 V.

D. Main-Bus Continuous: As indicated on drawings.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems."

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

K. Pull Box on Top of Switchboard (if required):

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
3. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
4. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
5. 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.

6. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
7. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. Four-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120-V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120.

F. SCCR: Equal or exceed 200 kA.
G. Nominal Discharge Current Rating: 20 kA

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electrical Power Monitoring and Control."
    f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time time adjustments.
c. Ground-fault pickup level, time delay, and I^2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. Siemens Energy & Automation, Inc.
c. Square D; a brand of Schneider Electric.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.

4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.

6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

    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. Megawatts: Plus or minus 2 percent.
    e. Megavars: Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.
    g. Frequency: Plus or minus 0.5 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
3. Integral demand indicator.
4. Contact devices to operate remote impulse-totalizing demand meter.
5. Ratchets to prevent reverse rotation.
6. Removable meter with drawout test plug.
7. Semi-flush mounted case with matching cover.
8. Appropriate multiplier tag.

C. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 30-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400 and NEMA PB 2.1.

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.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 03 3000 "Cast-in-Place Concrete"."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the 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.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 26 2500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 0553 "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 a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Equipment manufacturer certified service technician will assist the testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 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 specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 26 2416

PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

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.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. 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.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. 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.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Phase, Neutral, and Ground Buses:

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

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

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

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker or lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

H. Panelboards serving receptacle loads to be provided with 200% neutral and to be served by K-13 rated transformers.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 0913 "Electrical Power Monitoring and Control."
    f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 2813 "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or 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. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

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

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 0553 "Identification for Electrical Systems."

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

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for breakers, meters, and TVSS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, after all owner furnished equipment and appliances installed but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes to panelboards designated by Owner.

1. Measure as directed during period of normal system loading.

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

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 2500

ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Feeder-bus assemblies.
2. Plug-in bus assemblies.
3. Bus plug-in devices.

1.3 DEFINITIONS

A. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For each type of bus assembly and plug-in device.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
2. Show fittings, materials, fabrication, and installation methods for listed fire-stop barriers.
3. Indicate required clearances, method of field assembly, and location and size of each field connection.
4. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Wiring Diagrams: Power, signal, and control wiring.
6. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.

    a. Design Calculations: Calculate requirements for selecting seismic restraints.
    b. Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:

1. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
2. Clearances for access above and to the side of enclosed bus assemblies.
3. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
4. Support locations, type of support, and weight on each support.

B. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

C. Qualification Data: For professional engineer and testing agency.

D. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.

E. Manufacturer Seismic Qualification Certification: Submit certification that enclosed bus assemblies, plug-in devices, accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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.

F. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

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

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.

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

D. Comply with NEMA BU 1, "Busways."

E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

1.9 PROJECT CONDITIONS

A. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 122 deg F (50 deg C).

1.10 COORDINATION

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

B. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 ENCLOSED BUS ASSEMBLIES

A. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.

1. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure
2. Voltage: 120/208 277/480 V; 3 phase; 100 percent neutral capacity.
3. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
4. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
5. Ground:

    a. 50 percent capacity integral with housing.
    b. 50 percent capacity internal bus bars of material matching bus material.

6. Enclosure: Steel or Aluminum with manufacturer's standard finish.
7. Fittings and Accessories: Manufacturer's standard.
8. Mounting: Arranged flat, edgewise, or vertically without derating.

B. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.

1. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for switchboards with reinforcement strong enough to withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure.
2. Voltage: 120/208 277/480 V; 3 phase; 100 percent neutral capacity.
3. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
4. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
5. Ground:
6. Enclosure: Steel, with manufacturer's standard finish, plug-in openings 24 inches (610 mm) o.c., and hinged covers over unused openings.
7. Fittings and Accessories: Manufacturer's standard.
8. Mounting: Arranged flat, edgewise, or vertically without derating.

2.3 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with R-type rejection or J-type fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Section 26 2813 "Fuses" for fuses and fuse installation requirements.

B. Molded-Case Circuit Breakers: NEMA AB 1; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.

1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Section 26 0548.16 "Seismic Controls for Electrical Systems."
2. Design each fastener and support to carry 200 lb (90 kg) or 4 times the weight of bus assembly, whichever is greater.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Support bus assembly with not less than 3/8-inch (10-mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
5. Fasten supports securely to building structure according to Section 26 0529 "Hangers and Supports for Electrical Systems."

B. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.

C. Construct rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Section 07 8413 "Penetration Firestopping."

D. Install weather seal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 07 9200 "Joint Sealants" for materials and application.

E. Install a concrete curb at least 4 inches (100 mm) high around bus-assembly floor penetrations.

F. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.

G. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

H. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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

B. Tests and Inspections:

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

C. Remove and replace units that do not pass tests and inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.4 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.5 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION

SECTION 26 2713

ELECTRICITY METERING

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 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.3 ACTION SUBMITTALS

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

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. In addition include the following:

1. Application and operating software documentation.

2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

2.2 EQUIPMENT FOR ELECTRICITY METERS FOR OWNER USE

A. SCRRAC-Energy Metering shall be by Siemens and equal to MD-P1 and MD-P1D power meters and shall integrate into the BAS. Siemens, ViewPoint software shall be programmed to comply with specific output data and headend display requirements directed by the County.

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

1. Eaton.
2. Electro Industries.
3. E-Mon.
4. General Electric Company.
5. Leviton Manufacturing Co., Inc.
6. Siemens Industry, Inc., Energy Management Division.
7. Square D; by Schneider Electric.

C. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
4. Identification: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: Split and solid core.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

D. Kilowatt-hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.

E. Kilowatt-hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

F. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Manufacturer requirements and recommendations for cables.

G. Comply with Section 26 0523 "Control-Voltage Electrical Power Cables."

H. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for the following:

a. At least 15 departments.
b. At least 30 tenants.
c. At least five processes.

2. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare tenant bills based on metering of energy use. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, programming, display configuration, calibration, and network connection to assist in testing.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating to a circuit supplied by a metered feeder. Load size shall be equal to or larger than the manufacturer’s listed minimum accurate load size for each meter.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for four hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

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

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 2726

WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Receptacles with integral Arc Fault Circuit Interrupter, AFCI.
3. Twist-locking receptacles.
4. Isolated-ground receptacles.
5. Weather-resistant receptacles.
6. Snap switches and wall-box dimmers.
7. Solid-state fan speed controls.
8. Wall-switch.
9. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. AFCI: Arc Fault Circuit Interrupter.

B. EMI: Electromagnetic Interference.

C. GFCI: Ground-Fault Circuit Interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-Frequency Interference.

F. TVSS: Transient Voltage Surge Suppressor.

G. UTP: Unshielded Twisted Pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.

2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 5351 (single), CR5362 (duplex).
   b. Hubbell; HBL5351 (single), HBL5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5361 (single), 5362 (duplex).

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; VGF20.
   b. Hubbell; GFR5352L.
   c. Pass & Seymour; 2095.
   d. Leviton; 7590.

C. Arc Fault Convenience Receptacles, 125 V, 15A and 20A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Wiring Device-Kellems; AFR25TRW, AFR20TRW, or a comparable product by one of the following:

   a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
   b. Leviton Manufacturing Co., Inc.
   c. Pass & Seymour/Legrand (Pass & Seymour).

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; CWL520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Cooper; AH1221PL for 120 and 277 V.
    b. Hubbell; HBL1201PL for 120 and 277 V.
    c. Leviton; 1221-LH1.
    d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

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

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Cooper; AH1221L.
    b. Hubbell; HBL1221L.
    c. Leviton; 1221-2L.
    d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Cooper; 1995.
    b. Hubbell; HBL1557.
    c. Leviton; 1257.
    d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Cooper; 1995L.
    b. Hubbell; HBL1557L.
    c. Leviton; 1257L.
    d. Pass & Seymour; 1251L.

2.7 DECORATOR-STYLE ROCKER SWITCH

A. Switches: Square Face, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

1. Products: Subject to compliance with requirements, provide the following:

    a. Cooper; 7621 (single pole), 7623 (three way).

b. Hubbell; DS120 (single pole), DS320 (three way).
c. Leviton; 5621-2 (single pole), 5623-2 (three way).
d. Pass & Seymour; 2621 (single pole), 2623 (three way)

2.8 RESIDENTIAL DEVICES

A. Residential-Grade, Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; TR270.
b. Hubbell; RR155STR.
c. Leviton; T5320.
d. Pass & Seymour; TR62.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch- (1-mm-) thick, ~~satin-finished, Type 302 stainless steel~~**color white**.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic**, color white**.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift ~~cover, and~~**cover and** listed and labeled for use in wet and damp locations**, color white**.
~~4.~~5. B1 level locations: Heavy duty 316SS weatherproof spring-loaded covers, NEMA 4X (DGS approved).

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

2.11 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, flap-type, or above-floor, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.12 POKE-THROUGH ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand.
3. Square D/Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold/Legrand.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Coordinate with Telecommunications drawing(s)
4. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 27 1500 "Communications Horizontal Cabling."

2.13 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

B. Wall Plate Color: For plastic covers, match device color.

~~B.~~**C. Floor outlets: Flange and cover finish to be aluminum (silver finish) as approved by Architect.**

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

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

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 0553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

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

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 2813

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 control circuits or enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, 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.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," 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.
4. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

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. Service Entrance: Class L, time delay.
2. Feeders: Class L, fast acting.
3. Motor Branch Circuits: Class RK5, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally Closed.

B. NO: Normally Open.

C. SPDT: Single Pole, Double Throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers 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 from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. 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.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition, include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. 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.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. 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.

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

E. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.10 COORDINATION

A. 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.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 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.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 SHUNT TRIP SWITCHES

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

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Isolated neutral lug; 100 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. 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^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. 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.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. 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.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 26 0913 "Electrical Power Monitoring and Control."
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

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.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 26 0548.16 "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. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 0553 "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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Perform tests and inspections.

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

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

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 as specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

END OF SECTION

SECTION 26 2923

VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

1. Division 22 section “Motors for Plumbing Equipment”.
2. Division 23 section “Motors for HVAC Equipment”.
3. Division 26 section “Enclosed Switches, Breakers, and SPDs”.

1.3 DEFINITIONS

A. BAS: Building Automation System.

B. CPT: Control Power Transformer.

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.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification 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.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519 latest version.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1. In addition, 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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Power Fuses: .Furnish one set of each type and rating.
2. Indicating Lights: Two of each type and color installed.
3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
5. Circuit Breakers: Furnish one of each type and rating.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install electric heating of sufficient wattage to prevent condensation.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ABB
2. Danfoss Inc; Danfoss Drives Div.
3. Rockwell Automation, Inc; Allen-Bradley Brand.
4. Siemens Energy & Automation, Inc.

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.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application variable torque.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

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; 6 to 66 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 15 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 98 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
7. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet (1000 m).
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 10 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

F. Inverter Logic: Microprocessor based,32 bit, isolated from all power circuits.

G. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical

H. 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 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

I. 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.

J. Bypasses shall be furnished and mounted by the drive manufacturer. All VFD with bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label

K. 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.

L. 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.

M. 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.

N. 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.

O. 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.

P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. NC alarm contact that operates only when circuit breaker has tripped.

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.

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."

2.4 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 and additional readout devices as required, 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. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: Operator-selectable "x"- to "y"-mA dc.
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

a. 0- to 10-V dc.
b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.

3. Fixed frequencies using digital Input/Output Signal Interface: A minimum of one programmable analog output signal(s) operator-selectable "x"- to "y"-mA 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).

4. 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. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

G. BAS Interface: Factory-installed hardware and software shall interface with BAS 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.

2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with BAS to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration: Full-voltage type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity100 VA.

6. Overload Relays: NEMA ICS 2.

    a. Melting-Alloy Overload Relays:

        1) Inverse-time-current characteristic.
        2) Class 20 tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

    b. Bimetallic Overload Relays:

        1) Inverse-time-current characteristic.
        2) Class 20 tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
        4) Ambient compensated.
        5) Automatic resetting.

    c. Solid-State Overload Relays:

        1) Switch or dial selectable for motor-running overload protection.
        2) Sensors in each phase.
        3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
        5) Analog communication module.

    d. NC isolated overload alarm contact.
    e. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. 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 or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. 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.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires, this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal automatically or manually.

F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

G. Remote digital operator kit.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations.
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.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable pneumatic or solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

J. Spare control-wiring terminal blocks; wired.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

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 (2000 mm) 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 26 0529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03 3000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 07 7200 "Roof Accessories."
2. Structural-steel channels are specified in Section 26 0529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 2813 "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 26 0523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 0553 "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.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
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 Architect and 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. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. 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.

3.6 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.

3.7 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 Architect and Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 0573 "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.8 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.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 26 3213

ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency or standby power supply with the following features:

1. Diesel engine for the 350kW and 500kW gensets.
2. Natural gas engine for the 1040kW genset (existing, furnished by the County).
3. Unit-mounted cooling system.
4. Unit-mounted control and monitoring.
5. Performance requirements for sensitive loads.

B. Related Sections include the following:

1. Section 26 3600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid Petroleum.

C. NG: Natural Gas.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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. Qualification Data: For installer manufacturer and testing agency.

C. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition, include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. Comply with NFPA 110 requirements for Level 1 or 2 emergency power supply system.

K. Comply with UL 2200.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 43 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Natural gas, 1040kW, 480/277V, 3-phase, 60 Hertz, stand-by power rated Caterpillar generator is existing and owned by Montgomery County. Delivery and installation of this generator all associated gear will be performed under this project. Refer to electrical drawings for removal and reinstallation requirements of this generator.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Caterpillar, Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Caterpillar; Engine Div.
2. Kohler Co.
3. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2 for the 350kW and 500kW gensets and 0.5 psi natural gas (NG) for the 1040kW genset.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

3. Fuel Filters: Each diesel engine shall include a Racor brand fuel water separator with a water sensor in addition to an engine mounted fuel filter. Each natural gas engine shall have a factory provided fuel filter
4. Flex fuel lines: Each engine shall be provided with braided stainless steel flex fuel lines.
5. Natural gas engines shall be capable of operating on a supply gas pressure of 0.5 psi -5.0 psi natural gas and shall include a regulator designed to operate on this supply pressure.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Radiator shall be rated at no less than 110 degrees F ambient temperature and shall be based on a restriction level of 0.75" water column. The radiator shall also be able to accommodate an additional 7 degrees F temperature rise across the generator for an inlet air temperature to the radiator of 117 degrees F.
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements based on an exhaust piping run shown on the drawings for a generator installed inside the building.

1. The exhaust silencer shall have a minimum sound rating of a critical grade silencer and shall be a space saver type exhaust silencer
2. The vendor shall supply the exhaust flex, nut, bolt and gasket group
3. Minimum sound attenuation of 30 dB at all frequencies 500 Hz.
4. Exhaust sound level measured at a distance of 23 feet (7 m) from exhaust discharge after installation is complete shall be no greater than 60 dBA or less.

J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging. The batteries shall have a minimum rating of 1300 cold cranking amps/180 ampere hours for generators smaller than 1000kW for diesel and 300kW for natural gas and shall be rated for no less than 2600 cold cranking amps/360 ampere hours for generators larger than 1000kW diesel and 300kW natural gas.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 DIESEL FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Diesel Fuel Oil Tank: Factory installed and piped, complying with UL 2085 fuel oil tank. Features include the following:

1. Tank level indicator for high level, low level, critical high and critical low with alarms at each level of indication.
2. Each tank shall be designed to operate with a remote fill station and shall include an overfill prevention valve, manual fill port with overspill bucket
3. Capacity: Diesel Fuel for eight hours' continuous operation at 100 percent rated power output.
4. Vandal-resistant fill cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:

1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Switchboard Construction: Freestanding unit complying with Section 26 2413 "Switchboards."
3. Current and Potential Transformers: Instrument accuracy class.

F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1and 2 system, and the following:

1. AC voltmeter.

2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

H. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

I. Remote Alarm Annunciators: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Alternator shall be permanent magnet excited

C. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

D. Electrical Insulation: Class H or Class F.

E. Temperature Rating: The alternator shall have a temperature rating of no less than 125-degrees C temperature rise at 40-degrees C ambient

F. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

G. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

H. Enclosure: Dripproof.

I. Instrument Transformers: Mounted within generator enclosure.

J. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

K. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

L. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

M. Subtransient Reactance: 12 percent, maximum.

2.8 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing.

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.

f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

   1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 3000 "Cast-in-Place Concrete."

1. Comply with requirements for seismic control devices specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."
2. Comply with requirements for vibration isolation devices specified in this section.

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 23 2116 Hydronic Piping Specialties."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Section 23 2116 Hydronic Piping Specialties."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 23 1113 "Facility Fuel-Oil Piping."

F. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Section 23 0553 "Identification for HVAC Piping and Equipment" and Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest and reinspect as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

SECTION 26 3600

TRANSFER SWITCHES

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. Furnish and install automatic transfer switches with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.
3. Nonautomatic transfer switches.
4. Remote annunciation systems.
5. Remote annunciation and control systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 26 0548.16 "Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition, include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

C. 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.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

I. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 3000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

1. Manufacturers: Basis of design shall be ASCO Series 300. Any alternate shall be submitted to the consulting engineer in writing at least 10 days prior to bid. Each alternate bid must list any deviations from this specification.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include over current disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.

D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

F. Where neutral conductors must be switched, the ATS shall be provided with fully- rated neutral transfer contacts.

G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

H. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

I. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

2.3 CONTROLLER WITH INTEGRATED USER INTERFACE PANEL

A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via the Ethernet through optional communications module

C. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.1Hz. Time delay settings shall be accurate to ± 0.5% of the full scale value of the time delay. The panel shall be capable of operating over a temperature range of -20 to + 70 degrees C, and storage from -55 to + 85 degrees C.

D. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment. 61000-4 Testing and Measurement Techniques - Overview

    a. IEC 61000 – 4 - 2 Electrostatic Discharge Immunity
    b. IEC 61000 – 4 - 3 Radiated RF Field Immunity
    c. IEC 61000 – 4 - 4 Electrical Fast Transient/Burst Immunity
    d. IEC 61000 – 4 - 5 Surge Immunity
    e. IEC 61000 – 4 - 6 Conducted RF Immunity

2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions

2.4 ENCLOSURE

A. The ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.

B. Controller shall be mounted on, visible, and operational through enclosure door.

2.5 CONTROLLER DISPLAY AND KEYPAD

A. A 128*64 graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.

1. Nominal line voltage and frequency
2. Single or three phase sensing on normal
3. Transfer operating mode configuration, (open transition, or delayed transition) All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 VOLTAGE AND FREQUENCY SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified.

Parameter	Sources	Dropout/Trip	Pickup/Reset
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to115%	2% below trip
Undervoltage	N & E	85 to 98%	90 to 100%
Overfrequency	N & E	102 to 110%	2% below trip

B. Repetitive accuracy of all settings shall be within 1% at +25C

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage and frequency. Note: Single phase sensing on emergency

E. The backlit 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

2.7 TIME DELAYS

A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.

C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds.

D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

E. A cooldown time delay shall be provided on shutdown of engine generator, Adjustable 0 to 60 minutes 59 seconds.

F. All adjustable time delays shall be field adjustable without the use of special tools.

G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

H. In the event that the alternate source is not accepted within the configured Failure to Accept time delay, the common alert indication shall become active.

I. The controller shall also include the following built-in time delay for delayed transition operation.

1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds.

2.8 ADDITIONAL FEATURES

A. The user interface shall be provided with test/reset modes. The test mode will simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.

C. A single alarm indication shall light up the alert indicator and de – energize the configured common alarm output relay for external monitoring.

D. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.

F. LED indicating light shall be provided to indicate switch not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.

G. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).

H. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

I. A variable window inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO feature 27.

J. Terminals shall be provided for a remote contact to signal the ATS to transfer to emergency. This inhibit signal can be enabled through the keypad or serial port.

K. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key. This screen shall display a clear description of the active operating sequences and switch position. For example,

L. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

M. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication port with a network of transfer switches, locally (up to 4000 ft.). Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control, and setup of parameters.

N. Data Logging – The controller shall have the ability to log data and to maintain the last 300 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non – volatile memory.

1. Event Logging

   a. Data and time and reason for transfer normal to emergency
   b. Data and time and reason for transfer emergency to normal
   c. Data and time and reason for engine start
   d. Data and time engine stopped
   e. Data and time emergency source available
   f. Data and time emergency source not available

2. Statistical Data

   a. Total number of transfers
   b. Total number of transfers due to source failure
   c. Total number of day's controller is energized
   d. Total number of hours both normal and emergency sources are available
   e. Total time load is connected to normal
   f. Total time load is connected to emergency
   g. Last engine start
   h. Last engine start up time
   i. Input and output status

2.9 OPTIONAL FEATURES

A. Accessory Package - An accessory bundle shall be provided that includes:

1. A fully programmable engine exerciser with seven independent routines to exercise the engine generator, with or without load on a daily weekly, bi – weekly, or monthly basis.
2. Event log display that shows event number, time and date of events, event type, and reason (if applicable). A minimum of 300 events shall be stored.
3. RS – 485 communications port enabled.
4. Common alarm output contact.

B. Include source availability contacts with all ATSs.

2.10 WITHSTAND AND CLOSING RATINGS

A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.

2.11 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for

compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 0548.16 "Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 26 0529 "Hangers and Supports for Electrical Systems."

C. Identify components according to Section 26 0553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

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

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

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.

B. Coordinate this training with that for generator and ATS equipment manufacturers' recommendations.

END OF SECTION

SECTION 26 4113

LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection for structures, structure elements, and building site components.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.

2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I or Class II, copper unless otherwise indicated.

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

a. East Coast Lightning Equipment Inc.
b. ERICO International Corporation.
c. Harger.
d. Heary Bros. Lightning Protection Co. Inc.
e. Independent Protection Co.
f. Preferred Lightning Protection.
g. Robbins Lightning, Inc.
h. Thompson Lightning Protection, Inc.

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel, sectional type; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel or Solid copper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. Down conductors.
2. Interior conductors.
3. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

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 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION

SECTION 26 4313

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 26 2413 "Switchboards" for factory-installed SPDs.
2. Section 26 2416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-Oxide Varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Verification that all SPD are UL tested and labeled with 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780..

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For SPD devices, from manufacturer.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

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

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

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

1. Advanced Protection Technologies Inc. (APT).
2. Eaton Corporation.

3. Emerson Electric Co.
4. GE Zenith Controls.
5. Schneider Electric Industries SAS.
6. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 1.

C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1

1. SPDs with the following features and accessories:

a. Integral disconnect switch.
b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
c. LED indicator light display for protection status.
d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
e. Surge counter.

D. Comply with UL 1283.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 250 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V or 1000 V for 208Y/120 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

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

1. Advanced Protection Technologies Inc. (APT).
2. Eaton Corporation.
3. Emerson Electric Co.
4. GE Zenith Controls.
5. Schneider Electric Industries SAS.
6. Siemens Industry, Inc.

B. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1, with type matching the enclosure of panel or device being protected.

B. Outdoor Enclosures: NEMA 250, Type 3R, with type matching the enclosure of panel or device being protected.

2.5 CONDUCTORS AND CABLES

A. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 12 AWG, complying with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

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

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 26 5100

ARCHITECTURAL LIGHTING LUMINAIRES

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Provide the lighting and accessories as shown on the contract documents and as specified herein. The specifications in this section shall apply to the light fixtures specified by the Lighting Designer.

B. Lighting Scope Chart and Responsibility:

1. SCRAAC:

a. Front of House Lighting: CM Kling + Associates, Inc.

b. Back of House Lighting: Garage, etc. : AHA

2. Holy Cross Space:

a. AHA/KGD Architecture

C. Elizabeth House III Residential:

a. Lobby: CM Kling + Associates, Inc.

b. Levels 4~~-12~~Roof: AHA/KGD Architecture

D. Exterior Façade Lighting + Courtyard Lighting + Site Lighting:

a. CM Kling + Associates, Inc.

b. Egress Lighting: AHA

1.02 RELATED SECTIONS

A. Low-Voltage Electrical Power Conductors and Cables – Section 260519

B. Raceway and Boxes for Electrical Systems- Section 260533

1.03 DEFINITIONS

A. Specifier: Design team consisting of representatives of Lighting Designer, Architect, Electrical Engineer, and Owner/ User.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast or driver housing if provided.

G. LED: Lighting Emitting Diode

H. BF: Ballast Factor

I. CFL: Compact Fluorescent lamp

J. LM-79: Electrical and Photometric measurements applied to LED luminaires and sources.

K. LM-80: Lumen Depreciation test method applied to LED luminaires and sources.

1.04 SUBMITTALS

A. Product Data: For each type of luminaire, arranged in order of fixture designation. Include and clearly identify data on features, accessories, finishes, and the following

1. Complete luminaire lists of luminaires proposed to be used.
2. Submit manufacturer
3. Manufacturer's cut sheet or shop drawing/ illustrations
4. Manufacturer's complete model and specification number
5. Voltage
6. Ballast or Driver specifications and manufacturer for each luminaire
7. Lamp specifications and manufacturer for each luminaire
8. Photometric data, in IESNA format, based on laboratory tests by a qualified independent testing agency of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
9. Warranty

B. Shop Drawings

1. Supply complete manufacturers line drawing showing scaled dimensions, weights, methods of assembly, components, features, and accessories. Include all wiring diagrams and means of installation.
2. Shop drawings for non-standard product are required for fixture approval and must be submitted as part of submittal. Cut sheets for manufacturer and system approval prior to submission of complete shop drawing are not acceptable.
3. Fixture submittals may be submitted electronically in compliance with project submittal specifications.

C. Formatting

1. Fixture submittals shall be furnished in a single complete submittal containing all fixture types for project to include clearly outlined fixture type, fixture manufacturer, fixture model number, lamp manufacturer, lamp specification, ballast manufacturer and ballast specification.

D. Samples

1. It shall be the responsibility of the Contractor to provide sample fixture(s) as indicated in LIGHTING FIXTURE SPECIFICATIONS. When samples are called for the manufacturer shall provide working samples complete with lamp, ballast or driver.
2. Conditions for mock-up of individual luminaire types shall be indicated in LIGHTING FIXTURE SPECIFICATIONS on a per luminaire type. Contractor is responsible to provide sample fixture as indicated.
3. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
4. The purpose of the sample is to review manufacturing techniques, detailing,

lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.

5. Sample fixtures may not be used on the project.

E. Procurement:

1. Contractor must show, in writing, that the selected Electrical Distributor has received factory and/or factory representative pricing for this project and has ability to procure specified product.

2. Electrical Distributor must hold account in good standing with all specified manufacturers or be capable of opening such an account within time frame of project.

F. Contract Closeout Submittals:

1. Operating and Maintenance Manual with the following data:

A. Product data submittals.
B. Wiring diagrams.
C. Installation instructions (for other than lay-in type fixtures).
D. Parts lists.

G. Review:

1. Luminaire submittals shall be reviewed (2) two times per type. Additional reviews shall be at the expense of the Electrical Contractor and may not be charged against project budget. Reviews shall be conducted upon written acknowledgement of these conditions as Senior hourly labor rates for Lighting Designer, Architect, Electrical Engineer.

1.05 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: 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.

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

D. Comply with NFPA 70.

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color,etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Specifier’s approval prior to commencement of each mock-up.
The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At the time, certain minimal test variations may be

requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

G. Experience: Manufacturer(s) shall have no less than five (5) years experience in design and manufacture of lighting fixtures of the type and quality shown, unless otherwise indicated in specifications.

H. LED lighting must be provided with independent testing for LM-79 and LM-80 standards.

1.06 REFERENCE STANDARDS

A. Lighting fixtures shall be designed, manufactured, tested and installed in compliance with the following standards

1. NFPA 70 National Electrical Code
2. Underwriters' Laboratories (UL)
3. Illuminating Engineering Society (IES)
4. ANSI C62 and C82
5. FCC Part 18, Subpart C
6. ASHRAE/IESNA 90.1
7. FDA Food Code
8. International Energy Conservation Code (IECC)

1.07 MANUFACTURER BEST PRACTICES

A. After receipt of order and prior to fabrication fixture manufacturer shall issue a letter to Specifier stating best practices and products that meet specification intent. This shall include evolution of lamping, LED, optics, photometry and fixture performance.

1. This is to allow for improvements in technology during the period between the award and manufacturing. LED technology, specifically, is rapidly improving and likely could exceed the specifications.
2. Manufacturer to offer, at no additional cost, solutions that meet the design intent as alternates to the base design prior to fabrication.
   A. LED lighting: could included
      1. Improved (lower) wattage for same light output
      2. Improved (higher) lumen output for same wattage
      3. New fixture series in product line
      4. Improved color consistency and binning
      5. To be determined by manufacturer.
3. Submittal of letter does not imply approval of alternate product. Base product approved during standard submittal process shall still be available if desired.

B. LED correlated color temperature (CCT) shall have a tolerance of +/- 50 degree Kelvin from base CCT listed in product specification. Tolerance shall be across full product supplied. All Luminaires with continuous installation greater than 8’ shall also be subject to visual inspection for color or output shift.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are

packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10% but not less than 6 of each type of lamp.2. Ballasts: 5% but not less than 1 of each type of ballast.
3. LED Luminaries: 10% but not less than 2 of each LED downlight module and 4 of each unique length of LED channel.
4. LED power supply: 5% but not less than 1 of each type of driver.
5. LED lighting control box: minimum (1) spare per type.
6. Plastic Diffusers and Lenses: 10% but not less than 1 of each type of diffuser, lens, or baffle.
7. Globes and Guards: 5% but not less than one of each type of globe or guard.

PART 2 - PRODUCTS

2.01 FIXTURES AND LAMPS

A. Fixtures shall be provided as specified herein and as indicated on the drawings. Fixtures shall be complete with all required lamps, sockets, wiring, glassware, reflectors, hangers, fittings, plaster frames, etc., necessary for a complete installation.

1. All fixtures shall be cleaned and have all lamps at the time of final acceptance of the building. All burned-out lamps shall be replaced at the time of final acceptance of building.

2. All fixtures specified herein scheduled and/or detailed on the drawings, shall conform to the standards and bear the label of the Underwriters' Laboratories, Inc. Prior to the application of any finish, all metal parts of all fixtures shall be protected by a rust inhibiting process approved by the Architect. The rust inhibiting process shall be chemical. No type of sprayed, painted, or dipped primer may be used as the basic rust inhibitor. Any fixtures and/or parts of any fixtures which shall have begun to show signs of rusting or corroding at the time of completion of the job shall be removed and replaced by properly protected metal parts, subject to the approval of the Architect, and this shall be done before a final certificate of acceptance will be issued.

3. Where required, fixtures shall be furnished complete with internal wiring and ballasts. All joints and splices within the fixture housing shall be made as specified in Section 260519. Substitute material will not be acceptable.

4. All fixtures provided for this project shall be designed and rated by the fixture manufacturer for the intended application and for the location installed. All fixtures provided for this project shall be UL listed for the intended application and for the location installed. All fixtures exposed to outdoor weather conditions shall be suitable for outdoor weather conditions. All fixtures exposed to outside ambient temperatures shall be designed and rated for operation throughout the entire range of temperatures between the minimum and maximum outside ambient temperatures for this project. All fixtures exposed to damp locations, including but not limited to parking structure areas, shall be of damp rated construction. All fixtures shall be in accordance with the requirements of the Local Code Authority and the National Electrical Code. The requirements of this

paragraph shall be in addition to all the other requirements of this specification. The requirements of the specification shall be in addition to the requirements indicated in the lighting fixture schedule. All fixtures shall meet these requirements whether specifically indicated in the lighting fixture schedule or not. It shall be the responsibility of the fixture manufacturer to provide all necessary accessories and modifications to the fixtures specified to meet these requirements. Catalog numbers of fixtures in the fixture schedule are intended to establish manufacturer, type, quality, aesthetic appearance, and lighting characteristics of the fixtures and do not necessarily indicate all the requirements of the specifications.

5. All pole mounted parking lot light fixtures shall be full cut-off type.

B. Provide the proper fixture type for the type of ceiling or wall construction in which the fixture is to be installed. Regardless of fixture numbers given in the fixture schedule, the fixtures supplied shall have the proper trim, frames, mounting devices and configuration and accessories necessary to be properly installed in the building construction. Catalog numbers of fixtures in the fixture schedule are to establish a type of fixture and not to determine a method of mounting.

C. The ballasts for all fluorescent and high intensity discharge fixtures, unless otherwise noted in luminaire specifications, shall be Class "P" energy saving CBM approved, thermally protected. Ballasts shall be General Electric, Advance, Universal, Motorola, Thomas, Valmount or EBT.

1. Fluorescent ballasts shall be high-frequency (above 20 kHz) electronic, energy saving, high power factor (95% minimum), "A" sound rated, programmed start, universal voltage, and Type "P" automatic reset type. Ballasts shall generate less than 15% total harmonic distortion with a lamp current crest factor less than 1.7 and a ballast factor of .87 or greater. Ballasts shall operate as a parallel circuit, sustain variations of +/- 10% of voltage and frequency with no damage to the ballasts, tolerate operation in ambient temperatures up to 105 degrees F without damage, and operate with no visible flicker (less than 3% flicker index). Compact fluorescent ballasts shall be similar to above with lamp shutdown circuitry for end of lamp life protection, plenum rated, and instant on.

2. Ballasts shall be compatible for lamp type specified and shall be provided in quantity per fixture to perform the switching requirements indicated on the drawings.

3. All ballasts located in fixtures exposed to freezing temperatures shall be rated for zero degree operation. This shall include but not be limited to truck docks, site lighting and roof mounted fixtures.

4. All lighting ballasts shall have a two year manufacturer's warranty for all parts and labor.

5. Where dimming is specified, dimming ballasts shall meet the above ballast requirements in addition to proper dimming characteristics for the specific lamp and fixture type.

6. Power input to a 277-volt fluorescent ballast for two 32-watt F32T8 lamps shall not exceed 58 watts when tested per ANSI C82.2.

7. Ballasts for 3-tube fluorescent fixtures shall power three 32-watt F32T8 lamps. Power input shall not exceed 86 watts when tested per ANSI C82.2.

8. Ballasts for fixtures located in remote or difficult to access locations shall have separate ballasts remotely mounted from fixture. Remote ballasts shall be mounted in fully accessible locations. Light fixtures mounted outside on the skin of the building shall have remote ballasts mounted nearby in accessible ceiling plenum area or other accessible area. All ballasts located within environmental air plenums shall be rated for such a location.

D. All incandescent lamps shall be General Electric, Philips, or Osram Sylvania 120 volt, inside frosted lamps, except where lamps are indicated on the lighting fixture schedule.

E. All fluorescent lamps shall be energy-saving 32-watt F32T8 3500K unless indicated otherwise in the lighting fixture schedule. Fluorescent type (tube and compact) lamp color rendering index (CRI) shall be a minimum of 82 unless otherwise noted by the Lighting Consultant.

F. Fixtures shall be air handling type with provisions for air supply and return through the side slots and heat removal through the lamp cavity unless otherwise noted. The heat extract openings shall have sufficient area to limit the return air pressure drop to a maximum of 0.05" w.g. with 40 CFM flowing through the lighting fixture lamp cavity and the heat removal openings. Fixtures shall have louvered outlets on top of the fixture and combination light and dust trap air slots at the door frame end to provide return air flow through the lamp cavity. Each four foot side slot shall have an integral hinged air control damper blade to be used as a shut-off device or pattern controller. The fixture shall be designed to direct the supply air horizontally at the ceiling away from the lighting fixture. The contractor shall adjust the hinged air control dampers appropriately for proper return air balancing. Typically, all light fixtures within enclosed perimeter office areas or within 15 feet of the perimeter wall for open office areas will have their hinged air control dampers closed to disable the return air function of the light fixture when combination supply and return air perimeter slot diffusers are used along the perimeter wall.

G. The lighting fixture manufacturer shall submit certified test data listing the return air performance of the fixture with return air flowing only through the lamp cavity and with return air flowing through the lamp cavity and the two side slot openings.

H. All fixtures in elevator machine rooms, electrical rooms, telephone rooms, and equipment rooms shall have wire guards.

I. Supply ten (10) loose exit signs to owner at completion of project. Contractor shall use these where fire marshal instructs to add exit signs during inspection at no additional cost to owner.

J. All lighting fixtures in areas where there is exposed food, clean equipment, utensils, linens, or unwrapped single service and single use articles shall be lensed or provided with shatter resistant lamps in compliance with the most current FDA Food Code and other adopted codes.

K. New and existing indoor (non-dwelling unit) fluorescent light fixtures utilizing double ended lamps and ballasts within the area of work shall include required NEC ballast disconnect internal to fixture and be accessible to qualified persons. Disconnect shall be UL Listed with two mating finger safe halves disconnecting simultaneously all ballast supply conductors including the ground.

L. Solid State Lighting / Light Emitting Diode (LED) Lamps and Luminaires

1. General:

a. Luminaire manufacturer shall have a minimum of (5) years experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.

b. All components, peripheral devices and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system and shall operate as described in Lighting Designer's Control Narrative documents or Lighting Fixture Schedule.

c. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.

2. Replacement and Spares

a. Manufacture shall provide written guarantee of the following:

1) Manufacture will keep record of original bin for each LED module and have replacement modules from the same bin available for three (3) years after date of installation.

2) Manufacturer will keep an inventory of replacement parts (source assembly, power and control components).

3) Manufacturer's LED system will not become obsolete for ten (10) years: Manufacturer will provide exact replacement parts, or provide upgraded parts that are designed to fit into the original luminaire and provide distribution and lumen output similar to the original, without any negative consequences.

b. All parts of system shall replaceable in field. Manufacturer shall provide written guarantee of the following:

1) Manufacturer has in place a written recycling and re-used program, and will accept returned product and/or components for recycling or re-use.

2) Manufacturer will properly dispose of non- recyclable components that are deemed harmful to the environment.

c. System shall carry a full warranty for five (5) years. Manufacturer shall be responsible for cost of labor not exceed $50 per individual part, and cost of shipping, to replace any component of the system that fails within 2 years of installation.

3. Products and Components – Performance

a. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.

b. All LED luminaires shall be subjected to the following JEDEC Reliability Tests for Lead- free Semiconductors: HTOL, RTOL, LTOL, PTMCL, TMSK, Mechanical Shock, Variable Vibration Frequency, SHR, Autoclave.

c. All LED components shall be mercury and lead-free.

d. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color

shall remain stable through life of the lamp. Color shall match approved sample.

e. LEDs shall comply with IESNA LM-80- Standards for Lumen Maintenance of LED Lighting Products.

f. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains.

g. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaires housing shall be designed to transfer heat from LED board to the outside environment. Luminaire housing shall have no negative impact on life of components.

h. Manufacturer shall supply in writing a range of permissible operating temperatures in which system will perform optimally.

i. For wet and dump use, the LED-based luminaire itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.

j. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.

k. All LED luminaires (100% of each lot) shall undergo a minimum twenty-four (24) hour burn-in during manufacturing, prior to shipping.

l. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI, optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory.

m. Power / data supply shall have the following:

1) Supply outputs shall have current limiting protection.

2) Supply shall provide miss-wiring protection.

3) Supply shall have power factor correction.

4) Supply shall provide connections that are conduit-ready or clamp-style connections in case of low-voltage wiring.

5) Supply shall come with a housing that meets a minimum IP20 rating for dry location installation unless located in a damp or wet location.

6) Supply shall be UL listed for Class 1 or Class 2 wiring.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Recessed lay in type lighting fixtures shall be installed in the lay in type ceiling in such a manner that the lens or louver housing may be easily opened and so that the fixtures may be removed and relocated without forcing the fixtures or changing the grid system tie wires. The electrical subcontractor shall coordinate with the ceiling subcontractor before the ceiling grid is installed to assure a mutually satisfactory installation of ceiling and light fixtures, which will permit the fixtures to be relocated at a future date.

B. Lighting Fixtures shall be set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

3.02 SUPPORTS

A. Recessed downlight lighting fixtures (LED, incandescent, compact fluorescent, metal halide, etc.) installed in lay in type ceilings shall be supported by means of hanger bars extending across the main ceiling support members supported by wires at all four corners. Fluorescent lighting fixtures (1'x1', 1'x4', 2'x2', 2'x4', etc.) shall be supported independently of the ceiling grid by wires on all four corners. The four wires shall be independent to the structure above. All other type fixtures in lay in type ceilings shall have the outlet box rigidly supported from the building structural system. In addition, each fixture shall be supported independently of the ceiling grid and all other MEP equipment by support wires connected to the building structure. Provide removable clips to securely fasten light fixtures in place to the ceiling construction; however, support shall be via tie wires. In addition to above support methods, all Local Code Authority requirements shall be adhered to. Support means and methods shall be in accordance with manufacturer's recommendations and the Local Code Authority seismic requirements and wind loading.

3.03 CLEANING

A. All fixtures shall be cleaned of dirt, debris, and tape inside and outside and left in a clean condition at the end of the construction work.

3.04 SAMPLES

A. Provide samples of each fixture type as requested by the architect.

3.05 COORDINATION

A. The Contractors shall coordinate the control of all light fixtures with the lighting controls indicated in the Automatic Temperature Control System specification section.

END OF SECTION

SECTION 26 5119

LED INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 26 0923"Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. LEED Submittals:

1. Product Data for Credit IEQ 4.2: For paints and coatings, documentation including printed statement of VOC content.

D. Samples: For each custom luminaire and for each color and texture with standard factory-applied finish as requested by Architect.

E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

F. Qualification Data: For testing laboratory providing photometric data for luminaires.

G. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

H. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

I. Product Certificates: For each type of luminaire.

J. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

K. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: 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.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the 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.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. Recessed Fixtures: Comply with NEMA LE 4.

D. Bulb shape complying with ANSI C79.1.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. CRI of minimum 80Lamps dimmable from 100 percent to 0 percent of maximum light output.

G. Internal driver.

2.3 METAL FINISHES

A. 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.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps (non-LED fixtures only).

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls. Install luminaires per manufacturers' recommendations.

2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
2. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), 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 or 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.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
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.

J. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

K. Luminaire installation shall be per manufacturer’s installation requirements.

L. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. 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.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 26 5619

LED EXTERIOR LIGHTING

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. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

B. Related Requirements:

1. Section 26 0923"Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.

4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. LEED Submittals:

1. Product Data for Credit EA 5: For specified metering equipment.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

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. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: 20 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: One for every 20of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: 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 applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Lamp base complying with ANSI C81.61 or IEC 60061-1.

E. In-line Fusing: Separate in-line fuse for each luminaire.

F. Source Limitations: Obtain luminaires from single source from a single manufacturer.

G. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. 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.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming. Comply with requirements in 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 0533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections.

C. Coordinate "Operational Test" Subparagraph below with requirements in Section 260923 "Lighting Control Devices."

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

D. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

    a. IES LM-50.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

E. Luminaire will be considered defective if it does not pass tests and inspections.

F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within6 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.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 27 05 26
GROUNDING & BONDING FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and Bonding for Communications Systems.

B. Related Sections:

1. Division 01
2. Division 27 Section "Communications Equipment Room Fittings" for cabinets, racks, enclosures, cable management and ladder rack.
3. Division 26 Section “Grounding and Bonding for Electrical Systems”.
4. Division 26 Section "Identification for Electrical Systems."

1.2 SUBMITTALS

A. Refer to Division One Section “General Requirements”

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

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Grounding: Indicate locations of grounding bus bars.
2. Elevations and mounting details.
3. System line diagram.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

E. Source quality control reports.

F. Field quality control reports.

G. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: All installation of the Telecommunication Ground Systems shall be done by a licensed electrician.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD, or Commercial Installer, Level 2.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field test: certified third party organization.

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. Grounding: Comply with ANSI-J-STD-607-C.

D. Labeling: Comply with TIA/EIA-606-B.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather tight, wet work in spaces is complete and dry.

1.5 COORDINATION

A. Coordinate layout and installation of communications pathways with the other trades installing equipment in the ceiling.

B. Coordinate grounding and bonding of communications systems with the electrical installer.

C. Coordinate the labeling scheme for the communications systems with the Owner.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

A. Comply with ANSI J-STD-607-A and with requirements of Division 26 Section "Grounding and Bonding for Electrical Systems".

B. Telecommunications Main Grounding Bus Bar

1. The TMGB must be a predrilled copper busbar with holes for use with standard- sized lugs, have a minimum dimensions of 6.3 mm (0.25 in) thick by 101 mm (4 in) wide, and variable length. It must be listed by an NRTL.
2. Hole patterns on the Busbars shall accommodate two-hole lugs per the recommendation of BICSI and ANSI-J-STD-607-B standards.
3. Insulators shall electrically isolate Busbars from the wall, or other mounting surfaces, thereby controlling the current path.
4. Provide required stainless steel hardware to fasten the two-hole ground lugs to the Busbar.

C. Telecommunications Grounding Bus Bar

1. The TGB must be a predrilled copper busbar with holes for use with standard- sized lugs, have a minimum dimensions of 6.3 mm (0.25 in) thick by 51 mm (2 in) wide, and variable length. It must be listed by an NRTL.
2. Hole patterns on the Busbars shall accommodate two-hole lugs per the recommendation of BICSI and ANSI-J-STD-607-B standards.
3. Insulators shall electrically isolate Busbars from the wall, or other mounting surfaces, thereby controlling the current path.
4. Provide required stainless steel hardware to fasten the two-hole ground lugs to the Busbar.

D. Grounding Conductors

1. Telecommunications grounding connectors shall have a minimum size of 6/0 AWG.
2. Telecommunications Bonding Backbone shall be size 2/0 AWG.
3. All Telecommunication grounding conductors shall be copper conductors, calculated so that no more than 40 V can be present along its entire length.

PART 3 - EXECUTION

3.1 GENERAL

A. All installation of the Telecommunication Ground Systems shall be done by a licensed electrician. This includes but not limited to:

1. All Busbars
2. All bonding conductors
3. Bonding to all non-active (non-current carrying) metal support structures, rack, runway etc. within each Telecommunication Room or Space. Coordinate this bonding with the supplier and installer of rack, runway etc.

B. NOTE: The TMGB/TGB is to provide a single point ground reference within the room and IS NOT TO BE USED AS AN AC EQUIPMENT GROUND.

C. The TBB should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in conduit that exceeds 1m (3 ft) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

D. Each telecommunications grounding and bonding conductor shall be labeled. Labels shall be located on conductors as close as practicable to their point of termination in a readable position. Labels shall be nonmetallic and include the information "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER" Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

3.2 BONDING CONDUCTOR

A. Where building steel is available within the room, the TMGB/TGB should be bonded to the nearest structural steel column, provided that its bonding effectiveness has been verified via two point bonding testing. This connection would be an acceptable alternative to routing of a Bonding Conductor for Telecommunications (BCT) to the main electrical panel board.

B. A bonding conductor can be routed between TMGB and the nearest effectively grounded AC electrical branch circuit panel board, provided a low ground impedance of the panel board has been verified with a ground impedance tester. This connection would be an acceptable alternative to routing of a BCT to the main electrical panel board.

C. The size of any bonding conductors shall follow the recommended sizes shown on Telecom detail drawings.

D. All cabling used to bond grounds are to be tagged with labels with the point of origin and destination i.e. going to/coming from, with printed labels.

3.3 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section “Identification for Electrical Systems”.

B. Provide nonmetallic pre-printed labels, white background with black printing that can be permanently mounted to the busbar.

C. The bonding conductors for telecommunications, TBB conductor, and each grounding equalizer shall be green or marked with a distinctive green color.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section Firestopping."

3.5 TESTING

A. This testing is in addition to any commissioning requirements as specified in Division 01 General Commissioning Requirements. Specific testing requirements that are outlined within this Section will be incorporated into the commissioning process.

B. Two-point bonding measurements should be performed for all TGMB and TGBs using an earth grounding resistance tester configured for a continuity test. The recommended maximum value is 0.1 ohm. See Chapter 8 in BICSI TDMM for test configuration and calibration information,

END OF SECTION

SECTION 27 05 37

FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. General
2. References
3. Quality Assurance
4. Submittals
5. Installer Qualifications
6. Delivery, Storage, Handling & Product Conditions
7. Products
8. Acceptable Manufactures
9. Execution
10. Installation
11. Field Quality Control

B. Related Requirements:

1. RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

2. DEFINITIONS

- Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.
- Smoke and Acoustical Sealing: Material or combination of materials used to maintain an effective barrier against the spread of smoke and hot gases, and to restore the STC rating in through penetrations in non-fire rated wall and floor assemblies

1.2 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

This section includes labor, materials and equipment necessary to complete the installation required for the items specified under this section, including but not limited to:

Firestopping of Through Penetrations in Fire-Rated Assemblies.

Only tested firestop systems shall be used in specific locations as follows: Penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies) and vertical service shaft walls and partitions.

Smoke and Acoustical Sealing in Non-Rated Assemblies

Only tested smoke & acoustic systems shall be used in specific locations as follow: penetration for the passage of cables, conduits, and other electrical equipment through non fire-rated vertical and horizontal partitions.

PART 2 - REFERENCES

2.1

A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"

B. Test Requirements: UL 1479, “Fire Tests of Through-Penetration Firestops”

C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory:
   a. Firestop Devices (XHJI)
   b. Fire Resistance Ratings (BXRH)
   c. Through-Penetration Firestop Systems (XHEZ)
   d. Fill, Voids or Cavity Material (XHHW)
   e. Forming Materials (XHKU)

D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

E. Inspection Requirements: ASTM E 2174, “Standard Practice for On-site Inspection of Installed Fire Stops.”

F. Test Requirements: ASTM E 90, “Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements”

G. Test Requirements: ASTM E 2178, “Standard Test Method for Air Permeance of Building Materials”

H. Test Requirements: ASTM E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials.”

I. Test Requirements: ASTM E 2178, “Standard Test Method for Air Permeance of Building Materials”

J. International Building Code (IBC 2012)

K. NFPA 101 - Life Safety Code

L. NFPA 70 - National Electric Code

PART 3- QUALITY ASSURANCE

3.0 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) must be on-site during initial installation of firestop and sealing systems to train contractor personnel in proper written recommendations published in their literature and drawing details.

B. Firestop system installation must meet requirements of ASTM E 814 or UL 1479 tested assemblies that provide a fire rating equal to that of the construction being penetrated.

C. Proposed firestop and sealing materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop and sealing systems do not reestablish the structural integrity of load bearing partitions/assemblies or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

PART 4- SUBMITALS

4.1 SUBMITALS

B. Submit Product Data: Manufacturer’s specifications and technical data for each material including the composition and limitations, and manufacturer's installation instructions to comply with Section 01 30 00.

B. Submit qualified tested firestop system detail for each firestop application on the project.

C. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in drawing

D. Submit safety data sheets provided with product delivered to job-site, if required as per OSHA GHS/Hazard Communication Standard.

PART 5- INSTALLER QUALIFICATIONS

5.1 INSTALER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping/sealing manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the contractor or to an installer engaged by the contractor does not in itself confer qualification on the buyer.

PART 6- DELIVERY, STORAGE, HANDLING & PRODUCT CONDITION

6.1 DELIVERY, STORAGE & HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

6.2 PRODUCT CONDTIONS

A. Do not use materials that contain flammable solvents.

B. Scheduling

1. Schedule installation of cast-in place firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete. Schedule installation of firestop sleeves and smoke & acoustic sleeves before openings are made and cables are run.

2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures

exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 7 - PRODUCTS

7.1 GENERAL

A. Provide firestopping and sealing materials composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Provide a round fire-rated cable management device whenever cables penetrate fire rated walls, where frequent cable additions and changes may occur. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain and inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 12.4 inches. The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.

D. Provide a round cable management device whenever cables or cable bundles penetrate **non-fire** rated construction (e.g. smoke partition) where frequent cable additions and changes may occur. Manufacturer shall furnish independent test reports documenting the in use sound transmission class (STC) characteristics of the non-fire rated assembly as tested per ASTM E 90. The test report shall provide the STC ratings of the assembly while the device is in use, with a minimum of two additional data points other than 0% and 100% visual fill.

E. Provide non-curing, re-penetrable, intumescent firestop blocks around communication cable trays or ladder racks penetrating through fire rated walls. The firestop system assembly shall be accessible from one side of the wall. The firestop material shall allow up to 12” of unreinforced annular space.

F. Provide a stainless steel intumescent composite board for large non-penetrable openings through concrete walls or floors, or gypsum walls.

G. Provide a non-curing, self-adhesive, surface mounted cable disc for single cables and cable bundles up to one inch (1”) diameter in membrane and through penetration assemblies as tested in accordance with UL 1479 or ASTM E 814.

H. Penetrations in Fire Resistance-Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

I. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.

3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

J. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

K. Mold Resistance: Provide penetration firestopping and sealing with mold and mildew resistance rating of zero (0) as determined by ASTM G21.

PART 8- ACCEPTABLE MANUFACTURES

8.1 Hilti Firestop Products
3M Fire Stop Products
Or Pre-Approved Equivalent

8.2 PERFORMANCE REQUIREMENTS

A. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.

B. Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls.

C. Pre-formed, round firestop devices with integrated intumescent strips for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls.

D. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT).

E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe.

F. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles.

G. Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles.

H. Wall opening protective materials for use with UL-listed metallic and specified nonmetallic outlet boxes.

I. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways.

J. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways.

K. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected.

L. For single or cable bundles up to one inch diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies.

PART 9- EXECUTION

9.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping and sealing materials.
4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping/sealing products.
5. Do not proceed until unsatisfactory conditions have been corrected.

9.2 COORDINATION

A. Coordinate location and proper selection of cast-in-place and drop-in Firestop devices with trade responsible for the work. Ensure device is installed before placement of concrete.

PART 10- INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
2. Protect materials from damage on surfaces subjected to traffic.

PART 11 – FIELD QUALITY CONTROL

Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping and sealing shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Manufacturer’s Field Services: Contractor to ensure a manufacturer’s direct representative is on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. Training will be done per manufacturer’s written recommendations published in their literature and drawing details. During installation, contractor shall have manufacturer’s representative provide periodic visual observations and written documentation of the results.

END OF SECTION

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The work shall consist of but not limited to:

1. Provide the material and labor to label all components of the Premises Distribution Systems which includes but not limited to:
2. All copper and fiber optic backbone cables, and associated termination frames and panels.
3. All horizontal (station) cabling for copper and fiber, and associated termination patch panels, and outlet faceplates and connectors.
4. All other equipment and pathways related to Division 27, as described in TIA 606- B standard.

B. Provide all required records for Class 3 Administration as described by of TIA 606-B standard.

C. Related Sections:

1. Division One “General Requirements”
2. Division 27 Section "Communications Equipment Room Fittings"
3. Division 27 Section “Grounding and Bonding for Communications Systems”.
4. Division 27 Section "Communications Backbone Cabling."
5. Division 27 Section "Communications Horizontal Cabling."

D. All work area outlet label numbers must include the room numbers from the signage set only. Not from the Architectural set. This includes all ONT’s, copper locations, rack labeling & room identifiers labels.

1.2 SUBMITTALS

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

B. Submit actual Label samples. Failure to include actual label samples with the submittal package for this Section shall lead to rejection of the submittal.

C. Submit labels on project record documents (as builds) reflecting the actual labels installed.

1.3 QUALITY ASSURANCE

A. Comply with TIA/EIA-606-B.

1.4 CLASS OF ADMINISTRATION

A. The labeling scheme used shall meet all the requirements of a Class 3 facility as defined by ANSI/TIA/EIA 606-B, Administration Standard for the Telecommunications

B. Type, format, wording, printing, and placement of labels shall be coordinated with Owner's existing administration plan. Items and/or issues not addressed in Owner's established administration plan shall be addressed in accordance with TIA/EIA 606-B Standard (e.g. cable tray, conduits, junction boxes, grounding systems, etc.).

C. All annexes to the ANSI/TIA/EIA 606-B standard shall be followed, unless approved by the LGP, in writing.

1.5 COORDINATION

A. Coordinate the labeling scheme for the communications systems with each system's OWNER.

PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with requirements of TIA/EIA-606-B and UL969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements of Division 26 Section "Identification for Electrical Systems".

C. The identification for the communications systems shall meet all the requirements of a Class 3 facility as defined by ANSI/TIA/EIA 606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

D. Identify all the components of the communications systems.

E. For fire-resistant plywood, do not paint over manufacturer's label.

F. Labels shall be preprinted or computer-printed type.

G. Type, format, wording, printing, and placement of labels shall be coordinated with Owner's existing administration plan. Items and/or issues not addressed in Owner's established administration plan shall be addressed in accordance with TIA/EIA 606-B Standard (e.g. cable tray, conduits, junction boxes, grounding systems, etc.).

H. Labeling System

1. PC-based software, WINDOWS compatible, capable of supporting alpha numeric characters and Windows True Type Fonts.
2. Compatible with laser printers.
3. Label sizes supported:

a. Minimum: 0.8" W x 0.2" H.
b. Maximum: 3.0" W x 12.0" H.

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems". Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606- B for Class 3 level of administration including optional identification requirements of this standard.

C. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels; comply with TIA/EIA-606-B.

D. Color differentiate between different stakeholder's infrastructure when using common spaces; coordinate with the LGP.

E. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.

F. 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.

G. 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, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

H. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) 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 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 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number the wiring conductors connected to terminal strips,

and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.

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.

l. Labels shall 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/EIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

END OF SECTION

SECTION 27 11 00
COMMUNICATION EQUIPMENT ROOMS FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Division 01
2. Division 27 section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
3. Division 27 section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

A. Seismic Qualification Certificates: For equipment frames from manufacturer.

1.4 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 the direct supervision of an RCDD, or BICSI Installer, Level 2.
2. Installation Supervision: Installation shall be under the direct supervision of BICSI Technician Level 2 Installer, 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, or BICSI Installer, Level 2 to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames 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 from the device 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 (19 by 1220 by 2440 mm).

2.3 EQUIPMENT FRAMES

A. Manufacturers:

1. Chatsworth (CPI)
2. Leviton
3. Ortronics
4. Panduit
5. Middle Atlantic
6. Approved Equal

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.

2. Baked-polyester powder coat finish.

D. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Rack/Roof-mounted, 550-cfm (260-L/s) fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

E. Modular Wall Cabinets:

1. Wall mounting.
2. Steel or aluminum construction.
3. Treated to resist corrosion.
4. Lockable front and rear doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Rack/Roof-mounted, 250-cfm (118-L/s) fan.
9. Power strip.
10. All cabinets keyed alike.

F. Cable Management for Equipment Frames:

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.
1. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
2. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
3. Close-coupled, Cord connected with 15-foot (4.5-m) line cord.
4. Rocker-type on-off switch, illuminated when in on position.
1. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
2. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.5 DC POWER SUPPLY UNIT (DC PSU)

A. Used to remotely inject power from the POS location to the ONTs.

B. Rack mountable, with universal AC input (85 to 265 VAC single input) and modular hot swappable DC outputs (two DC outputs per module).

C. MTBF 262,800 hours or better

D. AC Input:

1. Voltage range: 85 to 265 VAC; 47 – 63 Hz. via IEC socket
2. Rated voltage (for safety approval): 100-240 VAC, 50-60 Hz.
3. Current: Maximum input current at 85 VAC is 2.8 Amp
4. Power Factor: >0.925 at maximum load
5. Efficiency For 100VAC input voltage: > 86% at 25°C*
6. For 100VAC input voltage: > 88% at 25°C*
7. At 55°C, efficiency is 85% and 86% correspondingly.

E. DC Output per port:

1. Voltage - 57 V constant output power
2. Maximum current - 1.7A
3. Power - 100 W

F. Power:

1. Max. system output power 1200 W@57 VDC
2. Polarity Positive earth; 57 V
3. Individual module power 200 W
4. Noise: Ripple <100Hz at max load @20 MHz BW

G. Protection:

1. Output Current Limit: Output current limit >94 W and <100 W
2. Auto-recovery when current is back within range.
3. Output Inrush: Current limiter supports startup with 500uF ±20% load capacitance and 200mA load
4. Over Voltage: Limit of 61V±4%.

5. Input protection Auto shutdown and auto restart when correct voltage is restored.
6. Input Fuses: Short circuit on main lines is protected by replaceable fuse.

H. Monitoring:

1. LED status indicator: green-normal operation,
2. LED status indicator: red- fault detected (low input voltage, fan failure, output voltage out of range, internal failure)

I. Environmental:

1. Operating Temperature 0 to +55◦C (32 to +131◦F)
2. Storage Temperature - 20□ to 85□C (-4□ to 185□F)
3. Operating Humidity Non-condensing relative humidity range: 5% to 95%

2.6 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless [compression] [exothermic]-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

4. Comply with J-STD-607-B and ANSI/NECA/BICSI-607.

2.7 LABELING

1. Comply with TIA/EIA-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 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements 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 the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 FIRESTOPPING

A. Comply with requirements in Section 27 05 37 " Firestopping."

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

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

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Comply with requirements for painting backboards. For fire- resistant plywood, do not paint over manufacturer's label.

A. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 3 level of administration including optional identification requirements of this standard.

B. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 27 13 00
COMMUNICATION BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. Fiber optic and UTP cable.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Cabling identification products.
5. Cabling management system.

B. Related Sections:

1. Division 01 “General Commissioning Requirements”
2. Division 27 section “Communications Horizontal Cabling”
3. Division 27 section “Grounding and Bonding for Communications Systems”
4. Division 27 section “Pathways for Communications Systems”
5. Division 27 section “Identification for Communications Systems”
6. Division 27 section “Communications Equipment Room Fittings”

1.2 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between the telecommunications spaces (MDFs, EFs, and IDFs/TEs) serving the building. 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 main cross-connects will be located in MDFs. Intermediate cross-connects will be located in the IDFs/TEs.

C. The backbone will be segregated in each communication space (MDFs, IDFs) for each main stakeholder, as per RPW requirements:

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-C.3, when tested according to test procedures of this standard.

1.4 SUBMITTALS

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

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance data.

1.5 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 the direct supervision of an RCDD, or BICSI Installer 2 Copper, or BICSI Installer 2 Fiber, or BICSI Technician.
2. Installation Supervision: Installation shall be under the direct supervision of BICSI Technician, BICSI Installer 2 Copper or BICSI Installer 2 Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Contractor: Currently registered by BICSI as RCDD, or BICSI Installer Level 2 to perform the on-site inspection.

B. Trained technicians for testing of the cabling who have successfully attended an appropriate training program, which includes testing with a Loss Test Set (OLTS) and an OTDR, if required, and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.

2. Manufacturer of the test equipment used for the field certification.

3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.

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

E. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-D.

F. Grounding: Comply with ANSI-J-STD-607-C.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

A. Cable Trays: refer to Division 27 section “Pathways for communications systems” and Section “Communication Rooms Fittings” for ladder rack and wire management inside the racks/cabinets.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" and Division 27 section “Pathways for communications systems”. Flexible metal conduit shall not be used, UON.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP BACKBONE CABLE

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

1. BerkTeck
2. CommScope
3. General Cable
4. Approved equal

B. Description: Category 3, multi-pair, number as indicated on drawings, covered with a gray thermoplastic jacket.

1. Comply with ICEA S-80-576 for mechanical properties.
2. Comply with TIA/EIA-568-C.2 for performance specifications.
3. Comply with TIA/EIA-568-C.2, Category 5e multi-pair backbone specifications
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70
5. Communications, Plenum Rated: Type CMP, complying with UL 444.

2.4 FIBER OPTIC CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
1. OCC
2. Corning
3. Approved Equal

B. Description: Single mode OS2 optical fiber cable with 12 strand subunit construction with fiber counts as indicated on drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA-568-C.3

1. Comply with ANSI/TIA -568-C.0
2. Comply with ANSI/TIA -568-C.3
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70
4. Communications, Indoor/Outdoor, for the OSP cables and plenum rated for the in-building cables, complying with UL 1666.
5. Cable shall be able to fit in a 1” innerduct for any cable construction

2.5 UTP CABLE HARDWARE

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

1. CommScope
2. Leviton
3. Ortronics
4. Panduit
5. Approved equal.

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA -568-C.2, for connecting hardware. Cables shall be terminated with connecting hardware of same category or higher.

C. Terminate the copper riser cables in rack mounted Category 3 Voice Riser panels with one pair per port to be patched for miscellaneous analog connectivity needs.

2.6 FIBER OPTIC CABLE HARDWARE

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

1. OCC
2. Corning
4. 3M
5. Commscope
6. Approved equal.

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA -568-C.3. Additionally the following performance characteristics are required:

1. **Matted pair connections:**
   a. 100% better than 0.75 dB
   b. 95% better than 0.5 dB
2. Splice connections: better than 0.05 dB

B. Fiber optic connectors for singlemode cables shall as a minimum conform to the performance specifications in Annex A of ANSI/TIA-568-C.3:

1. APC connector, type TBD.
2. Manufacturer recommended connector for optimal performance with approved cable type
3. Durability: < 0.2dB change, 500 re-matings, FOTP-21
4. Reflectance loss: -20dB minimum
5. Insertion loss of mated pair at 1310 nm and 1550 nm to be less than 0.5 dB at acceptance for every connector
6. Optimally keyed, allowing reproducible mating conditions each time a connection is made between connector and coupler
7. Fitted with color-coded strain relief boots to ensure durable and robust connections
8. Fitted with a tight fitting, polymer cap over the connector to prevent ingress of dirt and dust until the connector is fitted to a coupler
9. All connectors to be straight-pull and side-pull resistant, preventing accidental optical disconnect; comply with FOTP-21
10. Maximum of 0.2 dB increase in insertion loss for a 20 lbs. straight pull
11. Maximum of 0.5 dB increase in insertion loss for a 5 lbs. side pull
12. Ultimate pullout from coupling shall require a minimum of 25 lbs

C. Fiber Optic Patch Panel (1 and 2 RU)

1. Used in MDFs and IDFs to terminate the fiber backbone;

D. Fiber Splice Panel - 1RU optical splice shelf – used as indicated on drawings

E. Single-mode Adapter module - modular type, 12 connectors per module.

F. Fiber Optic connectors shall be field installable, fusion spliced SC/APC single-mode connectors, used in places where factory terminated assemblies are not possible to use.

G. Factory-terminated fiber optic assemblies, used with preference in all places where fiber optic connectivity is required.

1. Pigtails assemblies for patch and splice panels
2. Bend insensitive cable assemblies
3. Circular cable assemblies
4. Sub-unitized trunk cable assemblies

H. Passive Optical Splitter

1. Rack mounted shelf
2. Provide splitters with dual input and number of splits as indicated on drawings

2.7 FIBER OPTIC PATCH CORDS

A. The Owner of each system will install and connect equipment in the racks. Contractor shall include unit pricing for patch cords for different lengths. Coordinate patch cord length with Owner.

B. Description: Optical fiber patch cords for use with patch panels.

C. Specifications:

1. Fiber type: Single-mode
2. Patch cord outside diameter: 3.0mm
3. Patch cord minimum length: 3m
4. Connectors of same specifications as the one used in the patch panels.
5. Cords shall meet or exceed the minimum mechanical and optical characteristics for optical fiber patch cords as specified in ANSI/TIA/EIA-568-C.3.

D. Configuration: Duplex construction; to match optical patch panel connector type.

E. Acceptable manufacturers:

1. AFL
2. Corning
3. Approved Equal

2.8 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors

B. Comply with ANSI/TIA-607-C and ANSI/NECA/BICSI-607.

2.9 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA -606-B, TIA-598, and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.10 SOURCE QUALITY CONTROL

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

B. Factory test cables on reels according to ANSI/TIA -568-B.2.

C. Factory test UTP cables according to ANSI/TIA -568-C.0.

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

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in 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 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.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA -569-D.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate

general arrangement of pathways and fittings.

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

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA -568-C.0, and ANSI/TIA -568-C.1 standards.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. 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.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
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 ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature before unreeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable

pull tensions.

12. All installed cabling must be routed through the cable management systems, and be bundled using re-closeable Velcro wire ties. Ties must be neatly cable-sized and secured to existing cable-racks or walls.

C. UTP Cable Installation:

1. Comply with ANSI/TIA -568-C.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Fiber Optic Cable Installation:

1. Comply with ANSI/TIA -568-C.0.
2. Do not exceed minimum bend radius recommended by the manufacturer at all times
3. Use innerduct at any times the fiber cables are mixed with other media type in the same conduit. Innerduct shall be used in the OSP conduits, as per Port Authority guidelines.
4. Use factory terminated cable assemblies whenever possible; factor in 30' extra slack when determining the length.

5. The fiber optic assigned for Port Authority use will be terminated by the Port; leave fiber protected, with 30' of slack and perform testing to attest integrity of the installation.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA -569-D recommendations for separating unshielded copper voice and data 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 (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

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 (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and 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 (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
d. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
e. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIELD QUALITY CONTROL

A. This testing is in addition to any commissioning requirements as specified in Division 01911 General Commissioning Requirements. Specific testing requirements that are outlined within this Section will be incorporated into the commissioning process.

B. Tests and Inspections:

1. Visually inspect UTP 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 ANSI/TIA -568- C.0.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper 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.

C. Optical fiber cable testing:

1. Field-test instruments shall have the latest software and firmware installed.
2. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
3. Fiber end faces shall be inspected at 200X or 400X magnification. 200X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.

1) It is preferable that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.

4. Testing shall be performed on each cabling segment (connector to connector).
5. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
6. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
7. Optical loss testing

    a. Backbone link

        1) Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper or the equivalent method.
        2) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
        3) Use the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1 or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

8. OTDR Testing

    a. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

        1) Singlemode: 1310 nm and 1550 nm
        2) For PON links 1490 nm additional test may be required

    b. Each fiber link and channel shall be tested in both directions.
    c. A launch cable shall be installed between the OTDR and the first link connection.
    d. A receive cable shall be installed after the last link connection.

9. Magnified End face Inspection

    a. Fibers shall be inspected at 250X or 400X magnification. 250X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers.

10. Length Measurement

    a. The length of each fiber shall be recorded.
    b. It is preferable that the optical length be measured using an OLTS or OTDR.

11. Polarity Testing

    a. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA-568-C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Prepare test and inspection reports.

F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

H. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of the building. This CD-ROM shall include the software tools required to view, inspect, and print any selection of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information

    a. The identification of the customer site as specified by the end-user
    b. The name of the test limit selected to execute the stored test results
    c. The name of the personnel performing the test
    d. The date and time the test results were saved in the memory of the tester
    e. The manufacturer, model and serial number of the field-test instrument
    f. The version of the test software and the version of the test limit database held within the test instrument
    g. The fiber identification number
    h. The length for each optical fiber

        1) Optionally the index of refraction used for length calculation when using a length capable OLTS

    i. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).

j. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
k. The length for each optical fiber as calculated by the OTDR.
l. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
m. Optional

1) A picture or image of each fiber end-face
2) A pass/fail status of the end-face based upon visual inspection.

I. Record copy and as-built drawings

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project shall be in electronic format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. Electronic drawings are to incorporate test data imported from the test instruments.
2. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:

a. Field directed changes to pull schedule.
b. Field directed changes to cross connect and patching schedule.
c. Horizontal cable routing changes.
d. Backbone cable routing or location changes.

J. Associated detail drawings.

END OF SECTION

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling identification products.
6. Cabling administration system.

B. Related Sections:

1. Division 01 “Building enclosure Commissioning Requirements.”
2. Division 27 Section "Communications Backbone Cabling."
3. Division 27 Section "Communications Equipment room Fittings."
4. Division 27 Section "Pathways for Communications Systems.”
5. Division 27 Section "Identification for Communications Systems.”
6. Division 27 Section "Grounding and Bonding for Communications Systems.”
7. Division 27 Section “Data Communications Network”.

1.2 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware (Cabling Subsystem 1) provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the MDF/IDFs/TEs. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols. In the case of PON (Passive Optical Network) the permanent link is the portion from the outlet, the RJ45 port on the ONT (Optical Network Terminal) to the OLT (Optical Line Terminal) port corresponding to the outlet, where the testing is performed (if the OLT detects a transmission error, additional fiber testing, between the fiber port on the OLT to the fiber connector going to the ONT, will be required to isolate the problem). Please note that the fiber channel from the port on the OLT to the ONT includes the backbone portion of the infrastructure, which may be part of a different scope. Agreement on the testing responsibility matrix should be reached in that case.

B. For UTP cabling the following limitations apply:

1. ANSI/TIA -568-C.0 specifies that the cable lengths are dependent on the application and upon the media chosen. All Ethernet applications are limited to 100 m on UTP media; there fore the maximum permanent link length is 95 m (295’). Analog phone, fax and

ISDN applications are allowed to exceed this limitation.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

D. All station outlets will have RJ-45 interface, unless otherwise noted.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal UTP cabling system shall comply with transmission standards in ANSI/TIA -568-C.0 and ANSI/TIA -568-C.2 when tested according to test procedures of this standard. Fiber optic cabling and components shall comply with ANSI/TIA-568-C.3 requirements when tested according to test procedures of this standard. Additionally, the following performance characteristics are required:

1. Matted pair connections:
   a. 100% better than 0.75 dB
   b. 95% better than 0.5 dB
2. Splice connections: better than 0.05 dB

1.4 SUBMITTALS

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

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by LGP.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:
   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
   d. Passive optical splitters
   e. PON power distribution
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.
6. Pull schedules for each type of network's horizontal cabling installed

C. Samples: for workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

D. Qualification Data: for Installer, qualified layout technician, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance data.

1.5 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 the direct supervision of an RCDD, or BICSI Installer 2 Copper, or BICSI Installer 2 Fiber, or BICSI Technician.
2. Installation Supervision: Installation shall be under the direct supervision of BICSI Technician, BICSI Installer 2 Copper or BICSI Installer 2 Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Contractor: hold a current registration by BICSI as RCDD, or BICSI Installer Level 2 to perform the on-site inspection.

B. Trained technicians for testing of the cabling who have successfully attended an appropriate training program, which includes testing with a Loss Test Set (OLTS) and an OTDR, if required, and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
2. Manufacturer of the test equipment used for the field certification.
3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

C. Surface-Burning Characteristics: as determined by testing identical products according to ASTM E 84 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.

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

E. Telecommunications Pathways and Spaces: comply with ANSI/TIA -569-D.

F. Grounding: comply with ANSI/TIA-607-C.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. For cable trays, conduit and boxes refer to Division 27 Section “Pathways for communications Systems” and Section “Communication Rooms Fittings” for ladder rack and wire management inside the racks/cabinets.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backingpanels.

2.3 UTP CABLE

A. Manufactures: Subject to compliance with requirements, available manufactures offering products that may be incorporated into the work include to the following;

1. BerkTeck
2. Commscope
3. General Cable
4. Approved equal

B. Station cable: 100-ohm, 4-pair UTP, covered with a different color (depending on the system) thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA -568-C.0 for performance specifications and Port Authority standards and guidelines for PA Technology.
3. Comply with ANSI/TIA -568-C.2, minimum Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    b. For locations not requiring plenum rated, provide CMR rating.
    c. For locations indicated ‘OR’ on the drawings, provide outdoor rated cabling.

2.4 UTP CABLE HARDWARE

A. Manufactures: Subject to compliance with requirements, available manufactures offering products that may be incorporated into the work include to the following;

1. Commscope

2. Hubbell
3. Leviton
4. Ortronics
5. Panduit
6. Approved Equal

B. General Requirements for Cable Connecting Hardware: comply with ANSI/TIA -568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

1. Patch panel: Modular panels housing multiple numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
2. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: factory-made, four-pair cables in various lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Supply one Category 6 patch cord for each direct attached outlet to attach to an ONT.
3. Supply station cords in 96”(90%) and 120”(10%) lengths; estimate one per workstation.
4. Supply various lengths of patch cords at the RJ45 patch panel end as to assure a neat installation; estimate one per regular copper outlet location only.
5. Supply various colors for the different systems; coordinate colors with the system owner.
6. Provide add alternate price to install patch cords at one end and at both ends of the cord.
7. Provide unit prices for each length of patch cords to be used for additional patch cords as needed.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.0 for Category 6 performance.

B. UTP Workstation Outlets: one, two, –and four port-connector assemblies mounted in single faceplate. Refer to details on T series drawings for configurations.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Division 26 Section "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP work area cords.
   a. Flush Mounting jacks
4. Factory labeled by silk-screening or engraving for stainless steel faceplates.
5. Machine printed, in the field, using adhesive-tape label.
6. Snap-in, clear-label covers and machine-printed paper inserts.

7. Provides four 10/100/1000 Ethernet interfaces & POE Plus
8. Accepts a single mode SC-APC connector from a passive optical splitter. (POS)
9. Accepts DC power conductor from a DC power supply unit. (PDU)
10. accommodating any combination of UTP work area cords.
11. Snap-in, clear label covers and machine printed paper inserts.

2.6 FIBER CABLE

A. Refer to Division 27 section “Communications Backbone Cabling” for the backbone portion (the

cabling to the IDFs, or the location of the passive optical splitter (POS) if not located in the IDF.

B. From the POS to the Optical Network Terminal (ONT) location a composite cable consisting of

C. bend insensitive singlemode fiber and copper conductors for DC power distribution to the ONT could be used

D. Fiber optic cable should be the same manufacturer as the backbone cable to warranty a

complete installation,

E. Refer to the drawings for information regarding fiber quantity and power conductor sizing.

2.7 FIBER HARDWARE

A. Refer to Division 27 section “Communications Backbone Cabling” for backbone fiber termination hardware.

B. Passive Optical Splitters (POS)

1. Used to distribute the fiber signal to the ONTs
2. Dual input splitters, connecting to both MDFs
3. Size and quantity as indicated on drawings.
4. Manufacturer to be integrated in the overall fiber optic system warranty.

2.8 POWER CONDUCTORS

A. Used to power the ONTs from the DC power supply in the IDFs, delivering 1.5A @48 VDC.

B. Refer to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables”.

C. Provide sizes as indicated on drawings.

D. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

E. Comply with requirements in Division 26 Section "Identification for Electrical Systems".

2.9 GROUNDING

A. Comply with requirements in Division 27 Section "Grounding and Bonding for Communications Systems".

B. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

C. Comply with ANSI/TIA-607-C and ANSI/NECA/BICSI-607.

2.10 IDENTIFICATION PRODUCTS

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

B. Comply with requirements in Division 27 Section "Identification for Communications Systems".

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems".

2.11 SOURCE QUALITY CONTROL

A. Factory test UTP cables on reels according to ANSI/TIA -568-B.2.

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

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Cabling and its installation shall comply with authority having jurisdiction (AHJ) and applicable regulations.

B. The cable shall not be subjected to pulling tension exceeding the pulling strength rating of the cable.

C. The cable bend radius shall be greater than or equal to the minimum bend radius requirement during and after installation.

D. Wiring Method: 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.

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."

E. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

F. 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.

G. Maintain compatibility with the environmental conditions by means of enhanced cabling components, protection, separation, and isolation applicable to each area; refer to Annex F of ANSI/TIA-568-C.0.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA -569-D.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

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

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications spaces (MDFs and IDFs):

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA -568-C.0.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
   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 UTP at least 49 feet (15 m) from equipment room.
5. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before unreeling. Heat lamps shall not be used for heating.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with ANSI/TIA -568-C.0 and BICSI TDMM.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Fiber Optic Cable Installation:

1. Refer to Division 27 section “Communications Backbone Cabling” for the backbone portion (the cabling to the IDFs, or the location of the passive optical splitter (POS).

2. Separate the composite cable at the IDF end to connect the fiber at the POS and the copper at the DC power supply unit.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or

other potentially damaging items.

4. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA -569-C for separating unshielded copper voice and data 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 (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

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 (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and 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 (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
   d. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

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

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

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical

Protection" Chapter.

B. Comply with ANSI/NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA -606-B. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Install fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with ANSI/TIA -606-B for Class 3 level of administration, including optional identification requirements of this standard.

D. Cable Schedule: Post 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 an electronic copy of final comprehensive schedules for Project.

E. 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. Follow convention of ANSI/TIA -606-B. Furnish electronic record of all drawings, in software and format selected by LGP.

F. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) 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 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 each end and at intervals not exceeding 50 feet (15 m).
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 being extended from a panel or cabinet to a building mounted device shall be identified with name and number of particular device as

shown.

b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in telecommunications spaces: Label each connector and each discrete unit of cable-terminating and connecting hardware.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-B.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. This testing is in addition to any commissioning requirements as specified in Division 01911 General Commissioning Requirements. Specific testing requirements that are outlined within this Section will be incorporated into the commissioning process.

B. Tests and Inspections:

1. Visually inspect UTP cable 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 ANSI/TIA-568-C.0.

2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper 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 ANSI/TIA-568-B.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. Contractor should poses a valid calibration record for the test instruments used.

5. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to ANSI/TIA -568-C.0 and ANSI/TIA-568-C.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.

6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

7. Optical fiber cable testing: test fiber optic cable in accordance with ANSI/TIA -568-C.3, Annex E.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Prepare test and inspection reports.

E. Record copy and as-built drawings

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. CAD drawings are to incorporate test data imported from the test instruments.
2. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:

   a. Field directed changes to pull schedule.
   b. Field directed changes to cross connect and patching schedule.
   c. Horizontal cable routing changes.
   d. Backbone cable routing or location changes.

F. Associated detail drawings.

END OF SECTION

SECTION 27 41 00

AUDIO VISUAL 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.

B. All AV series contract drawings and single-line diagrams.

1.2 UNITS OF MEASURE

A. Contractor to Note: Per SI direction units of measure have been listed in both Metric and Imperial Units, with the metric unit listed first. The metric units are nominal and may not be in agreement with dimensioning on drawings. In cases of conflict the Imperial unit of measure shall govern. Contractor to note that for purposes of the work Imperial refers to United States Customary Units.

1.3 SUMMARY

A. Description of Work: Work of this Section includes, but is not limited to, the following:

B. The Contractor shall provide labor, materials and equipment necessary to provide complete audiovisual systems defined in this specification.

C. The Contractor shall be responsible for delivering a turnkey system to the Owner before the occupancy date specified.

D. The Contractor shall support the Owner in their effort to complete the project in accordance with the aforementioned schedule. Contractor is required to participate in all weekly construction meetings as a full member of the project team.

E. The Contractor shall furnish all equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operating system. The NIC (Not in Contract) and CFE (Customer furnished equipment) items and materials are specifically exempted from this requirement. The Contractor shall coordinate with “others” on their components when interfaced, or integrated, with other Trades, or Owner, marked in Contract Documents as NIC or GFE.

F. The Contractor shall generate all shop drawings and information for the complete installation and wiring of the system. The Contractor shall provide (or sub- subcontract) for the onsite installation and wiring, and shall provide ongoing supervision and coordination during the implementation phase.

G. The Contractor shall be responsible for the initial adjustment of the systems as herein prescribed and shall provide all test equipment for the system checkout and acceptance tests.

H. CONTRACTOR Supplier/Installer is required to provide client onsite training in the operation and maintenance of the systems for personnel designated by the C.O.R. (Contracting Officer's Representative). Training shall be provided no later than 2 weeks after final acceptance of the A/V systems. The Contractor shall produce and develop an instructional training manual showing all the specific functionalities of the A/V system that the Contractor installed. This manual will be made to assist the end-users on how to operate specific functions of all aspects of the A/V Systems. The Training Manual will include "screen shots" of specific functions of Touch Panel and other operational devices as well as written descriptions of how to manipulate those functions.

1.4 SUBMITTALS

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

B. Shop Drawings: For supports for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

1. For purposes of quality assurance and performance verification, prior to fabrication the Contractor shall submit (3) three copies of the following information for approval by the Owner, Architect and AV Consultant. Drawing submittal shall be on reproduci1›1e media. this information shall include, but is not limited to, the following:

   a. Line drawings - Complete system construction and point to point wiring schematic drawings, including all component values and showing complete letter and number identification of all wire and cable as well as jacks, terminals and connectors.

   b. Elevation drawings showing placement of all equipment.

   c. Reflective ceiling plan drawings showing placement of all equipment.

   d. Furniture drawing

   e. All panels, plates, and designation strips, including details relating to terminology, engraving, finish and color.

   f. Schematic drawings of all custom components, assemblies and circuitry.

   g. All unusual equipment modifications.

   h. Cable run sheets.

i. Sample cable labels.

j. Connector wiring diagrams.

k. Patch panel assignment layout drawings.

l. Front and rear mechanical drawings of each equipment rack.

m. All items of equipment whether a stock manufactured item or custom built shall be supported by complete and detailed schematic drawings and replacement parts lists. No "black boxes" or unidentified components shall be acceptable.

n. Verification of the focal lengths of video display/projector/wall and end-user seating placement to achieve the specified image sizes.

o. Product data: Manufacturer's product information and data sheets for all equipment items, cabling and materials provided.

p. Audiovisual control system Graphical user interface (GUI) and requirements SOW document for programmer.

q. Remote Control Panel layouts with button function descriptions.

r. Training Manuals

1.5 Final Documentation

1. At the completion of the installation, the Contractor shall submit final "as-built" documentation, including the following:

a. Same Equipment manufacturer's operation and Maintenance manuals, and Training Manual, described above for Shop Drawings. These documents shall be electronically saved as Adobe Acrobat PDF files onto a CD-ROM.

b. "As built" drawings that include any updates (red-lines) made in the field to the shop drawings. This package to install final versions of all shop drawings and is to include, but not limited to, line, elevation, rack, floor, including floor and reflected ceiling plans showing equipment and device locations and conduit pathways, system functional block drawings including all input and output circuit cable and terminal block numbers, all jack field circuit I.D. designations and every equipment item required for the system configuration.

c. Same "As built" drawings described above for every equipment item required for the

system configuration, electronic files, saved as editable AutoCAD 2010 (or newer version) and also as Adobe Acrobat PDF files onto a CD-ROM. The CD- ROM shall be labeled for "Section 274116, Audiovisual, AS-BUILT Documentation, System Drawings" with the project name, contractor's name and AV Contractor contact info and date of issue.

d. A System Operation and Training Maintenance Manual.

e. All documentation to be provided within 14-calendar days of the rooms acceptance.

1.6 WARRANTY

a. The Contractor shall provide a written warranty on the entire system, installation workmanship, materials employed and on the individual pieces of equipment installed. The system warranty shall be for 1 (one) year commencing from the date of final system acceptance by the Owner. This warranty shall obligate the Contractor to provide all equipment, material and labor during the warranty period, in the event of system or equipment malfunction.

1.7 Permits

b. The Contractor shall secure all appropriate permits for low voltage cable installation required by the local jurisdiction. Said documents shall be provided to the Consultant and Owner's project manager prior to the commencement of on-site installation. Costs for permits and accompanying inspections and documentation shall be included in the Contractor's proposal.

1.8 QUALITY ASSURANCE

a. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

b. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.

c. 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.

d. Comply with NFPA 70.

1.9 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.

2.0 MANUFACTURERS

a. Subject to compliance with requirements:
   1. JBL Professional
   2. Biamp Systems
   3. QSC
   4. Crestron
   5. Listen Technologies
   6. Extron
   7. Shure
   8. Middle Atlantic
   9. Chief Mfg.

2.1 FUNCTIONAL DESCRIPTION OF SYSTEMS

A. Competition Pool System Functions:

- **This system shall be bid as an <u>Alternate Deduct</u>**

1. Eight (8) Zone audio system for music playback and competition announcements.
2. Two Line Array type speakers to encompass the competition pool.
3. Two Smaller Line Array type speakers one for the Leisure Pool and one for the Recreation Pool.
4. Audio zones for Lifeguard area, Locker Rooms and Spectator seating area.
5. Line and Mic input plates are the 4 corners of the Competition Pool.
6. RF Based Listen Assist system.
7. One Zone control panel located near Competition Pool and One Zone control panel in Lifeguard Area.
8. The pickup, amplification, distribution, and reproduction of voice and/or other audio program material from various sources such as microphones, CD players, etc.
9. The system shall be of modular design to facilitate both expansion and service and shall use only solid state circuitry.
10. All equipment and installation material required to fulfill the above shall be furnished whether or not specifically indicated on the drawings.
11. System to include but not be limited to:

    a. One (1) Digital Signal Processor 12 analog input, 8 analog output
       - Biamp Tesira AI
    b. Two (2) Audio Amplifiers 2000 Watt
       - QSC CMX2000VA
    c. Two (2) Audio Amplifiers 800 Watt
       - QSC CMX 800VA
    d. Two (2) Large Active Beam Shaping Column Loudspeaker Arrays
       - JBL HP-DS370

e. Two (2) Medium Active Beam Shaping Column Loudspeaker Arrays
   - JBL HP-DS170

f. Two (2) Vocal wired microphones with 25' cable
   - Shure SM58S

g. Eight (8) 6.5'' Recessed ceiling speakers
   - JBL Control 26CT

h. Five (5) Wall mounted speakers
   - JBL Control 1 Pro

i. One (1) RF Based Assisted Listening System
   - Listen Tech LT-800 with extended antenna kit
   - Four (4) Listen Tech LR4200 receivers with charger

j. One (1) 8 Port POE Network Switch
   - HPE JL383A 8-Port POE Switch

k. Two (2) Wall mounted control panel
   - Biamp TEC-1L

l. One (1) 40 U Wall mounted rack system with all required power distribution and shelving and blank plates
   - Middle Atlantic SR-40-32 Swing out rack

B. Social Hall System Functions:
1. Program Audio throughout divisible space.
2. Single 6000 Lumen Projector displaying onto ceiling recessed 16:10 screen.
3. Two (2) wall plate HDMI, VGA/Audio.
4. Capable of displaying CFE Cable TV.
5. Two (2) Wireless Hand Held and Two (2) Lavalier Microphones.
6. Digital Video Switching System.
7. Control of Lutron Lighting system
8. Control system for all room functions
9. Assisted Listening System
10. System to include but not limited to:
    a. One (1) Ceiling Recessed Electric Screen
       - Da-Lite 208'' Ceiling Recessed Electric Screen
    b. One (1) 6500 Lumen Laser Projector with associated ceiling mount
       - Panasonic PT-RZ770BU
    c. Two (2) VGA/Audio HDMI HDBaseT Transmitter
       - Crestron DM-TX-200C-2G (coordinate color with Architect)
    d. One (1) Customer Supplied CATV Receiver
    e. One (1) Digital Video Switcher/processor
       - Crestron DMPS3-4K-350-C
    f. Digital Signal Processor 12 analog input, 8 analog output
       - Biamp Tesira AI
    g. One (1) Audio Amplifier 2 channel 200 Watt
       - Extron XPA 2002-70V
    h. Six (6) 6.5'' Recessed ceiling speakers
       - JBL Control 26CT
    i. Four (4) Wireless Microphones complete system

- One (1) Shure MXWAPT4
- One (1) Shure MXWANI4
- One (1) Shure MXWNCS4
- Two (2) Shure MXW2/BETA58
- Two (2) Shure MXWA1
- Two (2) Shure WL 183

j. Assisted Listening System
- One (1) Listen ILD122 (Loop Driver 3.5 Amps)
- Loop based floor wiring system around perimeter

k. One (1) Wall Mounted Control System Touch Panel 10''
- Crestron TWS-1060 (coordinate color with Architect)

l. One (1) 8 Port POE Network Switch
- HPE JL383A

m. One (1) 24 Unit Wall Mounted Rack System with all associate power and shelving
- Middle Atlantic SR-24-28

C. Fitness Area System Functions:
1. Two (2) Ceiling Mounted 55'' LCD displays for CFE Cable TV
2. System to include but not limited to:
   A. Two (2) LG 55LW540S
   B. Two (2) Chief MCM1U
   C. Two (2) Chief CMA100
   D. Two (2) Chief CMS018024
   E. Two (2) Chief FCA500

D. Gymnasium System Functions:
1. Three (3) Zone audio system for music playback and competition announcements
2. 4 Center court Monitor Speakers
3. 6 Spectator area pedant speakers
4. Audio zones for center court area and spectator seating area.
5. Line and Mic input plates at scoring location.
6. One Zone control panel located near scoring area.
7. The pickup, amplification, distribution, and reproduction of voice and/or other audio program material from various sources such as microphones, CD players, etc.
8. The system shall be of modular design to facilitate both expansion and service and shall use only solid state circuitry.
9. All equipment and installation material required to fulfill the above shall be furnished whether or not specifically indicated on the drawings.
10. All necessary hookup, installation, and testing shall be by a factory accepted representative.
11. System to include but not be limited to:
    a. One (1) Digital Signal Processor 12 analog input, 8 analog output
       - Biamp Tesira AI
    b. Two (2) Audio Amplifiers 800 Watt
       - QSC CMX 800VA
    c. Four (4) Indoor/Outdoor Monitor speakers ceiling suspended

- JBL Control 29AV-1

d. Six (6) Pendant speakers ceiling suspended
   - JBL JBL Control 67 P/T

e. Two (2) Vocal wired microphones with 25’ cable
   - Shure SM58S

f. One (1) RF Based Assisted Listening System
   - Listen Tech LT-800 with extended antenna kit
   - Four (4) Listen Tech LR4200 receivers with charger

g. One (1) 8 Port POE Network Switch
   - HPE JL383A 8-Port POE Switch

h. One (1) Wall mounted control panel
   - Biamp TEC-1L

i. One (1) 24 U Wall mounted rack system with all required power distribution and shelving and blank plates
   - Middle Atlantic SR-24-28 Swing out rack

E. Elevator Lobby Area Functions:
   1. Four (4) Portrait mounted 55’’ commercial displays
   2. Portrait Tilting Wall Mounts
   3. Digital Signage players
   4. System to include but not limited to:
      F. Four (4) LG 55UH5C-B
      G. Four (4) Chief MTMS1U
      H. Four (4) FCA112
      I. Four (4) Customer Supplied CATV Receivers
      J. Four (4) Brightsign XT1143

2.2 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with TIA/EIA-310-D.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

END OF SECTION

SECTION 27 51 00
PAGING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract Documents including general and supplementary conditions and Division 01 specification sections, apply to this section.

1.2 SUMMARY

A. This section includes a fully operational IP platform for internal and normal and critical communications Solution, incorporating recreation center facility safety notifications and general communications including but not limited to the following:

1. The platform shall provide complete internal communications and employ state of the art IP Technology including the minimum functions listed.
    a. Two-way internal intercommunications between staff locations and single zone office, classroom, conference and speaker/call-in station locations.
    b. Scheduled bell events.
    c. Emergency announcements that will override any pre-programmed audio, assuring that all Emergency/Lockdown etc., are heard at each speaker location.
    d. Capability of prerecording emergency announcements that can be activated by a Soft Key on an administrative console, panic button, dial string, or web browser.
    e. Atomic Time Synchronization.
    f. Web-based user interface.
2. The system shall support a minimum of 1000 level priorities which shall be user-definable, allowing each end point to place a minimum of 5 different priority calls at the same time.
3. Any authorized administrator shall be able to call from outside the facility into any zone, floor or entire facility via the County supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system.
4. Authorized system users shall be able to create a minimum of 100 automated sequences with voice instructions, tones, emails, program distribution, and relay activations and replay them.
5. Automated message strings shall be manually initiated from a single-button access on the console, on a SIP connected telephone, a panic button, from the web-based user interface or via interface with third party systems.
6. Paging and two-way intercom features shall be accessible from any system console or SIP connected telephone for each campus.
7. The platform shall synchronize its system time to the network timeserver or a web-based time server.
8. This specification establishes a minimum level of quality, features, and performance

for individual components as well as the integrated system.

9. Systems that do not comply with the feature-sets highlighted in this Specification will not be considered.

B. Section Includes:
   1. IP Paging Control Module
   2. Power amplifiers
   3. IP Microphone Control Module
   4. Equipment cabinet
   5. Equipment rack
   6. Loudspeakers
   7. Conductors and cables
   8. Raceways

1.3 REFERENCES

A. The following references are useful in specifying public address and mass notification systems. Other references may be needed for design purposes.
   1. National Electrical Contractors Association
   2. NECA 1-2000: Standard Practice for Good Workmanship in Electrical Contracting (ANSI)
   3. NFPA
   4. NFPA 70-2005: National Electrical Code
   5. Telecommunications Industry Association/Electronic Industries Alliance
   6. TIA/EIA-310-D-1992: Cabinets, Racks, Panels, and Associated Equipment (ANSI)
   7. Underwriters Laboratories Inc.
   8. UL 813-1996 (Rev. 1999): Commercial Audio Equipment
   9. Structural Engineering Institute/American Society of Civil Engineers
   10. SEI/ASCE 7-2002: Minimum Design Loads for Buildings and Other Structures

1.4 DEFINITION OF TERMS

A. Installer(s): Shall refer to the person, persons, or company who or which is contracted to perform the work specified herein.

B. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

C. VU: Volume unit.

D. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.5 SUBMITTALS

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

B. Shop Drawings: For supports for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

C. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.

D. Console layouts.

E. Control panels.

F. Rack arrangements.

G. Calculations: For sizing backup battery

H. Wiring Diagrams: For power, signal, and control wiring.

I. Identify terminals to facilitate installation, operation, and maintenance.

J. Single-line diagram showing interconnection of components.

K. Cabling diagram showing cable routing.

L. Delegated-Design Submittal: For supports for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

M. 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.

N. Qualification Data: For qualified Installer.

O. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.

P. Product Certificates: Signed by manufacturers certifying that products furnished comply with specified requirements.

Q. Installer Certificates: Signed by manufacturers certifying that Installers comply with specified requirements.

R. Manufacturer Certificates: Signed by manufacturers certifying that they comply with specified requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced Installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this

Section. Provide the following within thirty (30) days after notification to proceed:

1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
2. The Installer shall be bondable.

3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
   a. Adequate plant and equipment to pursue the work properly and expeditiously.
   b. Adequate staff and technical experience to implement the work.
   c. Suitable financial status to meet the obligations of the work.
   d. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.

4. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.
5. Because the life expectancy of this type of communications structure normally exceeds 10 years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturers product for it least 15 years, the following is required:

   a. A list of (2) systems manufacturers of which they currently are authorized service providers where the relationship exceeds 10 years.

   b. A letter from the manufacturer outlining the details of changes in service providers over the last ten years and what actions they will take to ensure continuity of service to the customer.

7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
8. Comply with NFPA 70
9. Comply with UL 60950.
10. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer

1.7 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

1.8 IN-SERVICE TRAINING

A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide Facility staff a complete understanding of how to utilize and properly operate all functions.

B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.

C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the Facility's administrative staff and Facility district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

1.9 WARRANTY

A. Provide a manufacturer's five-year warranty of the Facility communications network equipment against defects in material and workmanship. This warranty will cover all electronic system components. Additional warranties cover clocks, speakers, and call in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one year warranty shall be provided for labor.

B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the Facility communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.

C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.

D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide the following system:
   1. Atlas Sound IED - IP Paging
   2. Biamp Vocia – IP Paging
   3 Rauland-Borg Corporation. - IP Paging TCU

2.2 FUNCTIONAL DESRIPTION OF SYSTEM

A. The platform shall utilize state of the art IP Technology for Call-in Notification, Facility Safety Paging and Evacuation tones, Atomic Time Synchronization, Class or Event Change Tones utilizing multiple, programmable schedules for each zone, Two-way hands-free Internal Communications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard programming shall be web-based and user friendly to allow the system administrator the ability to easily program system features.

B. The platform shall be a single electronic system consisting of a minimum of 10 audio channels for each facility, IP Speaker Modules and call switches, IP Zone Modules connecting corridor speakers, inside and outside horns, IP Administrative Consoles, SIP enabled PBX integration and district-wide integration for paging, emergency notifications,

calendar scheduling and configuration.

C. Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones, and outside phones.

D. Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.

E. Call-ins may have priority (and annunciation route) changed by user action from a console or SIP enabled phone.

F. Call-in annunciation route shall include playing pre-recorded audio over speakers, sending a pre-configured email, and activating relays.

G. The platform shall lend itself to expansion by simple addition of hardware modules.

H. The platform shall connect directly to an existing, standard protocol WAN/LAN network, without the need for a separate server at each Facility location. Configuration, including bell schedules, calendars, and emergency sequences can be remotely created, changed, stored and downloaded to the system by an authorized user from a web-based user interface.

I. The platform shall provide the ability to initiate Facility safety paging announcements, evacuation tones and take cover tones from any telephone or connected web browser within the facility or outside the facility to any other location within the facility or district.

L. IP Addressable and POE powered Speaker Modules for individual rooms shall be system programmable and may be assigned any two, three, four, five or six digit number as well as name and description. Any extension may be reassigned at any time.

M. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in a campus. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre-announce tone and supervisory tones shall be disabled during designated emergencies automatically.

N. The platform shall allow users to configure multiple schedules per Facility, with a minimum of 500 unique events per schedule, and automatic Daylight Savings time correction. Schedules can be programmed to occur once, daily, weekly, monthly, or in any combination of the preceding recurrences. Each Facility may have a minimum of 20 unique bell schedules, with a minimum of 5 active schedules on any given day for each campus. User shall be able to select from 25 standard included tones as well additional user created and uploaded audio files for class change signaling and messaging. In addition, scheduled events shall include relay actions, email notifications, and paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server at each Facility location. Bell schedules can be remotely created, changed, stored and assigned to calendar days for the local Facility by an authorized user from a web-based user interface.

O. The platform allows for customization of preprogrammed sequences, used for emergencies, events, and everyday communications. Preprogrammed sequences can be activated from the push of a relay button, soft key of an administrative console, a dial string of a SIP phone, or a web browser configured to the district network. Sequences can be initiated automatically as part of a schedule or on the fly. Preprogrammed sequences can be customized to utilize any combination of audio tones, emails, relays, tone exclusions, swings, delays, duplex, SIP phone notifications, and program distribution. Audio tones can include customized audio files and voice messages, recorded in any language. Uploaded audio tones and messages can be preprogrammed to annunciate repeatedly or individually, as part of a scheduled sequence

or on the fly. Each Facility in a district can have its own customized sequences, and can be activated individually, in groups, or district-wide.

P. An all call microphone will be located adjacent to the Main Administrative Telephone for emergency and general all call announcements

2.3 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: UL listed Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with TIA/EIA-310-D.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 IP PAGING CONTROL SOFTWARE

A. Server Software

1. Provide facility wide paging, bell event scheduling, emergency notification Ability to configure system and initiate system features, per Facility and county-wide via web-based user interface.

    a. The software has the ability to sync system time to the Atomic Clock Signal or to the Facility's or district's network time server.

    b. The software will provide a web browser to deliver district-wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN/LAN of an alarm condition.

    c. The software can automatically broadcast emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based user interface. The emergency instructions are preprogrammed and require no user intervention. Bell tones are able to be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.

    d. The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.

    e. The software can be installed in cloud, virtual or physical server environments.

    f. The web-based user interface supports secure HTTP browsing.

    g. The software supports encryption to ensure secure access.

    h. The system shall monitor itself if devices go offline and system actions are not received. Specified users shall receive email notifications when devices

go offline.

i. The software will support a minimum of 20 bell schedules per Facility, with 5 schedules assignable to a specific Facility day. Bell schedules can be programmed to annunciate tones, activate relays, send emails, activate program distribution, and notify SIP phones.

j. The system allows programmable end points to be automatically included or excluded for live paging, bell tones, or prerecorded audio, depending on the time or day or day of the week. These inclusions/exclusions can be applied manually or automatically depending on their schedule.

k. The system has a minimum of 5 customizable emergencies, one of them being an All-Clear – with the ability to return the system from an emergency to normal status. Each emergency shall have a minimum of 500 unique events.

l. The communications software must allow upgrade from an individual Facility system to multiple Facilities, or an entire Facility district, using the same web-based user interface. The communications software from an individual Facility system must be identical in typical user operation to the multiple Facilities or entire Facility district communications system software.

2.5 IP Paging Facility Controller

A. The IP paging controller shall be rack mounted in the main equipment rack and provide the following features;

1. Provide call routing for paging and intercom for a single facility.
2. System shall connect to the county provided Telephone Network via a SIP connection.
3. Support a flexible numbering plan allowing two, three, four, five, or six digit extensions.
4. SIP interface to a district provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages and change priorities of call-ins in progress.
5. Direct dialing, two-way amplified voice intercom between any provided telephone or admin console and speaker without the use of a press-to-talk or talk-listen switch.
6. Ability to upgrade priority level from individual call switch.
7. The ability to answer intercom call-ins registered at administrative consoles and pre-selected telephones.
8. The ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
9. The ability to manually upgrade an intercom call-in to an alternate telephone or group of telephones.
10. Administrative console shall display locations that have not checked in to confirm their secured location and provide hands-free audio monitoring and communication to unsecured locations.
12. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP network.
13. Single button access from any console on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers.

Emergency announcements originating from any assigned administrative console shall have priority over all regular system functions.

14. Ability for administrative consoles and connected phones to selectively monitor audio at any two-way speaker during an emergency.
15. Stores a minimum of 48 hours' worth of Bell Event Schedules, all emergency notification sequences as well as facility wide configuration.
16. System has the ability to sync system time to the Atomic Clock Signal or to the Facility's or districts network time server.
17. System's SIP Interface shall provide:
    a. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
    b. Ability to answer a call-in directed to that SIP extension.
    c. Ability to upgrade a call-in directed to that SIP extension.
    d. Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
    e. Ability to initiate a Facility-wide emergency including lockdown and evacuate sequences.
    f. SIP device shall display call-in information from call in switch. Information will include a minimum of Classroom Name, Number, and Priority Level.
18. The system will have the ability to utilize a web browser and a USB microphone connected to the PC to deliver district-wide live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
20. The system can automatically broadcast emergency instructions throughout an entire facility when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. Bell tones are able to be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.

2.6 IP Addressable Modules General:

A. System shall provide multiple IP Addressable Modules for intercom, paging and relay activation.

1. All Modules are POE 802.3af compliant
2. All Modules support DHCP.
3. All Modules connect to network with a single RJ45 connector

2.7 IP Addressable Microphone Module

A. The Microphone Input Module provides an audio input point for either microphone or line level audio to the system.

B. The module allows use of either a balanced dynamic or balanced 12v DC phantom powered condenser microphone, with or without a Push-To-Talk (PTT) button. Any audio input through the module can be assigned a priority in in system programming. This provides an option to broadcast emergency audio from either a microphone or from an audio source, throughout a facility wherever there are connected speakers.

C. Audio from the module requires a contact closure. This can be from the latching pushbutton switch mounted on the enclosure, an external switch wired to the internal header, or from a PTT microphone.

D. The module also has a TCU programmable cough delay that provides a paging pause for an unexpected disruption during microphone usage.

E. A front panel mounted, 3-pin, XLR microphone socket allows a reliable, latching, quick connection point for balanced dynamic microphones. When using an XLR-equipped microphone, the pushbutton switch on the module provides the required contact closure to system

F. Balanced condenser mics that require 12VDC phantom power can also be connected to the XLR socket on the module. For PTT microphones with a multi-wire pigtail, the module has an internal terminal strip.

G. A pair of internal switches are used to select either professional or consumer level, audio input. This switch is also used to select if the audio will be at line level or microphone level.

H. Microphone audio can be through either a front panel 3-pin XLR socket or 8-position internal screw terminal. Line level audio can be input through either the front panel RCA jacks or the internal 8-position screw terminal connector.

I. Module Specifications

1. Power Requirements: Power Over Ethernet 802.3af (12.5 Watts Maximum) Power Usage: 3.0 Watts Network Requirements: Fully Switched 100 Mb/s Network Connector:
2. One RJ45 Network Socket Wiring Requirements: Category 5e or Greater (Cat5e+)
3. Audio Signal: 1.228 VRMS Maximum (professional audio range

2.8 IP Addressable Speaker Module

A. Shall interface to Facility's data network, a classroom speaker, and multiple call switches.
B. A minimum of 5 levels of call-in can be placed from an IP Speaker Module. The call-ins are routed to administrative consoles and select SIP connected telephones and can only be cleared from the system once answered. If a call-in is not answered within a preprogrammed time the call-in may reroute to other telephones, consoles, and speakers.
C. An option for Privacy call in switches is supported. When the Privacy switch is activated it

prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.

D. The ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones and class change tone zones; this assignment is a programmable function, changeable by time of day. Each IP Speaker Module's location shall be programmed in software to belong to any combination of software zones. IP Speaker Modules shall be designed to mount near ceiling and wall speakers and in the plenum space.

E. Intercom and paging volume adjustable from Software interface.

2.9 IP Addressable Zone Paging Module

A. Zone Paging Module shall connect multiple speakers for district all page, all page, zone paging, bells, audio events and, emergency notification.

B. Zone Paging Modules shall be rack and wall mountable.

C. Zone Paging Modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio and emergency notification.

2.10 IP Addressable Aux I/O Module

A. Aux I/O Module shall have two input contacts and two output contacts.

B. Input and output contacts are individually addressable.

C. Aux I/O Module shall be wall and rack mountable.

D. User can program relays to be activated manually, through an event/bell schedule, or during emergency notification.

E. Aux I/O Module can perform Facility lockdown from a single press of a panic button.

2.11. IP Addressable Program Line Input Module

A. Program Line Input Module shall provide line level audio program distribution into system.

B. Program Line Input Module shall have a 3.5mm cable jack.

C. Program Line Input Module shall be configured via web-based user interface.

D. User can configure program distribution to be activated manually or automatically through an event/bell schedule.

E. Program Line Input Module will have a system priority level such that emergency communications override program distribution.

2.12 IP Addressable Analog Gateway

A. IP Addressable Gateway provides integration with existing analog wiring infrastructure – consisting of shielded two-pair classroom field wiring. The Gateway provides the ability to reuse speaker wiring, speakers, and punch blocks to integrate analog infrastructure with IP platform.

B. Each Gateway will have 5 watts of power per port and 25 watts total per device.

C. Supports 24 rooms or circuits that utilize 25 Volt speakers and all current Telecenter call switches for front office notification.

D. Supports minimum of 5 call switch priorities per classroom, capable of lockdown check-in functionality, while reusing existing shielded two-pair classroom field wiring.

E. Classroom intercom volume adjustable from Software interface.

F. Classroom paging volume adjustable from Software interface.

G. Configured to the Facility network and can be used in conjunction with IP Addressable Modules.

2.13 IP Addressable Administrative Console

A. A full color screen with 64 soft keys, 3 line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.
B. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire Facility.
C. Programmable soft key access from any console on the system to initiate alarm signals within the Facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative console shall have priority over all regular system functions.
D. Programmable soft key access from any console to automatically broadcast page emergency instructions throughout an entire Facility when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
E. Ability to perform intercom to any single IP Addressable Speaker Module.
F. Ability to display 3 call-ins at a time on the screen while other call-ins are annunciating and the ability to scroll to view all call-ins.
G. Ability to upgrade a call-in via soft key.
H. Programmable soft key access from any console for activating relays, campus wide.
I. Ability to maintain, along with controller and other IP Modules system functions, including intercom, bells and paging for the local campus in the event of district-wide connection loss.
J. Classrooms that have not 'checked-in' during an emergency are listed on the Administrative Console's screen.
K. The time duration of an emergency is shown on the screen of the administrative console. The check-in timer is shown on the screen of the administrative console.

2.14. Audio Paging/Program Amplifiers

A. The four-channel power amplifier shall deliver a minimum 75 Watts RMS into 70V/100V loads with both channels operating.

B. The power amplifier shall have Euroblock input and output connectors.

C. The four-channel power amplifier shall have balanced analog inputs and a 80Hz high-pass filter.

D. The power amplifier shall have a 26db/36dB input sensitivity switch and remote standby.

E. The output circuitry shall be Class D, convection cooled with a frequency response of 20Hz to 20kHz ±1.0dB, -3dB @ 80Hz due to HPF.

F. Signal-to-Noise shall be greater than 100dB unweighted.

G. The front panel shall provide the status of power, standby, protect, signal level and clip. The amplifier shall mount in a standard 19 inch rack using two spaces (3.5" high)

H. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

2.15 Normal/Emergency Call Switches indicated on the drawings shall provide the following functions and features:

1. One (1) “Normal” call switch that shall activate a distinctive “NORMAL” level call from single button activation. The button shall be clearly marked “NORMAL” and will route the call-in to any one or more Administrative Consoles and/or Marquee Displays for quick and easy response from an Administrative Console.
2. One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.

2.16 Emergency/Check-In Call Switch

A. Emergency/Check-In Call Switched indicated on the drawings shall provide the following functions and features:

1. One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY” and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.
2. One (1) “CHECK-IN” call switch that shall activate a distinctive “CHECK-IN” level call from single button activation. The button shall be blue in color and shall be clearly marked “CHECK-IN” and will route the call-in to any one or more Administrative Consoles. This button will be used for emergency check-ins during Facility emergencies, notifying the front office of the classroom occupants’ safety during an emergency.

2.17 Volume Control Wall Plate

A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

1. Wattage Rating: 10 W unless otherwise indicated.

2. Attenuation per Step: 3 dB, with positive off position.

3. Insertion Loss: 0.4 dB maximum.

4. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.

5. Label: "PA Volume."

2.18 Microphone Outlet

A. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.

2.18 Desktop Microphone

A. The announcement/paging microphone shall be a Rauland 1295, or equivalent, omnidirectional pressure-operated dynamic type, offering a frequency response from 50-12,000 Hz, substantially independent of direction to the source of sound.

B. The output level shall be -55 dB 0dB = 1 volt/microbar) in the high impedance (40 K ohms) position, and -58dB (0dB = 1 mw/10 microbars) in the low impedance (400 ohms) position. The microphone shall offer dual impedance high or low) selectable by the simple adjustment of a slide switch.

C. The microphone diaphragm shall be fabricated of Mylar. A durable leaf-spring type push-to-talk switch incorporating additional contacts for remote relay operation shall be provided. There shall also be a switch “locking” capability.

D. The microphone base shall be of die-cast zinc alloy, with molded durable Cycolac® body, in professional black finish; four non-skid mar-proof molded feet shall be provided. It shall be equipped with a 7-foot long, 4-conductor, two-shield black cable. Size shall not exceed 9-3/8" high, 4-3/4" wide, and 5-7/8" deep; weight, including cable, shall not exceed 2 pounds.

2.19 Interior Ceiling Speakers – Classroom IP Module

A. Provide Ceiling Speaker Assembly consisting of 8 Ohm, 8” speaker mounted in a 2 foot by 2 foot, or 2 foot by 1 foot, lay-in baffle, with an integrated back box that covers the full area of the baffle.
B. The speaker shall be connected by inserting an 8-pin RJ45 terminated CAT 5e or Cat 6 cable.
C. The speaker shall include provisions to allow attachment of a safety cable if required.

2.20. Cone-Type Loudspeakers:

A. The speaker shall be a Drop-In Ceiling Speaker, which shall be fully enclosed and constructed of industrial grade steel.

B. It shall be comprised of a damped high-compliance factory-mounted 8" loudspeaker that shall consist of an 8" treated paper main cone, a secondary high frequency cone, and a minimum 5 ounce magnet.

C. The unit shall have a 25V transformer with power taps of 4, 2, 1, 0.5, and 0.25 watts, select-able by rotary switch. Output shall be 94 dB @ 1 watt / 1 meter (min.). Frequency response shall be 95 Hz - 20 kHz (min.)

D. The speaker shall include 4 seismic attachment points. The speaker shall have a non-reflective, off-white or bright white ("U" versions) metal finish grille. A front-mounted volume control shall be easily accessible.

E. The speaker assembly will fit into 1' x 2' and 2' x 2' ceiling tiles.

F. For 2' x 2' installations, a support rail shall not be needed and no cuts to the ceiling shall be necessary. For 1' x 2' installations, a single cut to the ceiling tile and an included support rail shall be needed.

2.21 Wall Mounted Horns

A. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion pattern shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed parts potted and a sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.

B. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4”x10-3/4”x6” deep.

C. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall a mar/scratch baked epoxy rust inhibitive finish.

2.22 Equipment Racks

A. All main equipment racks shall provide space for all rack mounted system equipment.

B. All equipment racks shall be multi-rack format (“gangable”) style, bolted together, and open cavity.

C. All equipment racks will be provided with lockable rear doors.

D. Equipment rack(s) shall be located in climate-controlled areas/rooms as shown on drawings.

E. All head-end, distribution, and source equipment, including data and power, shall be located in racks configured as approved by the Engineer.

F. Rack mounted equipment shall be accessible from front and rear.

G. All unused rack spaces will be covered with appropriate blank/vent panels.

H. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

2.23 Uninterruptible Power Supplies (UPS)

A. UPS equipment provided for this system will include Power Conditioning to smooth current

and voltage fluctuations.

B. UPS equipment will be sized in accordance with the system manufacturer's recommendations.

C. Provide an individual UPS for EACH SYSTEM CONTROLLER (Gateway) furnished with the system.

D. Provide additional UPS(s) for protection of all other equipment furnished with the system and housed in the equipment racks. If equipment and UPS is located in data racks furnished under a separate specification section coordinate UPS power with data contractor.

E. All UPS equipment shall be rack mounted.

2.24 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.

B. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.

C. Plenum Cable: Listed and labeled for plenum installation.

D. Speaker Cable – Minimum #20awg shielded for classrooms and #18awg shielded for hallways & horn circuits

2.25 RACEWAYS

A. Conduit and Boxes: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways 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.

B. Install plenum cable in environmental air spaces, including plenum ceilings.

C. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. 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 GENERAL

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install

equipment in accordance with manufacturer's written instructions.

B. Furnish and install all material, devices, components and equipment for a complete operational system.

C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.

D. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.

E. All housings are to be located as indicated.

F. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

H. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

I. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

J. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.3 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.

3.4 INSTALLATION OF CABLES

A. Comply with NECA

B. General Cable Installation Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements.
   2. Make terminations only at outlets and terminals.
   3. 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.

C. 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.

D, Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. 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.

F. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) 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-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.5 EQUIPMENT INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

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. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.

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.

D. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

F. 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.

G. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

H. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 GROUNDING

A. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
B. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
C. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
D. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
B. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.8 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner’s representative.

3.9 FIELD ACCEPTANCE TESTING

A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.

B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is

completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

D. Schedule tests with at least seven days' advance notice of test performance.

E. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

F. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

G. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

H. Public address systems will be considered defective if they do not pass tests and inspections.

I. Prepare test and inspection reports.

J. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

B. Complete installation and startup checks according to manufacturer's written instructions.

3.11 TRAINING

A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.

C. Schedule training with Owner through the owners representative, with at least seven days advance notice.

D. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

3.12 OCCUPANCY ADJUSTMENTS

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

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

3.13 PROJECT CLOSEOUT

A. Verify all training is complete

B. Verify all operational and maintenance information and as-built drawings have been turned over to owner's representative.

C. Verify warranty certificate has been turned over to owner's representative.

END OF SECTION

SECTION 28 3111

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Firefighters' two-way telephone communication service.
8. Firefighters' smoke-control station.
9. Magnetic door holders.
10. Remote annunciator.
11. Graphic annunciator. Separate graphic annunciators required for SCRRAC and HOC.
12. Addressable interface device.
13. Digital alarm communicator transmitter.
14. Radio alarm transmitter.
15. Network communications.
16. System printer.

B. Related Requirements:

1. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for electrical system pathways.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and 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. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include graphic annunciator panel drawings. Ensure that the layouts must use the actual room numbers not the Architectural floor plan room numbers.
9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
10. Include performance parameters and installation details for each detector.
11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
13. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; 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 required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
    f. Show air-sampling detector pipe routing.

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.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; Level III minimum.
c. Licensed or certified by authorities having jurisdiction.

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 the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the 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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, 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.

C. Field quality-control reports.

1.6 SAMPLE WARRANTY: For special warranty.

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, include the following and deliver copies to authorities having jurisdiction:

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

      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.

   i. Manufacturer's required maintenance related to system warranty requirements.
   j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level III or Level IV technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.10 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any 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 according to requirements indicated:

1. Notify no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Architect's] written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.

B. Automatic sensitivity control of certain smoke detectors.

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

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

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Carbon monoxide detectors.
7. Combustible gas detectors.
8. Automatic sprinkler system water flow.
9. Pre-action system.
10. Fire-extinguishing system operation.
11. Fire standpipe system.
12. Dry system pressure flow switch.
13. Fire pump running.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Transmit an alarm signal to the 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 heating, ventilating, and air-conditioning 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. Activate pre-action system.
12. Recall elevators to primary or alternate recall floors.

13. Activate elevator power shunt trip.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Fire pump running.
6. Fire-pump loss of power.
7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.
9. User disabling of zones or individual devices.
10. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:

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

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways 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 from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

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

1. Bosch Security Systems, Inc.
2. Faraday.
3. Gamewell - FCI by Honeywell.
4. Notifier.
5. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

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

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

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

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands

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

1. Pathway Class Designations: NFPA 72, Class A.
2. Pathway Survivability: Level 0.
3. Install no more than 100 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

    a. One dedicated RS 485 port for central-station] and remote station operation using point ID DACT.
    b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    c. One USB] and RS 232 port for PC configuration.
    d. One RS 232 port for VESDA HLI connection.
    e. One RS 232 port for voice evacuation interface.

F. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.
2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

G. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

H. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.

3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

I. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

    a. Elevator lobby detectors except the lobby detector on the designated floor.
    b. Smoke detector in elevator machine room.
    c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

J. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

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

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

M. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

    a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

N. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

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

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

1. Batteries: Sealed lead calcium.

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

2.5 PREACTION SYSTEM

A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a pre-action system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 MANUAL FIRE-ALARM BOXES

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

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit allowed by authorities having jurisdiction.
3. Station Reset: Key- or wrench-operated switch.

4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

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

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.8 PROJECTED BEAM SMOKE DETECTORS

A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.

B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.

C. An operator at fire-alarm control unit, having the designated access level, shall 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.).

2.9 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.

8. Test button simulates an alarm condition.

2.10 MULTICRITERIA DETECTORS

A. Mounting: Adapter plate for outlet box mounting.

B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

D. Test button tests all sensors in the detector.

E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present sensitivity selected.
4. Sensor range (normal, dirty, etc.).

F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
3. Heat sensor shall be as described in "Heat Detectors" Article.
4. Each sensor shall be separately listed according to requirements for its detector type.

2.11 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Non-system Smoke Detectors:

1. Non-system smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Non-system smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac
2. Auxiliary Relays: One Form C, rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
4. Visible Notification Appliance: 177-cd strobe.

5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.

    a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.

    a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.

4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.12 HEAT DETECTORS

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

1. Bosch Security Systems, Inc.
2. Faraday.
3. Fire-Lite Alarms, Inc.; a Honeywell International company.
4. Gamewell - FCI by Honeywell.
5. Gentex Corporation.
6. Notifier.
7. SimplexGrinnell LP.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.13 AIR-SAMPLING SMOKE DETECTOR

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

1. Ansul Incorporated; Tyco International.
2. Fenwal Protection Systems; A UTC Fire & Security Company.
3. Fike Corporation.
4. Notifier.

B. General Description:

1. Air-sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.
2. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.
3. The air being sampled shall pass through filters to remove dust particulates greater than 20 microns before entering the detection chamber.
4. Detectors shall have the capability via RS 485 to connect up to 100 detectors in a network.
5. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures, RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.
6. Pipe airflow balancing calculations shall be performed using approved calculation software.

C. Detector:

1. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed through the dual-stage filter and detector by the aspirator.
2. Obscuration Sensitivity Range: 0.005 - 6 percent obs/ft.
3. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.

    a. The four alarm thresholds may be used as follows:

        1) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.
        2) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.
        3) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.

4) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.

b. Final Detection System Settings: Approved by Architect.
c. Initial Detection Alarm Settings:

1) Alarm Level 1 (Alert): 0.08 percent obs/ft.
2) Alarm Level 2 (Action): 1.0 percent obs/ft.
3) Alarm Level 3 (Fire 1): 2.0 percent obs/ft.
4) Alarm Level 4 (Fire 2): 4.0 percent obs/ft.

4. Power Supply:

a. Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.
b. Battery backup shall provide 24 hours' standby, followed by 30 minutes at maximum connected load.

5. Detector shall also transmit the following faults:

a. Detector.
b. Airflow.
c. Filter.
d. System.
e. Zone.
f. Network.
g. Power.

6. Provide four in-line sample pipe inlets that shall contain a flow sensor for each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.
7. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet (200 m) in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.
8. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.
9. Provide software-programmable relays rated at 2 A at 30-V dc for alarm and fault conditions.
10. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.
11. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms. Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.

D. Displays:

1. Include display module within each detector.
2. Each display shall provide the following features at a minimum:

a. A bar-graph display.

b. Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to the four alarm thresholds of the indicated sector.
c. Alarm threshold indicators for Alert, Action, and Fire 1.
d. LED indication that the first alarm sector is established.
e. Detector fault and airflow fault indicators.
f. LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
g. Minor and urgent LED fault indicators.

E. Sampling Tubes:

1. Smooth bore with a nominal 1-inch (25-mm) OD and a 7/8-inch (21-mm) ID. Sampling pipe with between 5/8- and 1-inch (15- and 25-mm) ID can be used in specifically approved locations when recommended by manufacturer.
2. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics."
3. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.
4. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals according to NFPA 72.
5. Support pipes at not more than 60-inch (1520-mm) centers.
6. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

F. Sampling Holes:

1. Sampling holes of 5/64 inch (2 mm), or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.
2. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation systems.
3. Each sampling point shall be identified by an applied decal.

2.14 NOTIFICATION APPLIANCES

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

1. Gentex Corporation.
2. Siemens Industry, Inc.; Fire Safety Division.
3. SimplexGrinnell LP.
4. Wheelock; a brand of Eaton.

B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

F. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

   a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

G. Voice/Tone Notification Appliances:

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

H. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.15 Bi-Directional Antenna/Building Radio System

A. The contractor shall provide an in-building radiating cable system or internal antenna system in the Main Building Complex using an FCC approved Output Level Control (OLC) Type bi-directional antenna/UHF amplifiers manufactured by Radio Solutions, Inc. as needed to encompass the Local Fire Department radio frequencies.

B. The system shall be configured to maintain minimum radio signal strengths of -95 dBm uplink and -100dBm downlink available in 99% in critical areas (i.e. emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas) and 95% in all other areas of each floor of the building transmitted and received by the Local Fire Department's Communications Division.

C. Installation and location of roof-mounted or feed antenna shall be coordinated directly with the Local Fire Department and the Local Emergency Communications Division.

D. Provisions shall be made for extension of in building (radiating) coverage antennas to be provided as required for the tenant improvements.

E. The installation and testing of the system shall be in accordance with the Local Fire Department requirements. There shall be no connectivity between this radio amplification system and the fire alarm system.

F. The system shall be capable of operating on an independent battery/secondary power source for a period of at least 12 hours without external power input.

G. Each bi-directional amplifier shall be powered by its own twenty ampere circuit. Amplifier shall be installed in a 2-hour fire rated enclosure.

H. The cabinet shall be a NEMA 4 painted steel cabinet. The color will be red and bear the lettering as follows: "[Local F.D. Name in caps] FIRE DEPT. RADIO" in bright yellow lettering. The maintenance vendor and telephone number will be marked on the cabinet. The cabinet will have a locking mechanism to keep the unit(s) secure.

I. Each amplifier unit will have a monitoring system that monitors amplifier operation and primary power. A failure will activate a Xenon strobe light and associated audible device. The audible signal may be silenced but the strobe light must remain illuminated until the fault condition has been corrected. The strobe light will be located in a public space authorized by the Local Fire Department Communications Officer. A sign will be located at the strobe light with the name and telephone number of the equipment maintenance contractor. The Fire Department is to be notified of any failures that extend past the two hour time limit. The Fire Alarm contractor shall be responsible for furnishing, installing, and coordinating the above mentioned equipment.

J. System and Signal booster supervisory signals shall include Antenna Malfunction and Signal booster failure.

K. Power supply supervisory signals shall include loss of normal AC power, Failure of battery charger, and Low battery capacity (alarming at 70% of battery capacity).

L. A dedicated remote monitoring panel shall be provided within the fire command center to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:

1. Normal AC power
2. Signal booster trouble
3. Loss of normal AC power
4. Failure of battery charger
5. Low battery capacity

M. A donor antenna must maintain isolation from the distributed antenna system and shall be a minimum of 15db above the signal booster gain under all operating conditions.

N. Riser cables interconnecting individual floors and horizontal cable runs from head end equipment shall use either 2-hour rated cable assemblies, or installed within a 2-hour rated enclosure

2.16 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

A. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in Section 23 0993.11 "Sequence of Operations for HVAC DDC."
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.17 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.18 GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panels: Mounted in an aluminum frame with nonglare, minimum 3/16-inch- (4.76-mm-) thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Surface or Semiflush mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot (10-mm per meter) scale or larger. The layouts must use the actual room numbers not the Architectural floor plan room numbers. In addition, graphic representation must be created for head end system at Seven Locks Facility and graphics must be incorporated for both systems.

6. The LED representing a detector shall flash two times per second while detector is an alarm.

B. Graphic Annunciator Workstations: PC-based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, minimum 1TB hard drive, digital display monitor, with wireless keyboard and mouse.

2.19 REMOTE ANNUNCIATOR

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

1. Mounting: Flush cabinet, NEMA 250, Type 1.

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

2.20 ADDRESSABLE INTERFACE DEVICE

A. General:

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

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

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.21 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

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

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

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

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

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

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

2.22 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet for connection to building automation system.

2.23 SYSTEM PRINTER

A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.24 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

3.2 EQUIPMENT INSTALLATION

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

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

B. Equipment Mounting: Install fire-alarm control unit on finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

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

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."

D. Manual Fire-Alarm Boxes:

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

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m)].
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex Ain NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches ((910 mm)) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

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

H. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

J. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

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

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

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

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

3.3 PATHWAYS

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

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 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 08 7100 "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 a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

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

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

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

3.7 FIELD QUALITY CONTROL

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

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

C. Perform tests and inspections.

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

1. Visual Inspection: Conduct visual inspection prior to testing.

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

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

E. Fire alarm system shall be fully commissioned. Refer to specification section 019113.14 for further information.

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

G. Fire-alarm system will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

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

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

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service

organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

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

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

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 1000

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, removing site utilities, and abandoning site utilities in place.
7. Temporary erosion and sedimentation control.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 2000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

1. Comply with Maryland Department of the Environment (MDE) 2011 Standards for Soil Erosion and Sediment Control during construction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is also included in earthwork sections and in Section 02 4116 "Structure Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 4 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is not permitted.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 2000

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for foundation slabs, slabs-on-grade, walks, and pavements.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete pavements.
6. Subbase course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements: Related sections include, but are not limited to, the following:

1. Section 01 3202 "Photographic Documentation" for recording preexcavation and earth-moving progress.
2. Section 31 1000 "Site Clearing" for protection and removal of existing vegetation; stripping and stockpiling topsoil; removing above- and below-grade site improvements; disconnecting, capping or sealing, and removal of site utilities.
3. Section 31 2319 "Dewatering" for lowering and disposing of ground water during construction.
4. Section 31 5000 "Excavation Support, Underpinning, and Protection" for shoring, bracing, and sheet piling of excavations.
5. Section 33 4600 "Subdrainage" for drainage course installed as part of underslab subdrainage system.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

    a. Personnel and equipment needed to make progress and avoid delays.
    b. Coordination of Work with utility locator service.
    c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
    d. Extent of trenching by hand or with air spade.
    e. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Warning tapes.

B. LEED Submittals:

1. Product Certificates for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698 Standard Proctor.

C. Preexcavation Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service "Miss Utility" for area where Project is located before beginning earth-moving operations.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 01 5000 "Temporary Facilities and Controls" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Recycled Content of Subbase, Base, and Engineered Fill Materials: Subject to requirements, provide recycled concrete materials at fill locations outside the building footprint and at subbase and base courses below pedestrian paving.

C. Satisfactory Soils: Soil Classification Groups GW, GP, GM, GC, SW, SP, SC, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 4 inches in any dimension, debris, waste, frozen materials, organic material, vegetation, and other deleterious matter; and exhibiting Liquid Limit and Plasticity Index values of less than 45 and 20 respectively.

D. Unsatisfactory Soils: Soil Classification Groups CL, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, complying with satisfactory soils requirements and the following:

1. ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve, and not more than 75 percent passing a 3/4 inch sieve.
2. The following offsite borrow soils are acceptable as engineered fill:

a. Soils classified as ML or CL, and exhibiting Liquid Limit and Plasticity Index values of less than 45 and 20 respectively, and with a maximum dry density (ASTM D-698) or VTM-1 greater than 105 lb/cu. ft..

H. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

I. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; AASHTO Size 57.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

K. Sand: ASTM C 33/C 33M; fine aggregate.

L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

1. Provide temporary grading, dikes, or other means to facilitate control of surface water.

B. Protect subgrades and foundation soils from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. Promptly remove water that enters excavations, and repair damages to project site and adjacent facilities caused by water accumulation in excavations.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives, unless otherwise approved in writing by Owner.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials, replace with satisfactory soil materials.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Mat Slab Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

A. If Owner’s Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

B. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner's Geotechnical Engineer, and replace with compacted backfill or fill as directed.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation; or other method approved in writing by Architect and Owner's Geotechnical Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect and Owner's Geotechnical Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Below Grade Foundation Walls: Do not use backfill containing rocks greater than 4 inches or materials with more than 70 percent fines passing a No. 200 sieve. Compact to 95 percent of maximum dry density in accordance with ASTM D 698 Standard Proctor method.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Vehicular Roadways: Unless otherwise required on Drawings, provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 3000 "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under Walks and Pavements: Use satisfactory soil or engineered fill material. Place fill in loose lifts not greater than 8 inch, and compact to at least 95 percent of the maximum dry density as determined per VTM-1 method (ASTM D 698). Compact the final 12 inches of fill to 100 percent of the maximum dry density per VTM-1 method (ASTM D 698). Extend fill a minimum of 2 feet laterally beyond the curb line, plus an additional 1 foot for every foot above the subgrade. Comply with DDOT Road and Bridge Specifications.

a. Perform field density tests in accordance with ASTM D 6938 (nuclear method) or ASTM D 1556 (sand cone method) at frequency determined by Owner's Geotechnical Engineer.

2. Under Building Areas: Use engineered fill. Place fill in loose lifts not greater than 8 inch, and compact to at least 95 percent of the maximum dry density as determined per Standard Proctor (ASTM D 698); except where fill depth is in excess of 10 feet, compact to 98 percent of the maximum dry density per Standard Proctor (ASTM D 698). Extend fill a minimum of 5 feet laterally outside the building pad, plus an additional 1 foot for every foot above the subgrade.

a. Perform field density tests in accordance with ASTM D 6938 (nuclear method) or ASTM D 1556 (sand cone method) on each lift of compacted fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice. Remove frozen and frost-heaved soils prior to fill operations.

1. Do not install fill materials containing frozen materials.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in horizontal layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than 95 percent of the maximum dry unit weight according to ASTM D 698.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Walks and Paved Areas: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks in accordance with the "DC DOT Standard Specifications for Highways and Structures" and as follows:

1. Shape subbase course to required crown elevations and cross-slope grades.
2. Place subbase course 6 inches or less in compacted thickness in a single layer.
3. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course below slabs-on-grade in minimum thickness indicated on Drawings. Place on subgrades free of mud, frost, snow, or ice, and having a liquid limit and plasticity index values less than 45 and 20 respectively.

1. Where subgrades have a liquid limit or plasticity value greater than 45 or 20 respectively, undercut the slab subgrade at least 24 inches and replace with suitable, properly compacted engineered fill.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Permanent Underslab Subdrainage: Specified in Section 33 4600 "Subdrainage."

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency **(**Owner's Geotechnical Engineer) to perform special inspections, tests, and inspections, and to provide full time monitoring of the earth moving work.

B. Allow Owner's Geotechnical Engineer to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrades: Allow Owner's Geotechnical Engineer to inspect footing subgrades. Proceed with subsequent footing installation only after subgrades have been approved by Owner's Geotechnical Engineer.

D. Special Inspections: Testing and inspections as required by jurisdictional authorities.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 2319

DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes construction dewatering.

B. Related Requirements: Related sections include, but are not limited to, the following:

1. Section 01 3202 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 31 2000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, land surveyor, and professional engineer.

B. Field quality-control reports.

C. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work, with no less than 5 years of experience in successfully designing, installing, monitoring, and maintaining dewatering systems during construction similar to those required for this Project.

1.6 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. The geotechnical report is referenced elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, to reduce the groundwater pressure in soils to prevent instability of the excavated subgrade as a result of boiling and/or heaving. At a minimum, design the system to lower and maintain piezometric water levels to 48 inches below the lowest bottom of excavation level.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures. Ensure that no fine materials are being pumped from the surrounding overburdened soils
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

B. Groundwater Treatment Performance: Design, furnish, install, test, operate, monitor, and maintain groundwater treatment system capable of meeting WASA's current discharge limits and sustaining dewatering system's operational flow rates.

1. Obtain all necessary permits to discharge groundwater to Washington Area Sanitary Authority's (WASA) combined storm and sanitary sewer system.
2. Monitor and sample groundwater treatment system effluent in accordance with requirements of authorities having jurisdiction.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 01 5000 "Temporary Facilities and Controls," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing deep wells, well points, trenches, sumping, or similar methods, or a combination of methods; complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability. Do not permit pumping to remove fines or other soils from the surrounding overburdened soils.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of 60 inches below bottom of excavation, unless otherwise recommended by Owner’s Geotechnical Engineer.

C. Comply with requirements of authorities having jurisdiction for silt control of water removed by dewatering operations. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

E. Maintain uninterrupted dewatering in accordance with performance requirements.

1. Provide standby equipment on site, installed and available for immediate operation, to repair or replace installed equipment, if any part of system becomes inadequate, damaged, or fails.

2. Clean, repair and replace dewatering equipment as necessary to retain full functionality, including as necessary, dewatering degradation associated with iron oxide precipitation or iron bacteria.

F. Promptly restore structures, foundation soils, or adjacent facilities damaged by dewatering operations or by dewatering operations that do not comply with performance requirements.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide a minimum of two observation wells or piezometers. Take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect, Owner, and Owner’s Geotechnical Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION

SECTION 31 5000

EXCAVATION SUPPORT, UNDERPINNING, AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support, underpinning, and protection systems.

B. Related Information:

1. Document 00 3132 "Subsurface Soils Investigation Report" for geotechnical engineering report.

C. Related Requirements: Related sections include, but are not limited to, the following:

1. Section 01 3202 "Photographic Documentation" for recording preexisting conditions and excavation support, underpinning, and protection system progress.
2. Section 31 2000 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations and underpinning.
5. Review proposed equipment.
6. Review monitoring of excavation support, underpinning, and protection system.
7. Review coordination with dewatering.
8. Review coordination with waterproofing.
9. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support, underpinning, and protection system.

B. LEED Submittals:

1. Product Certificates for Credit MR c4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR c5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: For excavation support, underpinning, and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support, underpinning, and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support, underpinning, and protection, including sequence of construction of support and protection coordinated with progress of excavation.

D. Monitoring Program: Show arrangement, locations, and details of monitoring instrumentation.

1. Include a written instrumentation and monitoring statement, indicating instrumentation installation procedures, initial reading and baseline procedures, monitoring frequency, example weekly monitoring reports, limit and threshold values according to engineering design, contingency action to implement in case threshold or limit values are reached, decommission and abandonment procedures.
2. Manufacturers' product data, including instruction manual, warranty provisions, and factory calibration data of all instruments, targets, and other monitoring elements.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor and professional engineer.

B. Contractor Calculations: For excavation support, underpinning, and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support, underpinning, and protection systems. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

E. Monitoring Baseline Report: Provide instrumentation and monitoring baseline report. Submit before Work begins.

1. Include Calibration certificates for all instrumentation arriving on site at the time of delivery.
2. Include instrument installation logs.
3. Include post-installation acceptance tests to ensure that the system is functioning correctly.
4. Include raw initial data and graphical presentation of correlated and interpreted initial data.

F. Monitoring Weekly Report: Provide weekly paper reports containing the correlated and interpreted data from all instruments, including threshold and limits values for comparison and a written statement summarizing the results of the monitoring and any recommendations that may be necessary.

1.5 FIELD CONDITIONS

A. Geotechnical Information:

1. A geotechnical engineering report has been prepared for this Project and is available for information only as referenced in Document 003132 "Subsurface Soils Investigation Report".
2. Make additional test borings and conduct other exploratory operations necessary for excavation support, underpinning, and protection according to the performance requirements.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support, underpinning, and protection system capable of supporting excavation sidewalls and of resisting earth, and superimposed and construction loads.

1. Contractor Design: Design excavation support, underpinning, and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support, underpinning, and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Regional Materials: Provide steel and wood lagging products manufactured within 500 miles of Project site from materials that, to the greatest extent possible, have been extracted, harvested, or recovered within 500 miles of Project site.

C. Recycled Content of Steel Products: Provide steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 65 percent.

D. Structural Steel: ASTM A 36, ASTM A 690, or ASTM A 992.

E. Steel Piles: ASTM A 572.

F. Wood Lagging: Lumber, mixed hardwood, thickness according to engineered design, but not less than nominal rough thickness of 4 inches.

G. Tiebacks: Steel bars, ASTM A 722.

H. Tiebacks: Steel strand, ASTM A 416.

I. Welding Electrodes: Comply with E70 and AWS requirements.

J. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for pumpable application and a 30-minute working time.

1. Minimum compressive strength: Minimum 2,000 psi, prior to stressing tiebacks.

K. Water: Potable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate all utilities prior to drilling any tiebacks or installation of soldier piles. Contact Miss Utility prior to any site work. Coordinate with all utility companies and resolve all utility issues before starting work. Existing utilities that interfere with the excavation support system and associated excavation shall be abandoned or relocated as directed in contract documents prior to performing installation of soldier piles, tiebacks, or excavation.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support, underpinning, and protection system operations.

C. Install excavation support, underpinning, and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

D. Locate excavation support, underpinning, and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Fill voids behind lagging with soil, and compact.

1. Do not exceed two foot excavation lifts when installing lagging in soil, and four foot in rock. Reduce height of lifts as necessary based on conditions encountered during excavation.
2. Maintain a gap no greater than 2 inches between each vertically adjacent lagging for drainage between adjacent lagging sections. Do not place lagging boards in tight contact with adjacent lagging boards.

C. Install wales horizontally and secure to soldier piles.

3.3 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

1. The tieback installation technique shall be such that it is consistent with the geotechnical, logistical, environmental and load carrying conditions of the project. Select the drilling method and the grouting procedures used for the installation of the tieback.
2. All installation techniques shall be determined and scheduled such that there will be no interconnection or damage to tiebacks in which grout has not achieved final set.
3. Use drilling equipment and methods suitable for drilling through the conditions encountered at Project, with minimal disturbance to Project site or any overlying or adjacent structure or service.
4. Prior to placing grout and tendons, open borehole to the defined nominal diameter.

B. Test the load-carrying capacity of tiebacks in accordance with recommendations of professional engineer responsible for design of excavation support, underpinning, and protection system, and geotechnical engineer.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support, underpinning, and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 UNDERPINNING

A. Underpin walls, footings, columns and other items of existing work adjacent to or directly adjoining new work to be installed at levels lower than existing conditions.

B. Request permission to enter buildings directly adjacent to the areas of proposed underpinning. Verify the conditions of the existing adjacent buildings structure and footings to be underpinned. Determine wall and foundation loading of the adjacent building to be underpinned based on the existing building's structural drawings.

C. Upon approval by the Architect, Engineer and the authorities having jurisdiction, of the depth and material to which it is proposed to underpin, the length of the space shall be divided into an approved number of sections (no greater than six feet typically and no greater than three feet for rubble foundation walls) which shall be excavated and underpinned on an alternating sequence where sections closer than twelve feet apart shall not be excavated at the same time.

D. The space between the underpinning elements and the existing structure being underpinned shall be packed tight with dry-pack before any adjacent excavation for underpinning has been made.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified geotechnical engineering testing agency to perform the following special inspections:

1. Testing and inspections as required by the authorities having jurisdiction.
2. Excavation support, underpinning, and protection systems will be considered defective if they do not pass tests and inspections. Repair or replace work that is not in compliance with testing and inspections, and retest.

B. Monitoring: Read and maintain monitoring system daily during installation of excavation support, underpinning, and protection systems, excavation progress, and for as long as excavation remains open. Maintain, correlate, and interpret monitoring records and compare

with baseline records. Prepare weekly monitoring reports. Promptly notify Architect if threshold or limit values are reached, or if cracks, sags, or other damage is evident in adjacent construction. Implement contingency actions as needed.

C. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support, underpinning, and protection system remains stable.

D. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support, underpinning, and protection systems.

3.7 REMOVAL AND REPAIRS

A. Leave excavation support, underpinning, and protection systems permanently in place, unless otherwise indicated.

1. Remove top of excavation supports to conceal below grade. Coordinate with requirements in Section 07 1300 "Below-Grade Sheet Waterproofing" for coordination and protection of waterproofing components.

END OF SECTION

SECTION 32 1313

CONCRETE PAVING

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 Concrete Paving
   1. Walks.

B. Related Requirements:
   1. Division 31 Section "Earthwork" for subgrade preparation, grading, and subbase course.
   2. Division 3 Section "Cast-in-Place Concrete" for general building applications of concrete.
   3. District of Columbia Department of Transportation Standard Drawings (2015 or most current edition)
   4. MDOT Standard Specifications for Construction and Materials, current edition. See section 603 for sidewalk paving.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 LOCAL CODES AND STANDARDS

A. MDOT Standard Specifications for Construction and Materials, current edition

B. ANSI/ASTM.

C. American Concrete Institute (ACI).

1.5 ACTION SUBMITTALS

A. An MDOT approval stamp is needed to verify that product meets requirements for sidewalk paving

B. Product Data: For each type of product.

C. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

D. Material Certificates: Signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.
   1. Cementitious materials and aggregates.
   2. Joint fillers.

E. Quality control testing reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. It shall meet MDOT Standard Specifications for sidewalk paving

B. An MDOT approval stamp is needed and verification that the class of concrete matches the design.

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. In accordance with MDOT Standard Specifications.

2.4 CONCRETE MATERIALS

1. Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
1. Concrete materials shall comply with requirements for MDOT Standard Specifications

2.5 COLOR

1. Concrete shall be natural
2. Final Color to be reviewed and approved by landscape architect.

B. Water: Potable and complying with ASTM C 94/C 94M.

2.6 CURING MATERIALS

A. In accordance with MDOT Standard Specifications for sidewalk paving.

2.7 EXPANSION JOINTS

A. See drawings for expansion joint type.

B. Expansion and isolation joints which abut existing pavements, buildings, walls, curbs, utility structures shall meet MDOT Standard Specifications for sidewalk paving, AASHTO M 153, Type II (Cork) and ASTM D 1752.

1. Cork - Sample Supplier or approved equal: foamtastic, hohmann+barnard, inc., tel. 1-800-999-7816, http://www.h-b.com/
2. Backer rod - polyethelyne foam
3. Sealant - polyurethane or approved equal. Sample supplier: tremco or approved equal.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 30, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 Execution shall be per MDOT Standard Specifications for sidewalk paving.

3.2 ADDITIONAL EXECUTION REQUIREMENTS

A. EXAMINATION

1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

2. If concrete walks or similar lightly loaded paving does not require proof-rolling to the degree described in first paragraph below, revise requirements in paragraph to suit Project.

3. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   a. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   b. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 according to requirements in Section 312000 "Earth Moving."
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION
1. Remove loose material from compacted subbase surface immediately before placing concrete.

C. EDGE FORMS AND SCREED CONSTRUCTION
1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

D. STEEL REINFORCEMENT INSTALLATION
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
6. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
7. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

E. JOINTS
1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

2. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
3. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
    a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
    b. Provide tie bars at sides of paving strips where indicated.
    c. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
    d. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
    e. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
4. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
    a. Locate expansion joints at intervals of 50 feet unless otherwise indicated.

b. Extend joint fillers full width and depth of joint.
c. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

5. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
   a. See drawings for type.
      1) Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      2) Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
      3) Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

F. CONCRETE PLACEMENT

1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
8. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, and joint devices.
9. Screed paving surface with a straightedge and strike off.
10. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do

not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

11. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
12. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
13. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.3 FINISHING

A. Finish should be as per MDOT Standard Specifications for sidewalk paving and drawings.

B. FLOAT FINISHING

1. General: Do not add water to concrete surfaces during finishing operations.

2. Initial floating operation is included in "Concrete Placement" Article.

3. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.4 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, or curing compound as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.5 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.7 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 1400

UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Contractor to apply setting beds noted in the drawings.

1.2 SUMMARY

A. Section Includes:

1. Brick Paving
2. Stair Treads
3. Edge restraints

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 1313 – Concrete Sidewalk Paving
3. Section 32 9300 Planting Soils
4. MDOT Standard Specifications for Construction and Materials, current edition. See section 603 for sidewalk paving.

C. Referenced Standards

1. Publications listed herein are part of this specification to extent referenced.
2. MDOT Standard Specifications for Construction and Materials
3. American Society for Testing and Materials
4. American Society for Testing and Materials (ASTM):

a. ASTM A153: Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
b. ASTM A307 REV A-88: Carbon Steel Threaded Standard Fasteners.
c. ASTM C5: Quicklime for Structural Purposes.
d. ASTM C91: Masonry Cement.
e. ASTM C97: Absorption and Bulk Specific Gravity of Natural Building Stone.
f. ASTM C144: Aggregate for Masonry Mortar.
g. ASTM C150: Portland Cement.
h. ASTM C170: Compressive Strength of Natural Building Stone.
i. ASTM C207: Hydrated Lime for Masonry Purposes.

j. ASTM C217: Weather Resistance of Slate (for quartzite).
k. ASTM C241: Abrasion Resistance to Stone Subjected to Foot Traffic.
l. ASTM C295: Guide for Petrographic Examination of Aggregates for Concrete.
m. ASTM C880: Test Method for Flexural Strength of Dimensional Stone.
n. ASTM C503: Marble Building Stone.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data:

1. For the following products: Include data on physical properties required by referenced ASTM standards.

a. Pavers
b. Setting Bed Materials
c. Bituminous setting materials.
d. Mortar and grout materials, and sealant - . submit samples for each type and color
e. Edge restraints.
f. Concrete Base - It shall comply with MDOT Standard Specifications. A MDOT approval stamp is needed to verify that concrete meets all requirements.

C. LEED SUBMITTALS

1. Product Data and Certification Letter for Credit MR 4.1 and Credit MR 4.2: Indicate percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
2. Product Data for Credit MR 5.1 and Credit MR 5.2: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

D. Samples for Initial Selection for:

1. Paver - Each type of paver indicated on drawings.

a. Submit 2 samples of each paver in a size not less than 12 inches square by the specified thickness for each color, grade, and finish of pavers required; with specified finish on one face of each sample.
b. The samples, when reviewed and marked No Exceptions Taken, by the Landscape Architect will be considered the project control samples

c. Maintain and protect one full set of approved samples at the Owner's construction office throughout the period of the project.

2. Joint materials involving color selection.
3. Exposed edge restraints involving color selection.
4. Granite curbs

E. Shop Drawings: Show plans, sections, and details for stair treads. Indicate details of installation and adjacencies of other work.

1. At contractor's request, within 30 days of award of contract, Landscape Architect will provide electronic ACAD drawings for coordination, layout, and detailing of paving features. Electronic files are provided for contractor convenience in production of shop drawings. In using electronic files contractor will agree to stipulations of use as put forward by Landscape Architect at time of file transmittal.
2. Show dimensions and finishes of paving.
3. Include details of mortar joints, sealant joints and expansion joints.
4. Show locations and details of anchors.

F. Mock-ups:

1. Following approval of samples submitted and in accordance with final approved shop drawings, the Contractor shall construct a 10' x 10' sample panel for each paver and curb type. Build mock-ups to demonstrate aesthetic effects and set quality standards for materials and execution.
2. Construct mock-ups that accurately represent all materials, jointing, and any other elements of the finished assembly.
3. Include expansion joint.
4. Correct areas, modify method of application/installation, or adjust finish texture as directed by Architect to comply with specified requirements.
5. Approval of mock-ups does not constitute approval of deviations from the Contract Documents unless Architect specifically approves such deviations in writing.
6. Approved mock-ups may become part of the completed work if properly protected and undisturbed at time of Substantial Completion.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Source Limitations for Stone: Obtain each variety of stone required, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

C. Installer's Qualifications: In order to qualify for the work on this project, Trade Contractor must submit the following information for review and approval.
1. Installer must be experienced in application or installation of work and exterior unit paving similar in complexity to that required for this Project.
2. Installer must be acceptable to or licensed by manufacturer.

3. Not less than 5 years' experience with exterior unit paving.
4. Successfully completed not less than 4 projects, reasonably comparable in scale, and references from Owners or Architects of same.

D. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

E. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

F. Protection of Paving: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone paving when construction is not in progress.

1. Increase extent of cover in subparagraph below as needed to suit climatic conditions.

2. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

G. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of paving.

1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

1.8 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 PAVERS

A. See drawings for paver materials and types.

B. Brick Paving - See drawings for paver materials and types.

1. Suppliers:

   a. Endicott Clay Products Co., which is located at: 57120 707th Rd.; Endicott, NE 68350; Tel: 402-729-3315; Fax: 402-729-5804; Email:request info (endicott@endicott.com); Web:www.endicott.com

      1) Local Representative
      Potomac Valley Brick
      15810 Indianola Drive
      Suite 100
      Rockville, MD 20855
      Voice: 301-309-9600
      Fax: 301-309-0929

C. Precast Concrete Tread – see drawings

1. Recommended Suppliers
   Reading Rock
   https://readingrock.com/

2. ASTM C 629, Classification I Exterior, with a fine, even grain from clear, sound stock.

2.2 ACCESSORIES

A. Metal Edging for Pavers

1. Size: see drawings
2. Material: Steel
3. Finish- ~~Black Enamel Coating~~ Hot Dipped Galvanized and powder coated black.

   a. Galvanizing:

      1) Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, plates, bars, and strips indicated to be galvanized to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.
      2) Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
      3) Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

   b. Powder-Coat Finish (where indicated in drawings): Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

      1) Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
      2) Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.

3) Apply super-durable, thermosetting polyester or acrylic urethane powder coating meeting AAMA 2604 standards, formulated for exterior use, with cured-film thickness not less than 1.5 mils.
4) Color: Match Landscape Architect's sample.

4. Standards: Steel Plates, Shapes, and Bars- ASTM A 36.

B. EXPANSION JOINTS

1. See drawings for expansion joint type.
2. Expansion and isolation joints which abut existing pavements, buildings, walls, curbs, utility structures shall meet DDOT Standard Specifications for sidewalk paving, AASHTO M 153, Type II (Cork) and ASTM D 1752.

a. Cork - Sample Supplier or approved equal: Foamtastic, Hohmann+Barnard, Inc., tel. 1-800-999-7816, http://www.h-b.com/
b. Backer rod - polyethelyne foam
c. Sealant - polyurethane or approved equal. Sample supplier: Tremco or approved equal.

2.3 BASE MATERIALS

A. Soil Bases: It shall comply MDOT Standard Specifications.

B. Graded Aggregate Base for sidewalk pavers: Sound, crushed stone or gravel complying with MDOT Standard Specifications for Highways and Structures.

C. AASHTO #57 Stone as per MDOT Standard Specifications.

D. AASHTO #8 Stone as per MDOT Standard Specifications.

E. CONCRETE BASE FOR PAVING

1. It shall comply with MDOT Standard Specifications for sidewalk concrete. A MDOT approval stamp is needed to verify that concrete meets all requirements.

2.4 GEOTEXTILES

A. Filter Fabric: see Section 32 9100 Soils.

2.5 LIGHTWEIGHT AGGREGATE

A. Lightweight aggregate shall be Stalite graded Expanded Slate Lightweight Aggregate or accepted substitute.
1. Supplier or approved equal

Stalite Horticultural Aggregates
Salisbury, N.C.

(877) 737-6284
www.permatill.com.

2. ASTM C29 Unit Dry Weight loose (55 PCF)
3. ASTM C127 Specific Gravity to meet 1.58 to 1.67, SSD
4. ASTM C330: ASTM Gradation 3/8" - #8 size
5. Test for degradation loss using Los Angeles Abrasion testing in accordance with ASTM C131 modified method FM 1-T096. No more than 28% of weight of aggregate must be lost to degradation.
6. Expanded Slate: Contain no clay lumps or any organic impurities.

B. 3/4 "to #4 Stalite Rotary Kiln Expanded Aggregate:

Size mm (US Sieve)	Allowable Cumulative % Retained
1 inch	0
3/4 inch	0-10
3/8 inch	50 to 80
#4	90-100
#8	100

C. #10 (Tank B) Stalite Rotary Kiln Expanded Aggregate:

Size mm (US Sieve)	Allowable Cumulative % Passing
#4	7-11
#8	32-52
#16	65-72
#30	70-82
#50	78-88
#100	85-92

D. 3/8"-#8 Stalite Rotary Kiln Expanded Aggregate

Size mm (US Sieve)	Allowable Cumulative % Passing
1/2 inch	100
3/8 inch	80 to 100
#4	50 to 40
#8	0 to 20
#16	0 to 10

2.6 BITUMINOUS SETTING BED MIX

A. Products - Alternative #1

1. All materials and installation shall comply with the latest standards for Montgomery County Department of Transportation and Bethesda Streetscape Standards. Letter shall be provided noting Montgomery County Department of Transportation Standard approval.
2. Prime Coat

    a. Low Viscosity Liquid Asphalt

3. Bituminous Setting Bed

    a. Hot Mix Asphalt Superpave 4.75 mm for surface PG58-28 conforming to AASHTO designation M320
    b. Tack Coat

        1) 2% Neoprene Modified Asphalt Adhesive

    c. Joint Filler

        1) One part Portland Cement mixed with three parts sand

4. Neoprene Adhesive Coat

    a. 2% Neoprene Modified Asphalt Adhesive Primecoat

5. Joint filler

    a. Type: Portland Cement shall conform to ASTM C-150 and sand shall conform to ASTM C-33.
    b. Proportion: One part Portland Cement to three Parts sand.

~~A. Bituminous Setting Bed Mix, General: Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F.~~

~~B. Primer for Base: ASTM D 2028/D 2028M, cutback asphalt, grade as recommended by unit paver manufacturer.~~

~~C. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.~~

~~D. Asphalt Cement: ASTM D 3381/D 3381M, Viscosity Grade AC-10 or Grade AC-20.~~

~~E. Neoprene-Modified Asphalt Adhesive (use only where indicated on the drawings): Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.~~

~~F. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.~~

~~1. Provide sand of color needed to produce required joint color.~~

~~G. Asphalt cement to be used in the bituminous setting bed shall conform to ASTM Designation D-946-69A with a penetration at 77 degrees F. 100 G., 5 sec of minimum 85 millimeters and a maximum of 100 millimeters.~~

~~H.~~B. MORTAR SETTING BED

1. Mortar - General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

    a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
    b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
    c. Water shall be Potable.
    d. Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

2. Mortar: Portland Cement-Lime Mix.

    a. Type M mortars are mixed with 1 part Portland Cement, up to ¼ part lime, and 3 parts masonry sand. Water as required. It shall comply with ASTM C270

        1) Contractor to provide recommendations on mix to meet product, climate, and project needs.

    b. Standard Portland Cement shall meet the requirements of DDOT spec 2013 SECTION 801.01 Portland Cement and AASHTO M 85, Type I. Although ASTM C150 is similar, it cannot be used as a substitute standard.

        1) Provide natural color or white cement as required to produce mortar color indicated.
        2) Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

    c. Sand shall be masonry sand and shall comply with DDOT Specifications 2013 Section 803.06 and ASTM C144.
    d. Hydrated lime shall comply with ASTM C 207, Type S
    e. Masonry cement shall meet the requirements of ASTM C 91, Type M unless otherwise specified.
    f. Water: Potable.

2.7 ADDITIONAL SETTING BED MIXES

A. Setting beds listed in this section are not currently being used but are provided for reference purposes. See drawings for applicable setting bed types.

B. Sand Cement Setting Bed

1. Refer to DDOT 2013 Standard Specifications – Section 608.04

a. Bedding course shall consist of 1 part cement and 2 parts sand, by volume, mixed dry until the mass is of uniform color. Mixing may be done in an approved batch mixer or by hand on a clean, tight surface. Once thoroughly mixed, the mass shall be lightly moistened with water. Contractor to provide recommendations on mix to meet product, climate, and project needs.
b. Standard Portland Cement shall meet the requirements of DDOT spec 2013 SECTION 801.01 Portland Cement and AASHTO M 85, Type I. Although ASTM C150 is similar, it cannot be used as a substitute standard.
c. Sand shall be Concrete Sand: it shall comply with DDOT Specifications 2013 Section 803.06 and ASTM C33.
~~c. Sand shall be Concrete Sand: it shall comply with DDOT Specifications 2013 Section 803.06 and ASTM C144.~~
d. Water: Potable.

C. Mortar Setting Bed

1. Mortar - General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
c. Water shall be Potable.
d. Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

D. Mortar: Portland Cement-Lime Mix.

1. Type M mortars are mixed with 1 part Portland Cement, up to ¼ part lime, and 3 parts masonry sand. Water as required. It shall comply with ASTM C270

a. Contractor to provide recommendations on mix to meet product, climate, and project needs.

2. Standard Portland Cement shall meet the requirements of DDOT spec 2013 SECTION 801.01 Portland Cement and AASHTO M 85, Type I. Although ASTM C150 is similar, it cannot be used as a substitute standard.

    a. Provide natural color or white cement as required to produce mortar color indicated.
    b. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

3. Sand shall be masonry sand and shall comply with DDOT Specifications 2013 Section 803.06 and ASTM C144.
4. Hydrated lime shall comply with ASTM C 207, Type S
5. Masonry cement shall meet the requirements of ASTM C 91, Type M unless otherwise specified.
6. Water: Potable.

E. Latex- Mortar Setting Bed

1. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
2. Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
3. Install per manufacturer’s specifications
4. Supplier:
   Laticrete International, Inc.
   1 Laticrete Park North
   Bethany, CT 06524-3423 USA
   Tel. 203-393-0010
   1-800-4788
   www.laticrete.com
5. Laticrete System Materials
    a. LATICRETE® 254 Platinum - Install per manufacturer’s specifications
    b. Laticrete Permacolor Grout – color to match unit paver. Install per manufacturer’s specifications

F. Epoxy Setting

1. Product Option 1

    a. Manufacturer:
       Surebond, Inc.
       International Lane
       Madison, WI 53704
       Tel. 608-237-7554
       Fax. 608-237-7558

    b. Product: Paver Bond, SB10, quart containers (contractor grade).

2. Product Option 2: Approved Equal.

G. Drypack Mortar: Mortar setting bed consisting of one part ASTM C150, Type I/II Portland Cement and three to four parts sand (cement to sand ratio by volume of 1:3 to 1:4 adjusted for climate conditions at time of mixing.

1. Water: Potable.

H. Joint Grout: Comply with mixing requirements of referenced ANSI standards and manufacturer's written instructions.

1. Custom color to be approved by Landscape Architect.

I. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with liquid-latex additive at Project site.
3. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
4. Proportion and mix according to manufacturer's written instructions.

J. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.

1. Custom color to be approved by Landscape Architect.
2. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.

K. Standard Cement Grout: ANSI A118.6, sanded.

1. Custom color to be approved by Landscape Architect.
2. Packaged Grout:

a. Proportion and mix according to grout manufacturer's written instructions.

3. Job Mixed Grout

a. Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.
b. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
c. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.

L. High-Performance Cement Grout: ANSI A118.7, sanded.

1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
2. Polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.
3. Custom color to be approved by Landscape Architect.

M. Water-Cleanable Epoxy Grout:

1. ANSI 118.3, non-toxic, non-flammable, non-hazardous during storage, mixing, application and when cured and shall meet the following requirements:
2. Compressive strength: ANSI 118.3 – 3500 psi.
3. Shear bond strength: ANSI 118.3 – 1000 psi.
4. Water absorption: ANSI 118.3 <0.5%.
5. Cured epoxy grout to be chemically and stain resistant to ketchup, mustard, tea, coffee, milk, soda, beer, wine, bleach (5% solution), ammonia, juices, vegetable oil, brine, sugar, cosmetics, and blood, as well as chemically resistant to dilute acids and dilute alkalis.
6. Custom Color as selected by Landscape Architect.
7. SpectraLock Pro, by Laticrete International, Inc.
8. Epoxy grout for use at Display Panels as indicated per Drawings.

N. Joint Grout: Comply with mixing requirements of referenced ANSI standards and manufacturer's written instructions.

1. Custom color to be approved by Landscape Architect.

O. Latex Portland Cement Grout: Custom Color mix as selected by Landscape Architect to match stone paving. Comply with mixing requirements of referenced ANSI standards and manufacturer’s written instructions:

1. C-Cure Corporation.
2. Custom Building Products.
3. Laticrete International, Inc.
4. Mapei Corporation.
5. TEC Specialty Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase**] [**and**] [**base**] course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Where required, cut stone with motor-driven masonry saw equipment with diamond blades to provide clean, sharp, and unchipped edges. Hammer cutting of stone veneer is not acceptable.

C. Joint pattern: See Drawings for layout pattern.

D. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

E. Use full units without field cutting to greatest extent possible. Cut unit pavers with motor-driven masonry saw equipment with diamond blades to provide clean, sharp, unchipped edges. All cut lines to be straight and true. Cut units to provide pattern indicated and to fit adjoining work neatly. Hammer cutting is not acceptable.

1. For stone, cut lines straight and true with edges eased slightly to prevent chipping.

F. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

G. Pavers over Waterproofing and Over Structure:

1. Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
2. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
3. When over Structure, do not compact with vibratory equipment

H. Tolerances:

1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/16 inch in 10 feet from level, or indicated slope, for finished surface of paving.
2. Variation in Joint Width: Do not vary joint thickness more than twenty-five percent of nominal joint width.

I. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

J. Expansion and Control Joints: Provide joint filler at locations and of widths and type indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

K. Provide edge restraints as indicated. Install edge restraints before placing unit pavers as indicated.

1. Install edge restraints to comply with manufacturer's written instructions.
2. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
3. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
4. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

L. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.

1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 BITUMINOUS SETTING-BED APPLICATIONS

A. General

1. Supplier shall determine exact proportions of mixes to achieve the best mix to suit the materials, the site and the installation conditions.
2. All material should be stored and installed in accordance with the manufacturer’s recommendations.
3. When installing in Downtown Bethesda Central Business District or in Montgomery County, all installation shall comply with the latest standards for Montgomery County Department of Transportation and Bethesda Streetscape Standards.

B. Placing Base and subbase

1. Base and subbase materials should be placed per the design
2. Concrete base materials should be allowed to cure for a minimum of three days prior to paver installation and a minimum seven days prior to vehicular loads.

C. Placing Prime Coat

1. Prime Coat shall be used only when indicated on drawings.
2. Prime Coat should be installed when the ambient temperature is above 50 °F (10 °C) or per manufacturer's recommendations. The surface of the base material should be thoroughly clean and dry before application. The prime coat should not be applied if rain is likely before placing the setting bed. It should be thoroughly mixed and heated to the appropriate application temperature, taking all necessary safety precautions.
3. Apply Prime Coat to concrete slab immediately before placing setting bed. The installer should not apply more Prime Coat at any time than can be covered with the bituminous setting bed during the same day.
4. Prime Coat should be uniformly applied by spraying, brushing or squeegeeing to the top of the base and to all surfaces that will be in contact with bituminous setting bed. It should be applied to the base in a thin, continuous, uniform layer. Once applied, it should not be disturbed and should be allowed to cure before covering with the setting bed material.

D. Placing Bituminous Setting Bed

1. Setting bed material should be delivered to the job site in trucks with steel linings that are clean and have not been treated with materials (e.g., gasoline, kerosene, etc.) detrimental to the asphalt mix. To retain heat, the bituminous mixture should be covered prior to use. The temperature of the setting bed material at the time of delivery should not be less than 260 °F (127 °C) or more than 320 °F (160 °C). The installer should work quickly to spread and roll the material before it cools below 185 °F.
2. Prepare for setting-bed placement by locating 3/4-inch-deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated
3. As soon as this initial panel is completed advance the first bar to the next position in readiness for striking the next panel. Carefully fill any depressions that remain after removing the screed rails and wood chucks.
4. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary progresses to produce a firm even surface and to allow accurate setting of unit pavers to finished grades indicated.

E. Placing Neoprene Adhesive Coat

1. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of no more than 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

F. Placing Pavers

1. When Neoprene Adhesive Coat is dry to the touch, place pavers carefully by hand in indicated pattern, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels

as work progresses but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers.

2. If additional leveling of paving is required, the surface of the pavers may be rolled to fully compact the pavers into place. This should be undertaken with a light rubber-tired roller with sufficient pressure to achieve a full bond to the setting bed. The roller should not be used in a vibrating mode, as this may cause cracking of the pavers. Rolling should be undertaken at the warmest part of the day, but prior to final set of the adhesive. Care should be taken to ensure that the alignment is not altered.

G. Joint Filler and Pattern:

1. All joints shall be filled the same day as the blocks are laid. In no case shall a wearing course be left overnight or when work is stopped without the joint filling being completed. Filler shall not be applied if the blocks are wet or if the air conditions are such that the filler does not readily enter the joints.
2. Place unit pavers with hand-tight joints to a maximum of 1/8".

    a. Asphalt Block: Pavers should be laid with joints hand tight to a maximum of 1/16" wide.
    b. Concrete Unit Pavers: Pavers should be laid with a minimum joint width of 1/16" to a maximum 1/8". Care should always be taken to maintain this minimum joint spacing to minimize paver-to–paver contact.

3. Fill joints by sweeping Joint Filler over paved surface until joints are filled. Excess shall be removed.

    a. Install Polymeric Sand per manufacturer's specifications.
    b. Sand joint filler shall be swept dry.
    c. Sand-Cement Joint Filler

        1) Sweep a dry mixture of joint filler until joints are completely filled. Fog lightly with water. Pavers shall be cleaned of excess grout and joints finished prior to the grout setting up. All brick paving shall be kept moist for 4 days after filling the joints with grout. Cement stains that remain after the 4 day curing period shall be cleaned with a 10% solution of muriatic acid or mortar cleaner, or sweep with moist sand, followed by flushing clean with water. Care shall be taken to avoid the use of acid in areas where runoff could damage trees or other vegetation.

~~A. Apply primer to concrete slab or binder course immediately before placing setting bed.~~

~~B. Prepare for setting-bed placement by locating 3/4-inch-deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.~~

~~C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first~~

~~control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth control bars.~~

1. ~~Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.~~

~~D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.~~

1. ~~Neoprene-modified asphalt to be used only where called out in the drawings.~~

~~E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.~~

~~F. Joint Pattern: As indicated.~~

~~G. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.~~

3.5 MORTAR SETTING BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Where indicated on drawings, place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).

1. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

E. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

F. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

G. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to mortar bed or to back of each paver with a flat trowel.

H. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

I. Provide joint widths as indicated in the Drawings or approved shop drawings.

J. Retain three paragraphs below for grouted joints.

K. Grouted Joints: Grout paver joints complying with ANSI A108.10.

1. Grout joints as soon as possible after initial set of setting bed.
2. Force grout into joints, taking care not to smear grout on adjoining surfaces.
3. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
4. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
5. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
6. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.6 ADDITIONAL SETTING BED APPLICATIONS

A. Setting bed applications listed in this section are not currently being used but are provided for reference purposes. See drawings for applicable setting bed types.

B. Sand Cement Setting Bed Applications

1. Refer to DDOT Standard Specifications- Section 608.04 for installation.

C. Permeable Paving Applications

1. Refer to see Section 32 9113 Planting Soils
2. Refer to DDOT Green Infrastructure standards. See 2014 Version section 621.06

D. Epoxy Setting Bed Applications

1. Apply per manufacturer’s specifications.
2. Apply 4 beads of Paver Bond to back of paver.

E. Lightweight Aggregate Setting Bed over structure applications.

1. When over structure, do not compact with vibratory equipment.
2. Place and compact aggregate base to depth indicated.
3. Place setting bed to depth indicated taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
4. Set pavers with joint width as indicated.
5. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

3.7 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

D. Conform to waste management plan as specified in Section 01 5204, Construction Waste Management and Disposal.

END OF SECTION

SECTION 32 1713

PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete parking bumpers (wheel stops) in Garage.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of three factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.

2. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch diameter, 10-inch minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.

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

3.2 INSTALLATION

A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring.

C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION

SECTION 32 3300

SITE FURNISHINGS

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. Bike Racks
2. Trash + Recycling Receptacles
3. Slot Drain
4. Yard Drain Drain Cover
5. Trench Drain Cover
6. Sculptural Seating
~~6.~~7. Bench Seating

B. Related Requirements:
1. Division 01 – General Requirements
2. Section 03 3301 – Concrete Sidewalk Paving
3. Section 32 9113 Planting Soils
4. Section 32 9300 Unit Paving
5. MDOT Standard Specifications for Construction and Materials, current edition

1.3 QUALITY ASSURANCE

A. Manufacturer / Fabricator / Installer Qualifications:
1. In order to qualify for the work on this project, Trade Contractor must submit the following information for review and approval.
   a. Company specializing in design, fabrication, and installation.
   b. Able to document minimum 10 years experience for Project Manager, Shop Superintendent, and Lead Fabricator for fabrication and installation of type, scope and quality specified by this Section.
   c. Able to document capacity to apply finish systems of type specified by this Section.

1.4 ACTION SUBMITTALS

A. Submit in accordance with the requirements of Section 01 3300, Submittal Procedures and the following:
   1. Product Data: For each type of product.

   2. Shop Drawings: Provide shop drawings showing installation details and location dimensions for the following:
      a. Bike Racks showing installation in each type of application.
      b. Bollards - Installation in each type of application shall be shown.
      c. Trench Drain Drain Cover. Installation over drain body for all applications shall be shown.
      d. Yard Drain Drain Cover. Installation over drain body for all applications shall be shown.
      e. Slot Drain and Access Units - in addition to all drain details, the shop drawing shall show relationship to paving installed adjacent to and on the slot drain and access unit.
      f. Sculptural Seating - shop drawing shall show the location of the three support columns in the actual Sculptural Seat shipped to the site. This may differ from the product cut sheet. Support Columns for Sculptural Seat must align with location of support columns in the field. Contractor to coordinate.

B. LEED SUBMITTALS
   1. Product Data and Certification Letter for Credit MR 4.1 and Credit MR 4.2: Indicate percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
   2. Product Data for Credit MR 5.1 and Credit MR 5.2: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
   3. Parking Meter does not need a LEED submittal.

C. Samples: For each exposed product and for each color and texture specified.

D. Mock-ups:
   1. Build 10 ft. long section of slot drain with adjacent paving. Include 1 Access Unit as well. Mockups shall verify selections made under Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
   2. Construct mock-ups that accurately represent all materials, jointing, and any other elements of the finished assembly.
   3. Approved mock-ups may become part of the completed work if properly protected and undisturbed at time of Substantial Completion.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings 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. Number and Type to be determined by Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND PRODUCTS

A. Subject to compliance with requirements, products that may be incorporated into the Work include the following; colors to be selected by Landscape Architect.
   1. Bike Racks:
      a. Product: see drawings
      b. Supplier:
         Dero
         42 Northern Stacks Dr, Suite 100
         Minneapolis, MN 55421
         (888) 337-6729 : Toll Free
         (612) 359-0689 : Local
         (612) 331-2731 : Fax
         https://www.dero.com/contact/

   2. Trash & Recycling Cans:
      a. Product: See Drawings
      b. Supplier:
         Landscape Forms, Inc.
         7800 E. Michigan Ave.
         Kalamazoo, MI 49048
         USA
         800.430.6209 toll free
         269.381.0396 phone
         269.381.3455 fax
         specify@landscapeforms.comhttps://www.dero.com/contact/

   3. Yard Drain Drain Cover
      a. Product: See Drawings
      b. Supplier:
         Iron Age Designs
         2104 SW 152nd St. Suite #4
         Burien, WA 98166
         (877) 418-3568

(206) 276-0925
info@ironagegrates.com

4. Trench Drain Drain Cover
   a. Product: See Drawings
   b. Supplier:
      Iron Age Designs
      2104 SW 152nd St. Suite #4
      Burien, WA 98166
      (877) 418-3568
      (206) 276-0925
      info@ironagegrates.com

5. Slot Drain
   a. Product: See Drawings
   b. Supplier
      Aco Drain
      North East Sales Office
      9470 Pinecone Dr.
      Mentor, OH 44060
      Tel: (440) 639-7230
      Toll free: (800) 543-4764
      http://www.acodrain.us/contact-us.html
   c. See MEP Drawings

6. Sculptural Seating
   a. Product: See Drawings
   b. Supplier
      Landscape Forms, Inc.
      7800 E. Michigan Ave.
      Kalamazoo, MI 49048
      USA
      800.430.6209 toll free
      269.381.0396 phone
      269.381.3455 fax
      specify@landscapeforms.comhttps://www.dero.com/contact/

7. Bench
   a. Product: See Drawings
   b. Supplier
      Landscape Forms, Inc.
      7800 E. Michigan Ave.
      Kalamazoo, MI 49048
      USA
      800.430.6209 toll free
      269.381.0396 phone
      269.381.3455 fax
      specify@landscapeforms.comhttps://www.dero.com/contact/
   c.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211 (ASTM B 211M).
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Structural Pipe and Tube: ASTM B 429/B 429M.
4. Sheet and Plate: ASTM B 209 (ASTM B 209M).
5. Castings: ASTM B 26/B 26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
6. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
7. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
8. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.

C. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
3. Tubing: ASTM A 554.

D. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

E. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.

1. Polyethylene: Fabricated from virgin plastic HDPE resin.

F. Anchors, Fasteners, Fittings, and Hardware: Stainless steel or Manufacturer's standard, corrosion-resistant-coated or non-corrodible materials; quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site furnishings' assembly, mounting, and secure attachment:

1. Metal and fasteners shall be used that do not produce galvanic corrosion with adjoining materials.

2. Angle Anchors: For inconspicuously bolting legs of site furnishings to on-grade substrate; one per leg.

3. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit as required.

G. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.
1. Color: When visible, grout color to match adjacent paving color. Color to be approved by Architect prior to installation.

H. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.
1. Color: When visible, grout color to match adjacent paving color. Color to be approved by Architect prior to installation.

I. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.
2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.3 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.4 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.6 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

2.7 IRON FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.8 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: No 4.
3. Dull Satin Finish: No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout [or [anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION

SECTION 32 3913

MANUFACTURED METAL BOLLARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manufactured metal bollards.

B. Products furnished, but not installed, under this Section include anchor bolts to be cast into concrete.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts cast into concrete.

1.2 COORDINATION

A. Coordinate installation of anchor bolts in concrete with locations shown on template for bollard installation.

B. Coordinate locations of electrical conduit with location of manufactured metal bollards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Certificates for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Samples: For each exposed product and each finish specified.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 MANUFACTURED METAL BOLLARDS

A. Basis of Design: Subject to compliance with requirements, provide the following:

1. Gooseneck Stands (www.GooseneckStands.com); Model ADA-Stainless-Tower-48.

B. Bollard Construction:

1. Rectangular Tubing: Stainless steel Type 304.
2. Tube Wall Thickness: 0.120 inch (11 gauge).
3. Overall Height: 48 inches at back; 47 inches at front.
4. Overall Width: 6 inches.
5. Overall Depth: 4 inches.
6. Electrical Cutout: 2 inches by 3 inches for single gang electrical box near top of unit.
7. Access Panel: 6 inches by 10 inches access door at base of unit.
8. Installation Method: Bolted to cast-in anchor bolts.

2.3 FABRICATION

A. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

2.4 MATERIALS

A. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A240 or ASTM A666.
2. Tubing: ASTM A554.

B. Anchors, Fasteners, Fittings, and Hardware: Stainless steel exposed fasteners; galvanized steel concealed fasteners.

C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107; recommended in writing by manufacturer, for exterior applications.

D. Galvanizing: Where indicated for steel anchor bolts, provide the following protective zinc coating applied to components after fabrication:

1. Hot-Dip Galvanizing: According to ASTM A123, ASTM A153, or ASTM A924.

2.5 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.6 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: ASTM A480, No 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Install bollards level, plumb, true, and securely anchored with concealed fasteners at locations indicated on Drawings. Embed galvanized anchor bolts minimum 4 inches into concrete. Shim connections at anchor bolts to maintain plumb and level condition when installing unit on sloped surface. Seal around perimeter of the base of unit.

3.3 TESTING AND CLEANING

A. Clean manufactured metal bollards according to manufacturer’s recommendations. Restore marred, abraded surfaces to their original condition.

B. Demonstrate that electrical devices housed in the bollard function as intended.

END OF SECTION

SECTION 32 5001

MISCELLANEOUS METAL SITE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section Includes:

1. Bike Channel

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

1.2 COORDINATION

A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project Site in time for installation.

B. Where needed, coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Samples for Verfication: For each type of exposed finish.

C. Shop Drawings: Include plans, elevations, sections, and details of metal fabrications, connections, and installation details. Show anchorage and accessory items. Indicated layout, dimensions, materials, gauges, thicknesses, finishes, and all adjacencies.

1. Shop drawings shall be provided for the following items: Bike Channel.

1.4 MOCKUP

A. Furnish and install mockup fo the following:
   1. Bike channel - Typical section 4’-0” in length.

B. It shall show details of the following:
   1. Joinery and anchoring, including concealed welds.

C. Mock ups reviewed “No Exceptions Taken” may remain in place as part of finished installation provided

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates (if applicable): From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Manufacturer / Fabricator / Installer Qualifications: Submit resumes and qualifications for companies that can document the following:

   1. A firm experienced in producing metal systems similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units, metal design, fabrication, and installation.
   2. Able to document minimum 10 years experience for Project Manager, Shop Superintendent, and Lead Fabricator for fabrication and installation of custom commercial quality metal systems of type, scope and quality specified by this Section.
   3. Able to document capacity to apply metal finish systems of type specified by this Section.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

   1. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 LEED Submittals:

A. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

B. "Laboratory Test Reports for Credit IEQ 4" Subparagraph below applies to LEED for Schools.

C. Laboratory Test Reports for Credit IEQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services'

"Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Product Data for Credit MR 5.1 and Credit MR 5.2: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

A. Metal shall be as indicated in drawings and of type, grade, and class required for construction indicated and capable of withstanding design loads.

B. Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, or blemishes.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Use Metals indicated in drawings, shop drawings, and necessary for fabrication. They shall meet the following standards:

1. STAINLESS STEEL

a. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
b. Tubing: ASTM A 554, Grade MT 304.
c. Pipe: ASTM A 312/A 312M, Grade TP 304.
d. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.
e. Bars and Shapes: ASTM A 276, Type 304.

2.2 FASTENERS

A. General: Select fasteners for type, grade, and class required, suitable for construction indicated and capable of withstanding design loads.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Unless otherwise indicated, provide the following: Type 304 stainless-steel fasteners

D. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated.

E. Provide tamper-resistant flat-head pin-in-torx-style machine screws for exposed fasteners unless otherwise indicated.

2.3 STEEL FINISHES

A. Steel Finishes shall be as indicated in drawings and suitable for the design, the construction indicated, and site conditions

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

E. Provide exposed fasteners with finish matching appearance, including color and texture, of exposed metal piece unless otherwise noted.

F. Stainless Steel

1. Provide directional Satin Finish: no. 4 unless otherwise indicated.
2. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
3. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches.
4. Run grain of directional finishes with long dimension of each piece.
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

G. Other Metal finishes shall be as indicated and as per manufacturer’s specifications to meet project design conditions.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Nonshrink, Nonmetallic Grout (where indicated: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed and as indicated to secure metal systems to in-place construction and to support indicated loads.

B. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction

C. Set metal fabrications accurately in location, alignment, and elevation, measured from established lines and levels.

D. Shop Assembly: Fabricate metal fabrications in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

E. Complete field assembly of metal fabrications where required.

F. Perform cutting, drilling, and fitting required to install metal systems.

1. Cut, drill, and punch material cleanly and accurately. Remove sharp or rough areas on exposed surfaces. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.

G. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

2. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
3. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

H. Field Welding: Comply with AWS recommendations and the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

K. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

L. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated.

3.3 CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

3.4 PROTECTION

A. Protect finishes from damage during construction period with temporary protective coverings. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location. Remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 32 5001

SECTION 32 9100

SOILS

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. Preparation of all Soil Mixes:
   a. Imported Planting Soil
   b. 'Growth Media' for intensive green roof use.
   c. Amended Site Soil
2. Soil Amendments.
3. Soil Placement~~.~~
4. Minor Erosion Control Measures.
5. Filter Fabric
~~4.~~6. River Rock

B. Related Sections:

1. Division 1 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Division 7 Section "Green Roof Assemblies" for green roof system aspects such as waterproofing, drainage and root barrier.
3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
4. Division 32 Section "Plants" for plant procurement, installation, pruning, mulching, maintenance and warranty.

C. References and standards to be used:

1. ASTM: American Society of Testing Materials
2. USDA United States Department of Agriculture.
3. DDOT Green Infrastructure Standards and DDOT Standards latest edition.
4. American Association of Nurserymen, American Standards for Nursery Stock, (ANSI
5. Z60.1), latest edition, published by the American Association of Nurserymen, 1250 I
6. Street, N.W., Suite 500 Washington, D.C. 20005.
7. ASTM: American Society of Testing Materials.
8. ANSI: American National Standards Institute.
9. AOAC: Association of Official Agricultural Chemists.
10. USDA: United Stated Department of Agriculture.

11. LEED: Leadership in United States Green Building Council
12. ASTM E2400 – Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems
13. FLL (English Version) – Guidelines for Planning, Development and Maintenance of Green Roofs; Appendix – Determination of Apparent Density, Maximum Water Capacity, and Water permeability (Richtlinien für die Planung, Ausführung, und Pflege von Dachbegrunung, Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. – abbreviated as FLL)

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Green Roof: An area of planting/landscaping, built-up over a waterproof substrate at any level that is separated from the natural ground by a man-made structure.

D. Extensive Green Roof: Low to no maintenance green roof landscaping consisting of shallow soil depths (up to 8 inches) with plant varieties capable of withstanding harsh growing conditions (ie. drought, wind, frost).

E. Intensive Green Roof: Roof landscaping needing regular maintenance landscaping (ie. watering, fertilizing) consisting of deeper soil depths (> 8”) with a wider variety of plant species possibly including shrubs and trees.

F. Topsoil: The top six to ten inches of soil having higher organic matter content, higher biological activity, less compaction than the underlying subsoil and is better for the growth of plants. Topsoil should have sand, silt and clay contents within the following ranges: Sand 40 - 65%, Silt 25 - 60% and Clay 5 - 20%. Topsoil may be salvaged and stockpiled from on-site, manufactured or imported from off-site.

G. Manufactured Topsoil: Soil produced by homogeneously blending mineral soils and sand with stabilized organic soil amendments to produce topsoil.

H. Planting Area: Areas to be planted.

I. Planting Soil: Topsoil mixed with soil amendments for use in on grade areas.

J. Intensive Growth Media: Lightweight soil mix used in on structure applications to support diverse mix of complex plants in depths up to 3-4 feet.

K. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

L. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

A. Manufacturer's Product Data: Provide twelve weeks before installation of soil/media. For each type of product indicated.

1. Fertilizer(s).
2. Limestone.
3. Soil Acidifier.
4. Coarse Sand.
5. Expanded Slate.
6. PermaTill.
7. Compost and/or Pine Bark Fines (include pH).

B. LEED Submittals:

~~1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.~~

~~2.~~1. Recycled Content: Provide letter from the manufacturer indicating percentages of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product provided under this section.

~~3.~~2. Regional Materials: Provide letter from the manufacturer indicating the location of manufacture, extraction and harvest of all materials provided under this section. Include statement indication cost for each product provided under this section. To the greatest extent possible all materials shall be extracted, harvested and manufactured regionally within a radius of 500 miles of the project site.

~~4.~~1. ~~Provide letter from manufacturer indicating the location of manufacture, extraction and harvest of all materials provided under this section. Include statement indicating costs for each product provided under this section. To the greatest extent possible all materials shall be extracted, harvested and manufactured regionally within a radius of 500 miles of the project site.~~

C. Samples for Verification: Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the contractor. Delivered materials shall closely match the samples. Provide twelve weeks before installation of soil/media for each of the following in labeled bags:

1. 1 liter of each source of topsoil (salvaged, imported, manufactured) to be used.
2. 1 liter of each Soil Mix
3. 1 liter of each organic material (compost and/or pine bark fines).
4. 1 liter of coarse sand.
5. 1 liter of expanded slate.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

1.5 SOIL TEST REPORTS

A. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Soil Components Testing Agent or approved equal:
Waypoint Analytical, Inc.,
7621 Whitepine Road
Richmond, VA 23237
Tel. (804) 743-9401
Fax (804) 271-6446
www.waypointanalytical.com

~~A & L Eastern Agricultural Laboratories, Inc., 7621 Whitepine Road, Richmond, VA 23237. Tel. (804) 743-9401~~
~~Fax (804) 271-6446~~

2. Compost Testing Agent shall be STA Certified testing laboratory by the US Composting Council, www.compostcouncil.org. Recommended facility:
Woods End Research Laboratory 290 Belgrade Road
Mt Vernon ME 04352
Phone: 207-293-2457
Fax: 207-293-2488 www.woodsend.org

B. Provide test reports from qualified independent testing agency for all materials listed below:

1. Provide separate, clearly labeled, tests for each material and/or each source of materials if more than one for the same material.
2. Testing agency shall clearly indicate compliance, or lack thereof, with requirements of this specification.
3. Recommendations for amendments if applicable.
4. Material requiring test reports:
   a. Imported Planting Soil at grade.
   b. 'Growth Media' for intensive green roof use.
   c. Amended Site Soil

C. Testing for Toposoil, Planting Soil, and Growth Media – Intensive
1. Testing of individual base components is required prior to soil blending.
~~Testing of individual base components is required prior to soil blending.~~

After components have been tested, creating soil mix and perform tests described in the specification.

2. After soil mix test have been accepted, test every 200 cubic yards of soil mix for organic matter content, gradation, and pH.
3. When soil has been placed, compaction and infiltration tests shall be preformed as described in this section.

D. Existing Site Soil Sampling and Testing

1. One composite soil sample shall be submitted for every 5,000-sq. ft. (465 sq. m) of planting area or in locations indicated on drawings. Each composite soil sample submitted for analysis shall be taken from no less than 6 samples at random from each sampling area. ~~Each sample shall be extracted from a 6"-7" (45cm) deep core. Discard organic duff on top soil.~~ The samples shall be mixed together to form a composite sample from which a pint sample shall be extracted, air-dried, and submitted for testing.
   a. Existing Top Soil Sampling: Each sample shall be extracted from a 6"-8" (45cm) deep core. Discard organic duff on top soil.
   b. Existing Subgrade Soil Sampling: Subgrade soil sample shall be taken where indicated. Subgrade samples shall be kept and labelled separately from Existing Top Soil samples. Soil horizon profiles shall be delineated.
   ~~a.~~c. Contractor to review testing procedure with Landscape Architect.

2. Existing Site Soil testing results shall have numbers corresponding to test location numbers indicated on plan.

3. Recommendations for amendments shall be provided by testing agency.

~~2.~~4. Results of the soil tests shall be sent to Landscape Architect for recommendations of amendments and approval. It will be the responsibility of the Contractor to implement the recommendations made by the Landscape Architect

~~For soil testing of subgrade conditions in existing hardscape area, soil sample shall be obtained below subgrade base material. If there are layers of fill, these layers should be tested along with subgrade. This could be 2 to 3 ft below finished grade. Contractor to review testing procedure with Landscape Architect.~~

E. Soil Analysis:
1. Furnish analysis by a qualified soil-testing laboratory:
2. Testing for Growth Media shall include all those listed in this specification and by the designated manufacturer.

3. Chemical Analysis:

   a. Percentages organic content by dry weight
   b. pH and buffer pH
   c. Nutrient levels in parts per million including Nitrogen, Phosphorous, Potassium, Magnesium, Manganese, Iron, Zinc, Calcium, Boron, Copper.
   d. Cation exchange capacity CEC

e. Soluble salt by electric conductivity of a 1:2 soil water sample measured in Miliohm per cm.
f. Nutrient test shall include the testing laboratory recommendations for supplemental additions to soil mixes.

4. Texture Analysis: Particle size analysis by hydrometer (%sand, silt, clay)

5. Particle Size Analysis including the gradient of mineral content: (when indicated):

USDA Designation	Size (mm)
Gravel	+ 2 mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5-1 mm
Medium Sand	0.25-0.5 mm
Fine Sand	0.1-0.25 mm
Very Fine Sand	0.05-0.1 mm
Silt	0.002-0.05 mm
Clay	- 0.002 mm

6. Growing Media Weight Analysis:
   a. Testing for Growth Media shall include all those listed in this specification and by the designated manufacturer.
   b. Submit certified testing results for weight of one (1) cubic foot of growth media when saturated with water and compacted to 85% (proctor). Laboratory Density Testing: ASTM Designation: E 2399 – 05, Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems.
   c. Provide minimum two tests for each batch of growth media used.
   d. Saturated Hydraulic Conductivity:
      1) Test procedure ASTM D5856-95 (2000).
      2) Hydraulic Conductivity tests shall be performed on samples during QA/QC testing at the Soil Supplier's facility.

7. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
8. Report suitability of tested soil for plant growth.

   a. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

F. Infiltration Test Reports
   1. Locations of Infiltration Tests are indicated on plan. Test results shall have numbers corresponding to test location numbers indicated on plan.
   ~~9.~~2. In Field testing shall comply with DDOE Stormwater Guidebook (Appendix O in 2013 edition)

1.6 QUALITY ASSURANCE

A. Contractor is solely responsible for quality assurance of work.

B. Installer Qualifications: The installer shall be a firm with at least 5 years of successful experience in work similar in material, design and extent to that indicated for this Project and with a record of successful landscape establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

C. The Contractor shall comply with all applicable requirements of the laws, codes, ordinances and regulations of federal, state and municipal authorities having jurisdiction.

D. The contractor shall coordinate compatibility of all materials specified for use with on structure planting in this section with those specified by the architect for the same use.

E. The contractor shall comply with all requirements for control of silt and sediment during soil installation work as indicated in the contract documents.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination” with landscape architect, general contractor, all subcontractors, and owner’s representative attending. This conference can occur simultaneously with the “Plants” conference.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect materials from damage or deterioration during delivery and while stored at the site.

B. Weather: Do not mix, deliver or place any of the Soil Mixes in frozen, wet, or muddy conditions.

C. Protect Topsoil and Soil Mix stockpiles from rain and washing that can separate fines and coarse material. Cover stockpiles with plastic sheeting at the end of each work day.

D. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

E. Bulk Materials:

1. Do not dump or store bulk materials on existing turf or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

1.8 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned. Notification of Miss Utility, 1-800-257-

7777 is required for all planting around utilities. The contractor is responsible for knowing the location and avoiding utilities that are not covered by Miss Utility.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Weather Limitations: Proceed with soil preparation and installation only when existing and forecasted weather conditions permit work to be performed when beneficial and optimum results may be obtained.

1.9 COORDINATION

A. General: Prior to the start of Work, prepare a detailed schedule of the work for coordination with the other trades.

B. Schedule the installation of Soil Mixes only after work area is no longer required for use by other trades and work.

C. Schedule all utility installations prior to beginning work in this section.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. For use in mixing of Green Roof Media Alt. #2

~~A.~~B. Topsoil shall be fertile, friable, sandy clay loam soil that meets ASTM D 5268 and has a pH range of 5.5 to 7 and 1-5 percent organic material content.

~~B.~~C. Topsoil shall be free of stones larger than 1 inch in any dimension and other deleterious materials harmful to plant growth such as roots, sod, refuse, subsoil, heavy or stiff clay, sticks, brush or noxious seeds.

~~C.~~D. Topsoil shall be salvaged, imported or manufactured from off-site sources. Screen salvaged topsoil if necessary to removed stones, roots, vegetation or other deleterious materials. Imported topsoil shall be obtained from displaced topsoil from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.2 COARSE SAND

A. Coarse concrete sand, ASTM C-33 Fine Aggregate, with Fines Modules Index of 2.8 and 3.2.

1. Sands shall be clean, sharp, natural quartzite sands free of limestone, shale and slate particles. Sand pH shall be between 5.5 and 7.0.
2. Provide the following particle size distribution:

Sieve Size:	Percent Passing
3/8" (9.5mm)	100
No 4 (4.75mm)	95-100

No 8 (2.36mm)	80-100
No 16(1.18mm)	50-85
No30 (.60mm)	25-60
No50 (.30mm)	10-30
No100 (.15mm)	2-10

2.3 ORGANIC SOIL AMENDMENTS

A. COMPOST:

1. Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of leaf and yard waste composted for a minimum of one year (12 months). Compost shall not be derived from biosolids or industrial residuals. The leaf and yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf and yard waste compost shall be free of stones larger than 1/2", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.
2. The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.
3. Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (latest version). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by a DDOT approved lab.
4. Pathogens/Metals/Vector Attraction reduction for compost material derived from biosolids shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, (for applications to soils with human activity).
5. Organic Content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 3/8-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve.
6. pH: The pH shall be between 6.5 to 7.4 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis.
7. Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).
8. The compost shall be screened to 1/2 inch maximum particle size and shall contain no more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.
9. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH.

B. Compost shall meet the requirements of the US Composting Council “Landscape Architecture/Design Specifications for Compost Use”, section “Compost as a Landscape Backfill Mix Component”,

C. The Soil Supplier's Soil Scientist shall provide a recommendation as to the suitability of the compost based on review of the test results.

~~1. Compost shall meet the requirements of the US Composting Council "Landscape Architecture/Design Specifications for Compost Use", section "Compost as a Landscape Backfill Mix Component", with the following additional requirements:~~

~~2.~~1. ~~Compost shall be well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:~~

~~a. Compost feedstock shall be yard waste trimmings and/or source-separated municipal solid waste to produce a fungi-dominated compost. Compost shall not be derived from biosolids or industrial residuals.~~

~~b.~~a. ~~Organic Matter Content: 50 to 60 percent of dry weight.~~

~~c.~~a. ~~Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (version 4.0). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by Woods End Research Laboratory, Mt. Vernon, Maine.~~

~~B.~~D. PINE BARK FINES

1. Pine bark fines shall be horticultural grade milled Loblolly Pine bark size 0.1mm – 15.0 mm. Pine bark shall be aged at least nine months and shall be screened. pH shall range between 4 and 5.0.

2.4 EXPANDED SLATE

A. #8 Stalite PermaTill Rotary Kiln Expanded Slate to meet the following requirements:

1. ASTM C29 Unit Dry Weight loose (48 lb./cf to 55 lb./cf
2. ASTM C127 Specific Gravity: 1.45 to 1.60,SSD
3. ASTM C330: ASTM Gradation 3/8"- #8 size

Sieve Size:	%Passing
1/2"	100
3/8"	80-100
#4	5–40
#8	0–20
#16	0–10

4. Absorption (ASTM C127): No more than 12
5. The expanded slate must contain no clay lumps or any organic impurities.

2.5 GROWTH MEDIA – INTENSIVE – ALT #1

A. Lawn Growth Media
1. Hydrotech LifeTop Lawn Blend
2. For locations see drawings

B. Shrub / Perennial Growth Media
   1. Hydrotech LifeTop Intensive Blend –
   2. For locations see drawings

C. Supplier:
   American Hydrotech, Inc.
   303 E. Ohio St., Chicago, IL 60611
   Phone: 800-877-6125
   https://www.hydrotechusa.com/

2.6 GROWTH MEDIA – INTENSIVE – ALT #2

A. For intensive green roof planting provide an unconsolidated mixture of light weight mineral aggregates and organic compounds composed specifically for use in green roof application for project location and for reasonably anticipated weather conditions such as rainfall and wind uplift. Provide one of the following:

   1. A manufactured intensive green roof growth media designed to support vigorous plant growth of trees, shrubs and diverse perennials that is approved in advance by the Landscape Architect.
   2. The saturated unit weight of the soil mix shall be not more than **100 pounds per cubic foot** when tested according to ASTM Designation: E 2399 – 05, Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems.
   3. A mix using the four components listed below that meet or exceed the German FLL Guidelines:

      – 45%* 3/8” Expanded Slate
      – 30%* Amended Topsoil
      – 15% Coarse Sand
      – 10% Pine Bark Fines

      *Adjust mix ratio such that the maximum saturated weight of the mix is not exceeded

      a. Topsoil, Sand and Pine Bark Fines blending
         1) Mechanically mix 6 parts topsoil, 3 parts sand and 2 parts pine bark fines to provide a uniform distribution.
         2) Inadequate Moisture Content: Do not work planting medium when moisture content is so low that dust will form in the air. Wet planting medium as necessary to achieve optimum blending.
         3) High Moisture Content: Do not work planting medium when the moisture content is high enough that excessive compaction will occur. Aerate planting medium until moisture content is uniformly reduced as necessary to achieve optimum compaction.
      b. Final blending with Expanded Slate
         1) Saturate the Expanded Slate with water to ensure proper soil distribution.
         2) Mechanically mix 6 parts of the soil/sand/pine bark fines blend with 5 parts of the wetted expanded slate until a uniform distribution of the components is achieved.
         3) When stockpiling the finished mix, cover the pile with a plastic tarp after each workday to prevent drying out or soil separation from rain and wind

4) To reduce pH, add 0.25 lb. of elemental sulfur per cubic yard of soil mix to lower pH 0.5 to 1.0 unit

2.7 AMMENDED SITE SOIL

A. ~~Ammendments~~Amendments for existing site soil will be based on soil tests as performed by contractor and recommendations by landscape architect.

~~A.~~

2.8 FILTER FABRIC

A. Filter Fabric in ~~Streetscape Planter~~at grade planting
   1. It shall comply with DDOT Green Infrastructure Standards Section 621.02
   2. Products:
      a. Tencate Mirafi 140N
   3. Supplier
      a. TenCate Geosynthetics Americas Corporate Headquarters
         365 South Holland Drive
         Pendergrass, Georgia 30567
         Tel: 706-693-2226
         Fax: 706-693-4400
         Email: spec@tencate.com

B. Filter Fabric in Planter over structure
   1. Use filter fabric specified in roofing system. Material to be approved by architect and landscape architect.
   2. Non-woven polyester or polypropylene fibers resistant to soil chemicals, acids and alkali with a pH range of 3 to 12. Filter fabric shall be resistant to ultra-violet degradation
   3. Filter fabric shall be pervious and shall not contain a root barrier

2.9 EROSION-CONTROL MATERIALS

A. Provide erosion control materials specifically manufactured to be used to control erosion. Material shall be biodegradable such as twisted jute, spun-coir mesh or wood fiber mat that meet all federal, state and local erosion control requirements. All components of mat shall be biodegradable; no plastic materials of any kind shall be used. Install per manufacturer's or site E&SC Plan requirements.

2.10 ADDITIONAL SOIL PRODUCTS

A. The following are additional soil elements that may be required as per instruction of Landscape Architect during construction or as result of soil test recommendations. This is not an exhaustive list and other products may be recommended.

B. CHEMICAL AMENDMENTS

1. Chemical materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the season in which the products are to be used. Apply additives in amounts recommended in soil reports from a qualified soil testing agency. Submit manufacturer's product literature for each product used.

    a. Fertilizer for planting shall be an organic fertilizer such as Plant Tone by Espoma Company (856) 825-0542, organic bone meal or approved equal. Fertilizer selections shall be based on the recommendations of the soil tests. Specialty fertilizers and additives noted below shall be used where required by the specifications prior to the use of any additional fertilizer.
    b. Fertilizer for acid loving plants shall be Holly Tone Fertilizer by Espoma Company (856) 825-0542, or approved equal.
    c. Soil Acidifier for reducing the pH of soil where fertilizer is not required shall be Espoma Soil Acidifier by Espoma Company (856) 825-0542 or approved equal.
    d. To increase soil pH use a high quality agricultural ground limestone product with a calcium carbonate equivalent (CCE) of 100. Limestone selections shall be based on the recommendations of the soil test.
    e. Drainage aid: Drainage aid shall be soil amendment grade PermaTill by Stalite or approved equal. Follow manufacturer's recommendations for use.

2.11 RIVER ROCK

A. Product Information
    1. Product: See Drawings
    2. Supplier:
        Carderock
        8200 Seven Locks Road
        Bethesda, MD 20817
        301-365-2100
    3. Size: see drawings
    4. Color: see drawings

2.12 IMPORTED PLANTING SOIL

A. Imported Planting Soil recommendations will be determined by Landscape Architect following testing of existing site soil. See drawings.

B. Characteristics
    1. Texture shall be fertile, friable, sandy clay loam. However, as per detail, a different soil texture may be selected following analysis of subgrade soil.
    2. pH range shall be 5.8 to 7.0
    3. Organic content shall be 3-5% percent by weight. Percentage of organic content in installed Planting soil will vary depending on depth. See details.
    4. Additional requirements will be determined following testing of existing soil.

C. Imported Planting Soil shall be fertile, friable, sandy clay loam soil that meets ASTM D 5268 and has a pH range of 5.5 to 7 and 1-5 percent organic material content. See drawings for additional information. Additional requirements will be determined following testing of existing soil.

D. Imported Planting Soil shall be free of stones larger than 1 inch in any dimension and other deleterious materials harmful to plant growth such as roots, sod, refuse, subsoil, heavy or stiff clay, sticks, brush or noxious seeds.

E. Imported Planting Soil shall be salvaged, imported or manufactured from off-site sources. Screen salvaged topsoil if necessary to removed stones, roots, vegetation or other deleterious materials. Imported topsoil shall be obtained from displaced topsoil from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

F. Planting Soil shall not be delivered or used for planting while in a frozen or muddy condition

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine grading, verify all elevations and notify the Landscape Architect of any discrepancies before beginning work.

B. Examine soil and or roof conditions for areas to receive soil mixes for any circumstance that might be detrimental to plant growth. Verify that no foreign or deleterious material or liquid such as paint, concrete, oils, gasoline, paint thinner, etc have been deposited or spilled in planting area.

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

D. Do not proceed with installation of soil mixes until all utility work in the area has been completed.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, lawns and existing plants from damage caused by operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 SEQUENCE

A. Install subsurface drain lines as indicated prior to installation of all soil material.

3.4 DRAINAGE

A. Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

1. Fill excavations with water twice in succession and allow water to percolate out before planting. Notify the Landscape Architect if the time it takes for pit or bed to drain is slow or if pit does not drain.

2. Hardpan or Construction Activity Compacted Soils: In areas where hardpan is discovered or soils have been compacted during construction activity auger a 2-foot grid of 6-inch-diameter holes, minimum 2 per pit, into free-draining strata or to a depth of five (5) feet, whichever is less, and backfill with pine fines. Locate all utilities prior to beginning auguring.

3.5 GROWTH MEDIA OVER STRUCTURE INSTALLATION

A. It shall comply with suppliers recommendations

B. Growth Media over structure shall be installed only at the depth specified.

C. Growth media shall be dispensed in a manner that will not suddenly increase load to structure below. It shall be immediately spread to specified thickness. Coordinate with general contractor, structural engineer, architect, and landscape architect in locating loading extent and location to prevent overloading of structural members.

D. Isolate green roof areas from perimeter.

E. Evenly spread growth media in 6” lifts over drain board layer. Roll media between lifts to prevent excessive settling. Do not exceed 85% compaction in any location. Do not exceed thickness or elevations indicated.
1. Do not compact with vibratory equipment

F. Growth media shall not moved or worked when wet or frozen.

G. After last lift is installed grade media to produce a smooth, uniform surface plane. Slope media to drains as indicated. All finish grades of planted areas shall be set 2 inches below abutting pavements or walls unless otherwise indicated.

H. Uniformly moisten excessively dry media or media that is too dusty.

I. Cover media with plastic sheeting if planting and mulching will not commence in 24 hours to prevent media drying out and wind displacement/contamination of surround structure.

~~I.~~J. All soil depths are to be as measured after initial compaction and 12 months settlement. Soil that settles below the design grade after 12 months shall be regraded by removing the mulch, plants or sod and adding additional soil. If the soil settles greater than 3” below the design grade, remove all shrubs and other plants prior to regrading. All regrading work shall be at the landscape contractor’s expense.

3.6 ON GRADE PLANTING BED ESTABLISHMENT

A. Hardpan or construction activity compacted soils: In areas where hardpan is discovered or soils have been compacted during construction activity use one of the following methods to break up compaction. Do not perform in critical root zones of existing trees. Locate all utilities prior to beginning work:

1. Rip soil in crisscross pattern to depth of 20 inches using a solid shank ripper with shank spacing no greater than 3'-0" on center.
2. In areas with limited access or where utilities make ripping difficult auger a 2-foot grid of 6-inch-diameter holes into free-draining strata or to a depth of six 6 feet, whichever is less, and backfill with free-draining material.

B. Excavate all on grade planting bed areas to a depth of 12". Planting Beds include all on grade areas scheduled to receive trees, shrubs, perennials and/or annuals. Do not excavate planting bed areas located with the "Tree Protection Zone". Within the "Tree Protection Zone", install plants in a manner that minimizes impact to existing tree roots.

C. Loosen subgrade of planting beds to an additional minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off property.

D. Fill excavated planting bed with Planting Soil Mix to meet finish grades after natural settlement as follows:

1. Spread approximately 6 inches specified soil over loosened subgrade. Mix thoroughly into loosened 4 inches of subgrade. Lightly roll first lift. Spread and roll second lift of specified soil as needed to meet grades as indicated in the drawings. Lifts shall not exceed 12" depth.
2. Compaction
   a. Do not compact with vibratory equipment.
   ~~a.~~ Do not exceed 82% plus or minus 2% compaction as determined by AASHTO T-99. Subsoil ~~Spread approximately 6 inches Planting Soil Mix over loosened subgrade. Mix thoroughly into loosened 4 inches of subgrade. Lightly roll first lift. Do not exceed 75% compaction. Spread and roll second lift of Planting Soil Mix as needed to meet grades as indicated in the drawings.~~
   b. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

~~2.~~3. Suspend soil spreading, grading and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

~~3.~~4. Uniformly moisten excessively dry soil or soil that is too dusty.

~~4.~~5. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. All finish grades of planting beds shall be set 2 inches below abutting pavements.

3.7 EROSION-CONTROL MATERIAL INSTALLATION

A. Install erosion control materials at locations where finished grades exceed 3:1, in planted swales or as indicated. Do not install erosion control materials until after Planting Bed Establishment operations have been completed. Install erosion control materials prior to installation of plant

materials. Install erosion control materials in accordance with manufacturer's installation instructions.

B. Cut erosion control materials where necessary in order to install plants.

C. Install plants and mulch as specified below.

D. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.8 PROTECTION AND CLEANUP

A. Protect all adjacent project work from damage during soil preparation and installation operations. Treat, repair or replace damaged work.

B. Protect Soil Mixes from contamination and compaction during landscape installation or other construction activities until substantial completion is reached.

C. Keep adjacent paving clean and work area in an orderly condition for the duration of soil activities.

D. Keep the site free of garbage at all times. Immediately dispose of waste materials associated with products necessary for the completion of the work.

E. All garbage shall be kept in a central collection container. Do not bury garbage in back-fill.

F. Once installation is complete, remove any excess soil.

3.9 TESTING

1. Placed soils must be capable of infiltrating water at the minimum rate provided in this specification for each type of planting soil.

3.10 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off property.

END OF SECTION

SECTION 329200

TURF AND GRASSES

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. Sodding new lawns.
2. Erosion-control material(s).

B. Related Requirements:

1. Section 329100 "Soils" for suitable soils in landscaped areas.
2. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329100 “Soils” and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Topsoil: The top six to ten inches of soil having higher organic matter content, higher biological activity, less compaction than the underlying subsoil and is better for the growth of

plants. Topsoil should have sand, silt and clay contents within the following ranges: Sand 40 - 65%, Silt 25 - 60% and Clay 5 - 20%. Topsoil may be salvaged and stockpiled from on-site, manufactured or imported from off-site.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 1-May 15.
2. Fall Planting: August 15-October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOD

A. Sod: Certified turfgrass sod complying with ASPA specifications for machine-cut thickness, size, strength, moisture content, and mowed height, and free of weeds and undesirable native grasses. Provide viable sod of uniform density, color, and texture of the following turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

B. Sod shall be Maryland certified

~~B.~~C. Species

a. Provide sod of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated as follows:
b. Species for the following microclimates
1) Full Sun: 90 percent tall fescue and 10 percent Kentucky bluegrass
~~1)~~2) Part Shade and Part Sun: 100% Tall Fescue
~~2)~~3) Shade: Fine Fescue
c. Include at least three improved varieties of each species.

~~C.~~D. Quality Factors

1. Sod shall be not less than 10 months old that is mature and free of weeds, disease and insects.
2. Sod shall be composed of healthy living stems and roots providing a heavy and dense
3. Machine cut sod at a uniform soil thickness of 1” within a tolerance of +/-1/4”, excluding top growth and thatch.

4. Uniformity of cut is required. Sod thickness shall be 1" across the width and length of each section with a maximum deviation of 1/4". Thickness and width shall be kept to strict dimensions. Broken strips, irregularly shaped pieces, and torn or uneven ends will be rejected. Edges shall be cut at 90-degree angles to provide for tight fit during installation.
5. Quality Control: Sod shall be subject to inspection and approval by Owner's Representative at place of growth and upon delivery for conformity to specifications. Such approvals shall not impair the right of inspection and rejection during progress of the Work.
6. Owner may reject sod not meeting specification as determined by the Owner's sole judgment.
7. Mowing height: Sod shall be mowed and maintained uniformly at a height of 1.50 to 1.75 inches depending on environmental conditions for a period of 4 weeks prior to harvesting.
8. Before stripping, sod shall be groomed.
9. Diseases and soil borne insects: State Nursery and/or Plant Material laws require that all soil entering Interstate Commerce be inspected and approved for sale.
10. Weeds: Cultivated sod shall be free from objectionable grassy and broadleaf weeds. Sod will not be acceptable if it contains any weeds or if it is not true to species.
11. Moisture content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect survival of the sod.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329100 "Soils Preparation."

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SODDING NEW LAWNS

A. Lay sod within 24 hours of stripping. Do not lay sod if dormant or if ground is frozen.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

C. Saturate sod with fine water spray within 2 hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below the sod.

3.6 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of sod or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass from 2 to 3 inches high

2. Revise timing of fertilizer application in "Turf Postfertilization" Paragraph below if a slow-release fertilizer is initially applied.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.7 SATISFACTORY TURF

A. Sodded lawns will be satisfactory provided requirements, including maintenance, have been met and healthy, well-rooted, even-colored, viable lawn is fully established, free of weeds, open joints, bare areas, and surface irregularities substantial completion.

B. Replant lawns that do not meet requirements and continue maintenance until lawns are satisfactory.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.9 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Sodded Turf: 60 days from date of Substantial Completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION

SECTION 32 9300

PLANTS

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. Plants and Installation.
2. Pruning.
3. Mulching.
4. Tree Stabilization.
5. Decorative Gravel
6. Maintenance and Warranty Period.

B. Related Sections:
1. Division 7 Section “Green Roof Assemblies” for green roof system aspects such as waterproofing, drainage and root barrier.
2. Division 32 Section “Soils” for all planting media preparation and placement.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Integrated Pest Management Plan (IPM): The careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

G. Topsoil: The top six to ten inches of soil having higher organic matter content, higher biological activity, less compaction than the underlying subsoil and is better for the growth of plants. Topsoil should have sand, silt and clay contents within the following ranges: Sand 40 - 65%, Silt 25 - 60% and Clay 5 - 20%. Topsoil may be salvaged and stockpiled from on-site, manufactured or imported from off-site.

H. Planting Area: Areas to be planted.

I. Planting Soil: Topsoil mixed with soil amendments. See Section 329100 ‘Soils’.

J. Intensive Growth Media: Lightweight soil mix used in on structure applications to support diverse mix of complex plants in depths up to 3-4 feet. See Section 329100 ‘Soils’

K. Extensive Growth Media: Lightweight soil mix used in on structure applications to support limited plant pallet of mostly succulents in depths up to 8 inches.

L. Plant, Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, perennials, bulbs, corms, or tubers.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the trunks of trees below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

A. Manufacturer’s Product Data: Provide twelve weeks before installation of planting soil For each type of product indicated.

1. Mulch.
2. Tree Tie Material.
3. Watering Bags.
4. Anti-Desiccant.
5. Separation Fabric.

B. Samples for Verification: Provide twelve weeks before installation of planting soil for each of the following in labeled bags:

1. 1 liter of mulch.
2. 1 liter of decorative gravel.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.

D. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

E. Planting Schedule for Trees: Indicating anticipated planting dates.

F. Planting Schedule for Shrubs and Perennials: Indicating anticipated planting dates.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

H. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

1.5 QUALITY ASSURANCE

A. References and standards to be used:

1. ASTM: American Society of Testing Materials
2. USDA United States Department of Agriculture.
3. ANSI Z60.1 American Standard for Nursery Stock 2004 or more recent.
4. ANSI A300 Standard Practices for Tree, Shrub and other Woody Plant Maintenance.
5. Pruning practices shall conform with recommendations in *An Illustrated Guide to Pruning*, Second Edition, Edward F Gilman, Delmar Publishing, Albany, NY, 2000.

B. Contractor is solely responsible for quality assurance of work.

C. Installer Qualifications: The installer shall be a firm with at least 5 years of successful experience in work similar in material, design and extent to that indicated for this Project and with a record of successful landscape establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. The Contractor shall comply with all applicable requirements of the laws, codes, ordinances and regulations of federal, state and municipal authorities having jurisdiction.

F. The contractor shall comply with all requirements for control of silt and sediment during plant installation work as indicated in the contract documents.

G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination.”

1.6 SELECTION, TAGGING, ORDERING AND ACCEPTANCE OF PLANT MATERIAL

A. Plants shall be subject to selection, tagging and/or inspection and approval by Landscape Architect at place of growth and upon delivery for conformity to specifications. Such approval shall not impair the right of inspection and rejection during progress of the work. Submit written request for inspection of plant material at place of growth to Landscape Architect. Written request shall state the place of growth and quantity of plants to be inspected. Landscape Architect reserves right to refuse inspection at this time if, in his judgment, a sufficient quantity of plants is not available for inspection.

1. Notify Landscape Architect of sources of planting materials fourteen days in advance of delivery to site.

B. Before trees are dug and during tagging activities a Contractor or nursery representative shall apply a one inch diameter white dot of landscape marking paint on the North side of all trees 12 inches above the top structural root. Maintain North orientation when planted at Project site.

C. Substitutions of plant materials will not be permitted unless authorized in writing by Landscape Architect. If proof is submitted that any plant specified is not obtainable, a proposal will be considered for use of the nearest equivalent size or variety with corresponding adjustment of Contract price. These provisions shall not relieve Contractor of the responsibility of obtaining

specified materials in advance if special growing conditions or other arrangements must be made in order to supply specified materials.

D. Plant Acceptance: Landscape Architect will inspect all work for substantial completion upon written request of the Contractor. The request shall be received at least ten days before the anticipated date of inspection. Acceptance of plant material shall be for general conformance to specified size, character and quality and not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.

1. The Contractor is responsible for the condition and quality of work and materials during construction and until Acceptance. Contractor shall bear the cost of replacing any and all plant material until this time.
2. Remove rejected trees, shrubs or perennials immediately from Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect materials from damage or deterioration during delivery and while stored at the site. Adequately protect plants from drying out, whipping, exposure of roots to sun, wind, extremes of heat and cold temperatures or other handling or tying damage. Do not bend or bind trees or shrubs in such a manner that damages bark, breaks branches or destroys their natural shape.

B. When weather conditions are such that exposure to sun, wind and/or extremes of heat or cold temperatures during transit may adversely affect health of plants, transport plant material to site in controlled environment trailer. Use carrier experienced in handling live plants.

C. Provide protective covering over all vehicles during delivery of all plants.

D. Do not prune prior to delivery unless approved in advance by Landscape Architect.

E. If deciduous trees are moved when in full-leaf, spray with an approved anti-desiccant per manufacturer’s recommendations at nursery no greater than 48 hours prior to digging, and again two weeks after transplanting. Spraying should take place in early morning hours with foliage at maximum turgidity. It is the responsibility of the contractor to decide if anti-desiccant shall be applied to the tree before delivery.

F. Deliver trees and plants after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery:

1. Set trees and plants in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.
2. Mist plant tops regularly such that plant tops remain moist. Water root zones to maintain water levels in the root zone above wilt point but below soil saturation.
3. The duration, method and location of storage of plant materials shall be subject to approval.
4. Provide proper spacing for trees, such that the stockpiled plant material has full access to light and air. Take all precautions to prevent defoliation of stockpiled material.
5. Do not deliver more plants to the site than there is space with adequate storage conditions to receive the plants. Provide a suitable remote staging area for plants and other supplies.

6. Do not remove container-grown stock from containers until planting time. Prepare and plant container-grown stock immediately once removed from container.

G. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

H. Bulk Materials:

1. Do not dump or store bulk materials on existing turf or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

1.8 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned. Notification of Miss Utility, 1-800-257-7777 is required for all planting around utilities. The contractor is responsible for knowing the location and avoiding utilities that are not covered by Miss Utility.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15 – June 15.
2. Fall Planting: September 15 – December 15.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.

1.9 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period:

1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.
2. Warranty Period for Perennials: One year from date of Substantial Completion.

C. When the work is accepted in parts, the warranty periods shall extend from each of the partial acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of warranty, shall terminate at one time. An agreement by the owner that the overall project is at substantial completion does not begin the plant warranty period if all plants have not been accepted.

D. Plants shall be healthy, free of pests and disease, and in flourishing condition at the end of the warranty period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, and color for the species.

E. Plants that are dead, diseased, insect infested, or not in a vigorous, thriving condition, as determined by the Landscape Architect during or at the end of the warranty period, shall be deemed defective. Plants that have had more than 25% of their branches die or removed shall be replaced. Plants that have had a major branch or side of the plant removed such that current or future aesthetic appeal or structural integrity of the plant, as determined by the Landscape Architect, is diminished shall be considered defective. Plant material determined to be defective shall be replaced without cost to the Owner.

1. Remove defective or dead plants immediately. Replace as soon as weather conditions permit and within the specified planting period.

F. The Contractor is exempt from replacing plants, after Acceptance and during the warranty period, that are removed by others, lost or damaged due to occupancy of project in any part, lost or damaged by a third party, vandalism, or any natural disaster.

G. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

H. The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the extended warranty period, the Owner may elect one more replacement item or credit for each item. These replacement items are not protected under a warranty period.

I. At the end of the warranty period, and no less than five days prior to final inspection, tree ties and guying shall be removed from the site. All trees that have leaned shall be straightened

1.10 MAINTENANCE

A. General: During maintenance period, maintain plantings by pruning, cultivating, watering, weeding, fertilizing, resetting plants to proper elevations or vertical position, and performing other operations as required to establish healthy, viable plantings. Utilize an Integrated Pest Management (IPM) plan using organic methods to the greatest extent possible to keep plants free of harmful insects and disease. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than the following maintenance period.

B. Trees and Shrubs:

1. Maintenance Period: 12 months from date of Substantial Completion.
2. Remove tree guys and stakes no later than 12 months from date of Substantial Completion.
3. Tighten and repairing stakes and guy supports as required.

C. Perennials:

1. Maintenance Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL: GENERAL

A. Provide trees and plants of quantity, size, genus, species, variety or cultivars, and type (ball and burlap or container) as indicated in the drawings. All plant material shall conform to ANSI Z60.1 "American Standard for Nursery Stock", unless otherwise specified herein.

1. Plants larger than specified may be used if acceptable and approved. Use of such plants shall not increase the contract price. If larger plants are accepted the ball-of-earth shall be increased in proportion to the size of the plant.
2. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required.

B. Plants shall have outstanding well balanced and full form; heavily branched with an even branch distribution, densely foliated and/or budded, and a strong, straight distinct leader where this is characteristic of the species. Plants that meet the measurements specified, but do not possess a normal balance between height and spread, shall be rejected. The Landscape Architect shall be the final arbiter of acceptability of plant form.

C. Trees or large shrubs shall not have co-dominant leaders or branch crotch unions without evidence of a bark ridge.

D. Provide healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae, and defects such as knots, scrapes, broken or split branches, fresh limb cuts, sunscald, injuries, abrasions, or disfigurement. All graft unions shall be completely healed, free of extreme succulence. All graft unions shall be visible above the soil line.

E. Plants shall not be pruned before delivery. Trees, which have a damaged or crooked leader, or multiple leaders, unless specifically specified, will be rejected. Trees with abrasions of the bark, sun scalds, disfiguring knots, or fresh cut of limbs over 1" which have not completely callused, will be rejected.

F. All plants shall be harvested as required by ANSI Z60.1 and additional requirements cited in this section below. In the event that the required modifications are in conflict, the modifications shall take precedent.

G. All trees and shrubs shall be dug prior to leafing out (bud break) in the spring or when plants have gone dormant in the fall except for plants known to require spring transplanting, which are only to be dug prior to leafing out in the spring.

1. Written permission from the Landscape Architect is required to vary from this requirement.

2. Trees and shrubs shall not be dug in the summer.

H. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 BALLED AND BURLAPPED PLANT MATERIAL

A. Provide quality plant material of height or caliper as indicated in drawings and with branching configurations and spread characteristics as recommended by ANSI Z60.1.

B. Trees: Provide quality single-stem balled and burlapped (B&B) trees, except where special forms are indicated.

1. Large Caliper Trees: Large caliper trees are defined as trees with a trunk caliper of 4” or larger and shall meet all general and tree requirements.

C. Shrubs: Provide quality single-stem or caned balled and burlapped (B&B) deciduous shrubs, except where special forms are indicated.

D. Evergreens: Provide quality balled and burlapped (B&B) evergreens with well-balanced form complying with requirements for size relationships to the primary dimension shown. The landscape architect has the option to specify evergreen shrubs by height.

E. Harvesting and Root Ball Requirements: All balled and burlapped trees and shrubs shall be harvested with the following modifications to standard nursery practices.

1. Prior to digging each tree and any shrub greater than 3 feet in height, check for the location of the structural roots within the root ball area. Using a surveyor’s chain pin, or other suitable device, probe into the soil around the trunk of the plant to locate the position and depth of the structural roots. A surveyor’s chain pin is a metal rod approximately 3/16” in diameter, 12 inches long with a cone shaped point. The rod is painted with alternating bands 1” wide along its length.
2. A minimum of three radial roots shall be found in each plant. The top structural roots shall be defined as large woody roots found at a point 4” out from the trunk or shrub base. These roots shall be roughly radial to the trunk and be at approximately the same depth to each other. Plants with roots that appear to be circling, or at depths differing greater than 3 inches may be rejected. Plants with visible circling roots at the surface shall be rejected.
3. Apply a one-inch diameter, white dot of paint on the north side of all trees 12 inches above the top structural root.
4. For trees or shrubs where the top structural roots are three inches or less in depth, the soil at the top of the root ball may be left in place and the plant harvested. For trees with more than three inches of soil covers the top structural roots, soil should be carefully

removed to the depth of the highest root. This will expose the root flare of the tree. Care must be exercised not to damage the bark at on the root flare and the top of the structural root. For large trees, any excess soil over the roots shall be removed at the time the tree is root pruned.

5. After the removal of the required amount of soil, dig the root ball. Trees larger than 5" in caliper shall be dug with a minimum root ball diameter of 11 inches of diameter for each inch of trunk caliper and depth of the ball shall be a minimum of 2/3rd of the ball diameter. Trees 5" or smaller in caliper and all shrubs shall be dug with root ball sizes as required by ANSI Z60.1.
6. Plants shall be burlap wrapped either using ANSI Z60.1 drum lacing technique or a wire basket. If wire baskets are used, a low profile basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less that 4" and no greater than 10" below the shoulder of the root ball as indicated on the drawings.
7. Twine and burlap used for wrapping the root ball shall be natural, untreated, biodegradable material.
8. Apply 1/8" thick, wax sealed, corrugated cardboard trunk protection around the trunk of the tree from the top of the root ball to the first branch. Cardboard shall be coated to reduce water penetration, and fabricated for this application. Secure the cardboard with biodegradable twine.

2.3 CONTAINER GROWN PLANT MATERIAL

A. Container grown plants shall consist of small shrubs and perennials. Large container grown shrubs may be permitted when indicated on the drawing or approved. Container grown trees shall not be permitted.

B. Provide plants established and well rooted in removable containers or integral peat pots and with not less than the minimum number and length of runners required by ANSI Z60.1 for the pot size shown or listed.

C. Container class size shall conform to ANSI Z60.1 for each size and type of plant.

D. Container-grown stock shall have been grown in a container long enough for the root system to have developed sufficiently to hold its soil together but not so long as to have developed a girdling root mat around the edge of the container.

E. The root system of each container grown plant shall be inspected by the contractor to determine the condition of the roots. Remedial action to remove circling and matted roots on the edge of the container as described in Part 3 of this section shall be performed.

2.4 TREE BRANCH HEIGHT REQUIREMENTS

A. Shade Trees: One-half of tree height

B. Street Trees: Limb up trees to a height of 8' above finished grade, or one half of tree height, whichever is greater.

C. Small Ornamental Trees: Branched or pruned naturally according to species and type.

D. Multi-trunk Trees: Branched or pruned naturally according to species and type.

E. Coniferous Evergreens: Well-balanced and branched to the ground on all sides.

F. Broadleaf Evergreens: Well-balanced and branched to the ground on all sides.

2.5 MULCH

A. Characteristics
1. Mulch shall be composted Pine bark. It shall be aged minimum of six months and not longer than 2 years. Mulch shall be composted to the point where all wood has turned dark brown within the interior of the fragment.
2. It shall consist of minimum 90 percent of composted Pine bark and no more than 10 percent of cellulose and hemicellulose materials.
3. Material shall be mulching grade, uniform in size and foreign matter.
4. It shall be free from roots, leaves, twigs, debris, stones, fungus, crabgrass rhizomes, or any material detrimental to plant growth. and suitable as top dressing of trees and shrubs.
5. It shall be long, fibrous, 2" to 4" in length, free of chunks and pieces of wood thicker than one quarter inch and over 3 inches in width. It shall not contain excess of fine particles.
6. Mulch that has become saturated with water and presents an anaerobic odor shall be rejected.
7. It shall be dark brown in color

B. Supplier or approved equal:
Shredded Pine Bark Mulch from Grant County Mulch,
181 Mulch Drive, Petersburg WV 26847.

C. Only upon approval of landscape architect may shredded hardwood chips be substituted for the Composted Pine Bark. All other requirements of mulch shall still apply.

~~A. Mulch shall be double shredded hardwood bark free from roots, leaves, twigs, debris, stones, fungus, crabgrass rhizomes, or any material detrimental to plant growth. Material shall be mulching grade, uniform in size and foreign matter. Wood content shall not exceed 15% by volume. Mulch shall be composted to the point where all wood has turned dark brown within the interior of the fragment. Mulch that has become saturated with water and presents an anaerobic odor shall be rejected. It shall be aged a minimum of six months and not longer than 2 years.~~

~~B.~~D. Depth: Depth of mulch indicated means the depth of mulch after settlement.

2.6 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or redwood, free of knots, holes, cross grain, and other defects, 2 by 2 inches by length indicated, pointed at one end.

B. Tree guying to be flat woven polypropylene material, 3/4" wide, 900 16 break strength. Color to be Green. Product to be ArborTie, manufactured by Deep Root Partners, L.P. (800) 458-7668, or approved equal.

2.7 ANTI-DESICCANT

A. Anti-Desiccant shall be emulsion type, film-forming agent similar to Dowax by Dow Chemical Company, or Wilt-Pruf by Nursery Specialty Products, Inc., Croton Falls, New York, or approved equal. Anti-desiccant is designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and use in accordance with manufacturer's instructions.

2.8 WATERING BAGS

A. Watering bags shall be Treegator Irrigation Bags, or approved equal. The bags shall be sized to the appropriate model for the requirements of the plant, manufactured by Spectrum Products, Inc, Youngsville, NC 27596.

~~2.9 DECORATIVE GRAVEL~~

~~A. Gravel: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:~~

~~B. Type: Delaware River Rocks, or approved equal:~~
~~1. Size: Small 1 inch to 3 inch.~~

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine grading, verify all elevations and notify the Landscape Architect of any discrepancies before beginning work.

B. Examine soil conditions for areas to receive plants for any circumstance that might be detrimental to plant growth. Verify that no foreign or deleterious material or liquid such as paint, concrete, oils, gasoline, paint thinner, etc have been deposited or spilled in planting area.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, lawns and existing plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Complete all soil preparation and placement activities and erosion control measures as described in Section 329100 'Soils' in each planting area before beginning planting activities.

3.3 SEQUENCE AND LAYOUT

A. Landscape Architect shall be on site to approve layout and position of plants prior to installation.

B. When applicable, plant trees before adjacent shrubs, vines and perennials are in place.

C. Notify the Landscape Architect, one (1) week prior to layout for approval. Lay out all individual tree and shrub locations. Place plants above surface at planting location or place a labeled stake at planting location. Layout bed lines with paint for approval. Where spacing dimensions or locations are not clear, notify the Landscape Architect. Secure acceptance before digging and start of planting work.

D. Plants are not precise objects and minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some or all of the plants are installed. Make adjustments as required by the Landscape Architect.

3.4 INSTALLATION OF BALL AND BURLAP TREES AND SHRUBS

A. Inspect each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.

B. Excavate pits and trenches with 2:1 sloped sides and with the bottom of excavation slightly raised at center to provide proper drainage. Leave pedestal as required to meet the tree or shrub root flare elevation as indicated in drawings. If pedestal is disturbed during excavations compact pedestal to 90% dry density. Provide planting pits at least three times the size of the rootball. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of the root ball. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Landscape Architect before planting. Dispose of detrimental subsoil removed from planting excavations and do not mix with planting soil or use as backfill.

C. Scarify hard subsoil on side walls and around perimeter of undisturbed tree ball pedestal. For plants to be planted in prepared planting soil, tamp the soil under the root ball using a motorized jumping jack tamper, to assure firm bedding for the root ball.

D. Set edge of the root ball at the elevation of the proposed finish grade. Consult the grading plan and utilize a builder’s level or transit to determine the grade at the tree trunk. For trees on sloped surfaces, set the edge of the root ball at the average grade around the tree. Set the plant plumb and in the location indicated on the plan and approved by the Landscape Architect. Set so the root flare and tree graft, if applicable, shall be visible at the top of the root ball, above the grade after backfilling.

E. Trees shall be oriented so their north side, as marked by the white dot on the trunk from the nursery, faces north. The Landscape Architect may require trees to be oriented slightly in another direction based on the form of the tree or other conditions.

F. When set, brace root ball by tamping backfilled Planting Soil around the lower portion of the root ball. Remove plastic, wood containers and root-bags totally from ball and planting pit at this time. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Work each lift to settle backfill and eliminate voids and air pockets. When excavation is approximately two-thirds full the follow shall be performed:

1. Cut and pull back ropes or strings on top of ball.
2. Cut and removed burlap or cloth wrapping from the top of the root ball.
3. Cut the top horizontal ring of support wire basket in four places and fold the top half of the wire basket down into the soil.
4. Water thoroughly before placing remainder of backfill.
5. Repeat watering until no more is absorbed.

G. Complete backfilling in 6-inch lifts as described above. Ensure all grades and elevations indicated are met. Do not place soil on top of the root ball. The root flare and tree graft, if applicable, shall be visible at the top of the root ball, above the grade. Water again after placing final layer of backfill.

H. Remove all nursery plant identification tags and ribbons.

I. All evergreen plant material shall have anti-desiccant applied to it for Fall installations.

J. Remove trunk protection just prior to substantial completion.

3.5 INSTALLATION OF CONTAINER GROWN PLANTS

A. Remove plastic, paper or fiber pots from containerized plant material. Inspect the root system. Plants that have girdling roots that cannot be removed without severely stressing the plant shall be rejected. Notify the Landscape Architect of any plants with girdling roots. The Landscape Architect may request that random containerized plants be dug up after planting to inspect the roots for compliance with these specifications.

B. Pull roots out of the root mat, cut circling roots with a sharp knife. Loosen the potting medium and shake away from the root mat.

C. Install the plant such that the top of the root ball is at the finish grade of the surrounding soil. Pack Planting Soil with fingers around roots to eliminate air pockets. When back filling is complete form a slight saucer indentation around plants to hold water.

D. Water each plant on the day of installation to saturate the Planting Soil around the roots and settle soil into the root zone. Take care not to cover crowns of plants with wet soil.

E. After the Planting Soil has drained, reset any plants that settled too low and/or adjust grades around the plant, adding Planting Soil if required.

3.6 MULCHING OF PLANT MATERIAL

A. Mulch top of root balls and planting beds, covering the entire planting bed area. Provide the following thickness of mulch. Top of mulch shall be smooth and even in all directions.

1. Tree and shrub planting areas: 2 to 3-inch depth continuous from plant to plant. See details. Depth indicated is depth after settling.

B. In no case shall mulch come in contact with any part of trunk or root flare.

C. Apply mulch after all plants have been installed and approved.

D. Contractor shall not over-mulch planting beds with excess mulch. Excess mulch shall be removed and disposed of off-site.

E. Lift all leaves, low hanging stems and other green portions of plants out of the mulch if covered.

3.7 TREE AND SHRUB PRUNING

A. Prune plants as directed by Landscape Architect at time of planting.

1. Pruning shall be performed by arborist certified by the International Society of Arboriculture and according to standard horticultural practice. Do not apply pruning paint to wounds.

2. Prune plants to retain natural character of the plant or to remove injured or dead branches.

3. Unless otherwise indicated by Landscape Architect, do not cut tree leaders.

4. Required height and spread shall be met after pruning.

3.8 GUYING AND STAKING

A. Upright Staking and Tying: Stake trees of 2-5 inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Support trees with woven polypropylene material as indicated in drawings. Allow enough slack to avoid rigid restraint of tree. Use the number of stakes as follows:

1. Use 2 stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; 3 stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.

3.9 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of acceptance.

B. If planting areas are not irrigated or if irrigation system is not operating, hand water root balls of all plants to assure that the root balls have adequate moisture. Test the moisture content in each root ball to determine the water content. The Contractor shall install one set of watering bags for each tree to be maintained (and not irrigated) for tree watering during the warranty period. Watering bags shall be removed between December 1 and March 1.

3.10 STRAIGHTENING TREES AND SHRUBS

A. Maintain all trees and shrubs in a plumb position throughout the warranty period. Straighten all trees including those not staked.

B. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled. Do not straighten plants by pulling the trunk with guys.

3.11 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

A. Do not apply any additional amendments to plantings during the first year after transplanting, unless subsequent soil test determines amendments are required. Apply amendments only upon the approval of the Landscape Architect.

B. Amendments shall be applied according to manufacturer's instructions and standard horticultural practices only.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent pavings and construction clean and work area in an orderly condition.

B. Keep the site free of garbage at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All garbage shall be kept in a central collection container. Do not bury garbage in back-fill.

D. Protect plants from damage due to landscape operations, operations by other contractors and trades and others. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged plantings.

E. Damage to plants as a result of activities by the Contractor, or any of their sub-consultants, shall be replaced by the Contractor at no expense to the Owner.

F. Once installation is complete, remove any excess soil from pavements or embedded fixtures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site.

3.13 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off property.

END OF SECTION

SECTION 33 4600

SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes subdrainage systems for the following:

1. Underslab areas.

B. Related Requirements: Related sections include, but are not limited to, the following:

1. Section 07 1300 "Below-Grade Sheet Waterproofing" for drainage panels, base drainage strips, and drainage accessories that connect perimeter foundation drainage to underslab subdrainage system.
2. Section 31 2000 "Earth Moving" for drainage course under concrete slabs-on-grade.

1.2 COORDINATION

A. Provide drainage materials and installation that are compatible with below-grade waterproofing assemblies.

1.3 PREINSTALLATION MEETINGS

A. Building Enclosure Preconstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 3100 "Project Management and Coordination."

B. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of pipe, pipe fitting, and geotextile filter fabrics.

1.5 WARRANTY

A. Single-Point Exterior Building Envelope Warranty: Comply with requirements in Section 01 7700 "Closeout Procedures".

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Solid PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints; in sizes indicated on Drawings.

1. Gaskets: ASTM F 477, elastomeric seal.

C. Special Pipe Couplings: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

2.2 CLEANOUTS

A. Cleanouts: ASTM D 3034, PVC cleanout threaded plug and cast-iron threaded pipe hub with round, cast-iron lid.

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

a. Zurn Industries, LLC; Z-1404 Floor Access Housing.

2.3 SOIL MATERIALS

A. Drainage Fill/Drainage Course: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, AASHTO Size No. 57, unless otherwise indicated on Drawings.

2.4 GEOTEXTILE FILTER FABRICS

A. Description: Woven or non-woven geotextile filter fabric of PP or polyester fibers or combination of both; with 70 US Sieve apparent opening size per ASTM D 4751, and with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

1. Products: Subject to compliance with requirements, provide one of the following or an equivalent product:

a. Propex Fabrics, Inc.; Propex 4545 (previously BP Amoco 4545).
b. TenCate Geosynthetics Americas; Mirafi 140N.
c. US Fabrics, Inc.; US 90NW.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Verify that drainage piping and drainage panels installed as part of foundation wall and blind-side waterproofing have inverts as shown on the Drawings and are properly positioned to drain into subdrainage system.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 2000 "Earth Moving."

3.3 INSTALLATION, GENERAL

A. Install thermoplastic piping according to ASTM D 2321.

B. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material as shown on the Drawings. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Lay perforated pipe with perforations down.
2. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
3. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

D. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

E. Comply with requirements for storm piping indicated on Drawings and specified in Section 22 1413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.4 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Cut trench in width indicated on Drawings. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap at least 6 inches at the top.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric.

D. Install piping in center of trench, level or pitched down in direction of flow, unless otherwise indicated.

E. Add drainage course in trench to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

G. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at locations shown on Drawings; and at minimum 100 foot spacings and at each change in piping direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 PVC soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

H. Connect underslab subdrainage system to building's solid-wall-piping storm drainage system, as indicated on Drawings.

3.5 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 31 2000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.6 FIELD QUALITY CONTROL

A. Owner will engage a qualified geotechnical engineering testing agency to witness testing for underslab subdrainage system, and to observe placement of filter fabric, drainage fill, and pipes.

B. Tests: For underslab subdrainage, perform the following:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.

2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

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

D. Prepare test and inspection reports.

3.7 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

APPENDIX A

GEOTECHNICAL REPORTS

REPORT OF

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING ANALYSIS

ELIZABETH HOUSE
SILVER SPRING, MARYLAND

FOR

LEE DEVELOPMENT GROUP

AUGUST 5, 2014

August 5, 2014

Mr. Melvin Tull
Lee Development Group
8601 Georgia Avenue, Suite 200
Silver Spring, Maryland 20910

ECS Job No.: 13-6318

Reference: Report of Subsurface Exploration and Geotechnical Engineering Analysis, Elizabeth House, 1315 Apple Avenue, Silver Spring, Maryland

Dear Mr. Tull:

As authorized by acceptance of our proposal 13-7404-GP dated June 3, 2014 (Revised), ECS Mid-Atlantic, LLC (ECS) has completed subsurface exploration and geotechnical engineering analysis for the Elizabeth House located in Silver Spring, Maryland. Our report, including the results of our subsurface exploration program, laboratory testing, and geotechnical engineering analysis is enclosed with this letter, along with a Site Vicinity Map and a Boring Location Diagram.

We understand that the project will consist of two high-rise residential buildings. One building will be 12 stories over three levels of below grade parking. The second building will be 20 stories over three levels of below grade parking. A plaza slab will also be constructed between the buildings and have three levels of below grade parking underneath. At this time, final location of the proposed buildings as well as final site grading has not yet been determined.

The enclosed report provides comments on soil bearing pressures, foundation settlement estimates, placement and compaction of new fills, drainage, construction, and other factors which may influence construction at the site.

We appreciate this opportunity to be of service to Lee Development Group on this project. If you have any questions regarding the information and recommendations contained in the accompanying report, or if we may be of further assistance to you in any way during planning or construction of this project, please do not hesitate to contact us.

Respectfully,

ECS MID-ATLANTIC, LLC

Gregory A. Ratkowski
Senior Project Engineer

Jeffrey A. McGregor, P.E.
Principal Engineer

Enclosures: (1) Report

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REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING ANALYSIS

PROJECT

Elizabeth House
1315 Apple Avenue
Silver Spring, Maryland

CLIENT

Mr. Melvin Tull
Lee Development Group
8601 Georgia Avenue, Suite 200
Silver Spring, Maryland 20910

Submitted by
ECS Mid-Atlantic, LLC
5112 Pegasus Court
Suite S
Frederick, Maryland 21704

PROJECT 13-6318

DATE August 5, 2014

ELIZABETH HOUSE

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PROJECT OVERVIEW

Project Location and Proposed Construction

The project site is located at the northwest corner of the intersection of 2nd Avenue and Apple Avenue in Silver Spring, Maryland. The site is bound to the north by Fenwick Lane and to the west by a WMATA rail line. The site is currently occupied by office townhomes along the western portion of the site, and an existing high-rise building along the east and south side of the site. The office townhome structures and the northeast portion of the high rise building will be demolished to make way for the new buildings.

The project will consist of two high-rise residential buildings. One building will be 12 stories over three levels of below grade parking. The second building will be 20 stories over three levels of below grade parking. A plaza slab will also be constructed between the buildings and have three levels of below grade parking underneath. We have assumed that the first finished level will be at or near existing grades, meaning cuts of 30 to 40 feet will be necessary to reach the lowest parking level slab.

It is our understanding that the buildings will be constructed of post-tensioned concrete floor slabs and concrete columns. Typical unfactored interior column loads will be on the order of 2,400 kips (12-story building) and 3,600 kips (20-story building).

Scope of Work

The conclusions and recommendations contained in this report are based on our field subsurface explorations and review of available geologic and/or geotechnical data. The subsurface exploration program included a total of fourteen soil borings (GSB-1, and GSB-3 to GSB-15), extended to a maximum depth of up to 53.5 feet below the existing ground surface. Boring GSB-2 was not completed due to conflict with an existing gas line. Boring GSB-16 has not yet been completed due to utility conflicts. This boring will be completed at a later date and results will be transmitted under separate cover.

Visual classifications were then performed on soil samples to classify the soils and to assist in determination of the properties of the on-site soils. We also visited the site to conduct a site reconnaissance of current conditions.

ECS also completed a ReMi survey to determine the seismic site classification.

The boring locations were selected by your office and located in the field by the project civil engineer, VIKA. The Boring Location Diagram in the Appendix indicates the approximate physical location of the borings performed at the site.

Purposes of Exploration

The purpose of our subsurface exploration was to explore current soil and groundwater conditions at the site and to develop engineering recommendations to guide in the design and construction of the proposed project. We accomplished these purposes by:

1. drilling borings to explore the subsurface soil and groundwater conditions,

2. completing a ReMi survey to assess the seismic site classification,

3. performing visual classification and laboratory testing on the soil samples from the borings to evaluate pertinent engineering properties,

4. analyzing the field, laboratory, and classification test results to develop appropriate engineering recommendations.

EXPLORATION PROCEDURES

Soil Borings

The ECS soil borings were performed using an all-terrain vehicle (ATV) mounted drill rig (CME 55LC), which utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used in this process.

Representative soil samples were obtained by means of the split-spoon sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-spoon sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last 12-inch interval is termed the Standard Penetration Test (SPT) value, or N value, and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of noncohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the soils encountered in the borings was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and brought to our laboratory for further visual examination.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ the transitions may be gradual.

Soil samples received from the soil borings will be retained in our soil laboratory for a period of

60 days after which they will be discarded unless other instructions are received as to their disposition

Refraction Microtremor (ReMi) Sruvey

Refraction Microtremor (ReMi) data was processed using SeisOpt® ReMi™ software to reveal a one-dimensional average shear-wave (S-wave) velocity image for each line. The method provides an effective and efficient way to generate information on large volumes of the subsurface profile in one dimension along each line. In addition, the survey also provides the average shear wave velocity to a depth of 100 feet that is used to evaluate the seismic Site Class per the IBC 2012 requirements.

The data gathering process in the field used standard refraction seismic equipment to measure subsurface soil and/or rock characteristics using ambient vibrations (microtremors) as a seismic source. The equipment used for the survey is a SeisDAQ ReMi recording unit capable of storing record lengths up to about 100 seconds using 12, 10-Hz, and 4.5 Hz geophones. A single geophone sensor was used at each one of the channel geophone locations to record surface wave velocity dispersion. The analysis presented here was developed using 19 to 22 channels with 10 Hz and 4.5 Hz geophones (seismometers) set along a straight line at evenly spaced intervals of 10 feet between the channels, yielding total transect lengths of 210 feet for Remi line 1 and 180 feet for Remi line 2. A minimum of 20 unfiltered 30-second records were recorded along each line.

EXPLORATION RESULTS

Current Site Conditions

The project site is currently occupied by office townhomes along the western portion of the site, and an existing high-rise building at the northeast corner. These structures will be demolished to make way for the new buildings. To the west of the site are railroad tracks followed by residential and commercial buildings. To the northwest of the site is Fenwick Lane and condominiums. To the southeast is Apple Avenue and an apartment building, and to the northeast is 2nd Avenue and an above ground parking structure and a commercial building.

Current site topographic plans were not available at the time of this report. However, based on our site reconnaissance, the site appears to be relatively flat to slightly sloping.

Regional Geology

The project site is located in the Hampstead Upland District of the Piedmont Physiographic Province. The Hampstead Upland District is described as rolling to hilly uplands interrupted by steep walled gorges. Differential weathering of adjacent, contrasting lithologies produces distinctive ridges, hills, barrens, and valleys.

According to the Geologic Map of Maryland (1968), the project site appears to be located at the intersection of the Lower Pelitic Schist (west side of the site) and the Boulder Gneiss (east side of the site), both believed to be of the Late Precambrian. The Lower Pelitic Schist is described as medium to coarse-grained biotite-oligoclase-muscovite-quartz schist with garnet, staurolite, and kyanite; fine- to medium-grained semipelitic schist; and fine-grained granular to weakly

schistose psammitic granulite. The Boulder Gneiss (Formerly mapped as Sykesville and Laurel Formations.) is described as thick-bedded to massive, pebble and boulder-bearing, arenaceous to pelitic metamorphic rock; typically a medium-grained, garnet-oligoclase-mica-quartz gneiss. Depths to auger refusal in the Boulder Gneiss formation can vary significantly over short horizontal distances.

Soil Conditions

Subsurface conditions within the proposed building areas were evaluated with fourteen soil test borings (GSB-1, and GSB-3 to GSB-15), extended to a maximum depth of up to 53.5 feet below the existing ground surface. Boring GSB-2 was not completed due to conflict with an existing gas line. Boring GSB-16 has not yet been completed due to utility conflicts. This boring will be completed at a later date and results will be transmitted under separate cover. The approximate boring locations are presented on the enclosed Boring Location Diagram.

Borings GSB-1, GSB-6 and GSB-10 indicated between 4 to 6 inches of asphalt at the ground surface underlain by 6 to 8 inches of gravel. Boring GSB-15 indicated 8 inches of concrete at the grounds surface. Boring locations GSB-5, GSB-7 and GSB-8 indicated ground cover consisting of 4 to 6 inches of topsoil, and borings performed at locations GSB3, GSB-4, GSB-9 and GSB-11 through GSB-14 had no ground cover over the existing natural or fill soils.

Existing fill soils were encountered at the surface or below the surface cover at boring locations GSB-1, GSB-3, GSB-6, GSB-7, GSB-9 and GSB-11 through GSB-15. The fill soils extended to depths of approximately 2.5 to 13.5 feet below existing grades. These fill soils consisted of Micaceous Silty SAND (SM FILL), Silty SAND (SM FILL), Sandy SILT (ML FILL), Micaceous Sandy SILT (ML FILL), CLAY (CL FILL) and Silty CLAY (CL FILL).

The cohesionless fill soils (SM FILL and ML FILL) contained varying amounts of mica, rock fragments, clay, organics and roots. Based on Standard Penetration Test (SPT) results, the density of the cohesionless fill soils ranged from very loose to medium dense. The color of these soils was dark brown to brown and the moisture content was described as moist.

The cohesive fill soils encountered (CL FILL) contained mica, varying amounts of silt, and trace amounts of sand, rock fragments, organics and roots. Based on Standard Penetration Test (SPT) results, the consistency of the cohesive fill soils ranged from soft to stiff. The color of the fill soils ranged from brown to light brown, and the moisture contents of these materials were characterized as moist.

Natural soils were encountered at the ground surface at location GSB-4 and below the existing ground cover or fill soils at the remaining boring locations. The natural soils encountered were predominately Micaceous Silty SAND (SM) with varying amounts of decomposed rock. Based on Standard Penetration Test (SPT) results, the density of the Micaceous Silty SAND materials ranged from very loose to very dense, but was predominately loose to medium dense. The color of these soils was light brown to brown and the moisture content was described as moist.

Also present, but to a lesser degree, were natural soils consisting of SILT (ML), Sandy SILT (ML), Micaceous Sandy SILT (ML) and Clayey SILT (ML). These soils contained varying amounts of mica, clay, rock fragments and roots. Based on Standard Penetration Test (SPT) results, the density of these soils ranged from loose to medium dense. The color of these soils

was brown and the moisture content was described as moist.

Below the natural soils at all boring locations except GSB-10, very dense materials exhibiting an SPT N-value greater than 60 have been classified on the boring logs as decomposed rock. Decomposed rock materials were encountered at the boring locations at depths of ranging from about 13.5 feet to 33.5 feet below existing grades. These materials exhibit rock like qualities and depending on various parameters may be extremely difficult to excavate and portions of the decomposed rock will require rock excavation methods for removal.

Auger refusal was encountered at the soil borings at depths ranging from about 18.5 to 53.0 feet below the existing ground surface. The auger refusal levels encountered at the boring locations are assumed to be the depth to rock. The chart below indicated the boring locations along with the associated depth to decomposed rock and auger refusal (AR).

Boring Location	Depth (ft) Below Existing Grade to Decomposed Rock Material	Depth (ft) Below Existing Grade to Auger Refusal (AR)
GSB-1	23.5	27
GSB-3	33.5	53.5
GSB-4	28.5	36
GSB-5	23.5	39
GSB-6	23.5	38.5
GSB-7	33.5	43.08
GSB-8	33.5	41.5
GSB-9	23.5	37
GSB-10	N/E	18.5
GSB-11	33.5	40.5
GSB-12*	13.5	37.5
GSB-13	18.5	20
GSB-14	28.5	45
GSB-15	23.5	30.5

* GSB-12 encountered decomposed rock from 13.5'-18.5' and again from 23.5'-37.5' with natural soils between the decomposed rock material

N/E = Not Encountered

More detailed descriptions of the soils encountered are presented on the Boring Logs in the Appendix.

Groundwater Observations

In auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the boreholes. Furthermore, visual observation of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions. Observations for groundwater were made during sampling and upon completion of the drilling operations at each boring location. Groundwater was encountered at boring locations GSB-1, GSB-4, GSB-7

through GSB-12, GSB-14, and GSB-15. The water level in these borings ranged from about 15 feet to 23 feet below the ground surface. The following table outlines the depth to groundwater at each of the boring locations.

Boring Location	Depth (ft) Below Existing Grade to Groundwater, During Drilling
GSB-1	23
GSB-3	Dry
GSB-4	20.5
GSB-5	Dry
GSB-6	Dry
GSB-7	28
GSB-8	15
GSB-9	17
GSB-10	17
GSB-11	17
GSB-12	18.5
GSB-13	Dry
GSB-14	20
GSB-15	15.5

The highest groundwater observations are normally encountered in winter and early spring. Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of exploration. Free water may also be encountered at the interface of fill soils, if present, and natural soils, or at the interface of natural soils and decomposed rock or bedrock.

The water levels reported in the above table were taken during drilling in cased boreholes. They were not taken in developed wells and therefore should only be considered approximate. Long-term steady state water levels may be higher or lower than those reported herein.

GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

The recommendations presented in this report are based on the project information provided to us, the results of the soil test borings, and our engineering analysis. Considering the results of our field exploration, and based on our experience with similar projects, it is our opinion that the site can be made suitable for construction of the proposed residential development. The dense natural soils expected at subgrade levels are considered to be suitable for the support of shallow spread footings. The existing natural soils and new structural fill are considered suitable for the support of slabs on grade, provided that the subgrade soils have been properly prepared, as described in this report, and approved by the Geotechnical Engineer or their authorized representative. Some undercut and replacement of soft, loose, or wet soils should be expected where slab levels extend below the water table.

Foundation Recommendations

Based on the test borings and a lowest finished floor three (3) levels below existing grades (approximate cut of 30 to 35 feet), the soils anticipated at nominal foundation subgrade levels

are expected to consist of natural medium dense to dense Silty SAND (SM) or decomposed rock. Based on the results of the subsurface exploration, recommendations outlined in the **"Earthwork Operations"** section, and our engineering analysis, the proposed structure can be supported on spread footing foundations when founded on suitable natural materials or decomposed rock. Footings should not be designed to bear on materials which do not meet the criteria outlined below. If unsuitable bearing materials are encountered at footing subgrade levels, footings should be lowered to bear on suitable soils at greater depths.

The geotechnical analysis of the soil indicates that footings supported on the natural dense sandy materials or decomposed rock may be designed for a bearing pressure of 20,000 psf. These soils may be identified on the boring logs as those natural materials exhibiting an SPT N-value of 30 blows per foot (bpf) or greater. Some minor (less than 5 feet) lowering of footings may be necessary in some areas to achieve a 20,000 psf bearing pressure, specifically the area of borings GSB-3, GSB-8, and GSB-11.

Boring	Minimum Depth (ft) Below Existing Grade Suitable for Support of a 20,000 psf Bearing Pressure
GSB-1	25
GSB-3	30
GSB-4	20
GSB-5	25
GSB-6	20
GSB-7	25
GSB-8	35
GSB-9	25
GSB-10	20
GSB-11	35
GSB-12	25
GSB-13	20
GSB-14	25
GSB-15	25

The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure.

It is anticipated that footing subgrades will generally be supported on natural ground. However, the bases of all foundation excavations should be observed and tested by the Geotechnical Engineer. Highly plastic silts may be present in areas at the site which were not explored. Highly plastic materials while not usually found in significant quantity, may be found in isolated areas in this geology. If unsuitable soils are encountered at planned subgrade levels for any footing, the unsuitable soils shall be undercut to suitable bearing materials. The footing can be directly supported on competent soils at greater depths or, alternatively, the design footing bearing level can be restored through placement of lean (2,500 psi) concrete. Replacement of footing undercuts with flowable fill or compacted engineered fill materials is NOT acceptable due to the high bearing pressures required. If lean concrete is to be used to restore foundation bearing levels, the undercut excavations can be made "neat" with the dimension of the footing.

Lean concrete shall conform to Maryland State Highway Mix No. 1. All foundations should be constructed with Type I Portland cement concrete.

Settlement of individual footings, designed in accordance with the recommendations outlined above, is expected to be within tolerable limits. Within the proposed construction, total settlements on the order of one inch are anticipated, with differential settlement on the order of about half the total settlement.

In order to prevent disproportionately small footing sizes and to prevent shear failures, we recommend that continuous footings have a minimum width of 1.5 feet and that isolated column footings have a minimum lateral dimension of 2.5 feet. The minimum dimensions recommended above help reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" action. In addition, footings should be placed at a depth to provide adequate frost cover protection. Therefore, perimeter footings subject to freezing should be placed at a minimum depth of 2.5 feet below finished grade.

Footings Adjacent to the Existing Building

New footings in areas adjacent to the existing residential structure to remain will require special consideration. Construction of footings adjacent to the existing building should be performed carefully so as not to undermine the existing footing or induce additional stress from the new footing. At this time, it is not known whether the existing building is supported on shallow spread footings or a deep foundation system. Underpinning may be required for existing shallow spread footings located within the zone created by an imaginary line extending upward and outward from the bottom edge of the new footing at a 45-degree angle.

Additionally, the effects of additional lateral loading from the new footings applied to any existing deep foundation elements located within the zone created by an imaginary line extending downward and outward from the bottom edge of the new footing at a 45-degree angle should be analyzed. If the potential additional lateral load will exceed the capacity of the existing deep foundation element, the new footing should be lowered such that the load spread created will not impact the existing element.

Seismic Site Class

Data Processing

A Refraction Microtremor (ReMi) survey was performed at the subject site at two sub-perpendicular transect locations designated as Remi-1 (210') and Remi-2 (180'). The approximate locations of the ReMi lines are shown on the Boring Location Diagram in the Appendix.

ReMi processing requires three steps: 1) velocity spectral analysis, 2) Rayleigh phase velocity dispersion picking and 3) shear wave velocity modeling. The seismic data records collected above were processed using proprietary software and the refraction microtremor method described by Louie (2001) and Pullammanappallil et. al. (2003). A brief discussion of each of the three steps is presented below:

Step 1: The velocity spectral analysis is the p-tau transformation which consists of multiple seismogram amplitudes relative to distance and time. The seismogram amplitudes are converted to the ray parameter (p) which is the inverse of apparent velocity and an intercept time (tau). The transform is a simple line integral across a seismic record in distance and time where the inverse in the apparent velocity is the slope of the line ($p = dx/dt$) in the x direction. The distances used in the refraction microtremor are distances of geophones from one end of the array. A complex Fourier transform is computed from the p-tau traces where the power spectrum is the magnitude squared of the complex Fourier transform. The distinctive slope of dispersive waves is an integral part of the p-f analysis. By recording many channels and using the p-f method the program successfully analyzes Rayleigh wave dispersion.

Step 2: Rayleigh-Wave Dispersion Picking: A spectral power ratio calculation is added to the p-f technique for spectral normalization of the record. Picks are made at frequencies where there is a definite peak in spectral ratio often below 4 Hz and above 14 Hz where an identifiable dispersive surface wave does not appear. The p-f image often shows the average velocity to 100 feet of depth from the phase velocity of a strong peak ratio appearing at 4 Hz for soft sites and 8 Hz for stiffer sites. An attempt is made to pick the lower edge of the lowest velocity but at a reasonable peak ratio.

Step 3: Shear Wave Velocity Modeling: This step consists of interactive forward-modeling of dispersion curves by the practitioner which yields information on velocity constraints. A code is used which produces results that are identical to those of other forward-modeling codes used. The modeling iterates on phase velocity at each period and reports when a solution has not been found within the given parameters. The program uses a graphical modeling adjustment that allows rapid fitting of the dispersion curves.

Analysis and Results

The results of the shear wave velocity profiles along each line are contained in the Appendix. The seismic site class definitions for the weighted average of shear wave velocity in the upper 100 feet of the soil profile are presented in Table 1613.5.2 of the 2012 IBC Code as shown on the table below:

Site Class	Soil Profile Name	Shear Wave Velocity, Vs, (ft./s)
A	Hard Rock	Vs > 5,000 fps
B	Rock	2,500 < Vs ≤ 5,000 fps
C	Very dense soil and soft rock	1,200 < Vs ≤ 2,500 fps
D	Stiff Soil Profile	600 ≤ Vs ≤ 1,200 fps
E	Soft Soil Profile	Vs < 600 fps

Conclusions – Site Classification

The modeled ReMi data collected from line Remi 1 and Remi 2 produced average shear wave velocities of 1,644 ft/s and 1,729 ft/s, respectively, to a depth of 100 feet below the existing ground surface. Using the data collected from Line 1 and Line 2, the soil/rock profile type for the Phase I building locations falls in the range of Seismic Site Class “C”, as shown in the preceding table in accordance with the IBC 2012.

Qualification of ReMi Report

The measured results represent average shear wave velocities of a large cross-sectional area of the subsurface and thus are representative of conditions responsible for site response to earthquake. The local velocities and depths of individual layers may vary along the length of lines. Some variation in shear wave velocities should be expected across the site.

Floor Slab Design

According to the test borings and a lowest floor level three levels below grade, the soils anticipated below the floor slabs should consist of medium dense to dense natural sandy soils or decomposed rock. These soils are expected to be suitable for support of the floor slabs. However, some areas of loose or excessively wet soils requiring undercut should be expected, especially where slab level will be below the groundwater table. The floor slab subgrade should be prepared in accordance with our recommendations outlined in the section entitled "**Earthwork Operations**", which includes undercut guidelines and fill placement. Floor slabs designed via the recommendations provided in this report may utilize a subgrade modulus, k, of 150 pci. A sliding coefficient of 0.4 may be utilized for slabs supported on AASHTO #57 stone.

We recommend that floor slabs be isolated from the foundation footings so that differential settlement of the structures will not induce stresses on the floor slab. Also, in order to minimize the crack width of any shrinkage cracks that may develop near the surface of the slab, we recommend mesh reinforcement be included in the design of the floor slab. The mesh should be in the top half of the slab to be effective.

Groundwater levels observed in the borings indicate that the water level at this site should be anticipated between 15 and 20 feet below existing grades. Therefore, the lowest slab level is expected to be approximately 10 to 15 feet below the groundwater table, therefore underslab drainage will be necessary.

We recommend that a capillary cutoff layer be provided under the floor slab to prevent the rise of moisture through the floor slab. The capillary layer should consist of a minimum of 6 inches of clean crushed stone or washed gravel, with a maximum 2% fines passing the No. 200 sieve. AASHTO No. 57 stone should be suitable for this purpose. A vapor barrier should be placed on top of the stone to provide additional moisture protection only in occupied or enclosed areas of the structure. A vapor barrier is not necessary in general parking areas. Placement of this vapor barrier should occur immediately before the placement of floor slab concrete in order to minimize damage to the layer. However, special attention should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking.

Slabs designed per the recommendations outlined above should be suitable to support non-load-bearing walls. The structural engineer, however, should incorporate the dead load of these walls in the design of the slab thickness.

Subdrainage Recommendations

Water levels measured in the boreholes indicate ground water will be above the lowest floor grade; therefore, subdrainage is expected to be necessary. Basement floors would need to be designed for hydrostatic pressures if the recommended subdrainage systems are not installed. The following section details subdrainage recommendations for the office building.

Subdrainage systems will require pumped discharge into the storm sewer system from sump pits installed in the lowest level. We recommend that a preliminary pump capacity of about 75-g.p.m. initially be selected. The final pump size should be adjusted based on the results of field measurements during construction. Flow quantities during construction should be measured after water flow has stabilized and prior to final selection of a specific capacity pump to verify this estimated flow quantity. Standby pumping facilities should be planned in the event of failure of the main pump system and should remain operational during power outages.

Interior collector lines below floor slabs consisting of 4-inch diameter, corrugated, slotted, polyethylene pipe per ASTM F-405 are considered adequate for the under-floor subdrainage system. Slot widths should not exceed 1/8 inch. Pipes should be placed essentially level at least 14 inches below the floor. The drainage pipe should be surrounded with a minimum of 4 inches of stone filter material on all sides. Filter material should meet requirements for AASHTO No. 57. The drainage filter material should be wrapped in filter fabric for added protection against siltation of fines. Filter fabric such as Mirafi 140, Fibretex by Crown Zellerbach, or similar material may be used for this purpose. The interior collector lines should be placed in a grid pattern at a maximum spacing of 60 feet on-center. This layout should be considered schematic only, and the final layout should be designed to avoid structural and mechanical elements and utilities. Cleanouts should be constructed after every second right angle bend in the subdrainage collection line system.

The design and construction of a subdrainage system is not completely foolproof and localized system failures may occur due to various causes. Therefore, maintenance of this system will be required if soil particles infiltrate the pipes. Flushing periodically may be required.

Subdrainage requirements have been prepared to assist in the design of a subdrainage system for this project. They are based on the subsurface and water data reviewed herein. A plan should be prepared to indicate the entire subdrainage system including sump pump and cleanout locations and layout of interior collection lines for efficient disposal of collected water. Attention to details of construction and proper observation by qualified personnel is considered necessary for the subdrainage system recommended herein. If substantially different water flow quantities are encountered during construction or if lowest floor levels are changed, we should be contacted so that we may evaluate any effect on the recommendations given herein.

AASHTO No. 57 stone is considered adequate for the washed gravel or crushed stone drainage blanket below the floor slabs and should be at least 6 inches thick. This layer is part of the subdrainage system and should be protected from contamination by soil and concrete.

Water is expected to be encountered above lowest planned floor grades; therefore drainage panels will be required. Drainage panels such as Geotech Drainage Boards, Enka Drains, or Mira Drains should be placed continuously along the outside of the basement walls. If Geotech Drainage Boards are used, a minimum 2-inch thickness should be maintained. The drainage

panels can be attached to the outside face of the walls in areas where open excavations are used or they can be attached directly to the face of the lagging system should a braced excavation be utilized. A layer of filter fabric should also be used between the drainage panels and backfilled soil. Minimum 3-inch diameter weepholes should be provided through the base of foundation walls to allow collected water from drainage panels to discharge into the under-floor subdrainage system.

Vertical drainage panels should be installed on exterior walls to a height of 5 feet below final exterior grades. Elevator pits and utility trenches extending below the subdrainage system should be waterproofed and designed for hydrostatic pressure.

Basement walls in occupied areas should be waterproofed. Generally, waterproofing with drainage boards will provide the best protection against moisture penetration.

Construction Dewatering

Based on the anticipated design subgrade elevation and the measured groundwater levels during the subsurface exploration, groundwater should expect to be encountered during construction of the below grade levels. Consequently, a dewatering system consisting of either deep wells or well-points should be designed and installed by a qualified dewatering contractor. The dewatering system should be designed such that the ground water level is lowered to at least 2 feet below the bottom of the footing elevations and/or floor slab.

Ideally, the deep wells or well-points should be located immediately outside of the excavation limits. In addition to the construction dewatering system, localized dewatering by use of perimeter interim trenches, sump pits and pumping, should be anticipated during the footing and possible floor excavation to control the flow of perched or isolated groundwater intrusion as it is encountered. Multiple sump pits and pumps may be required as pockets or layers of groundwater are anticipated. At the time the floor slab is placed, any installed temporary sump pump should be removed, and the temporary sump pit should be abandoned in place by filling it with concrete or stone after cleaning of any loose and/or disturbed material.

The actual extent of the dewatering system will need to be determined at the time the excavation is performed. Settlement of nearby structures should be relatively minor considering the nature of the soils being dewatered. However, a monitoring program of the near by structures should be considered. We recommend that we review the proposed dewatering system once a system has been proposed.

If a soldier pile and wood lagging system is used for sheeting and shoring, groundwater seepage or flow between the lagging boards can result in loss of soil and subsequent settlement of streets, sidewalks or possibly the floor slab of existing buildings. If this condition is encountered the contractor should be prepared to install geotextile fabric between the lagging board and the retained soils.

Below Grade Walls

Below grade walls should be designed to withstand lateral earth pressures at at-rest conditions and any surcharge loads within a 45 degree slope from the base of the wall. We recommend that the below grade walls be designed for a linearly increasing lateral earth pressure of 60 psf per vertical foot of wall. This lateral earth pressure diagrams does not include hydrostatic pressure and assumes full drainage and a subdrainage system should be installed behind the walls. In addition exterior grades should be properly sloped to allow drainage of surface runoff away from the building. We recommend a minimum slope of 5% away from the structures. Surcharge loading within a 45 degree slope from the bottom of the wall should be applied with a combined active and at rest pressure coefficient of 0.4. In order to maintain a 60 psf lateral earth pressure, drainage of the backfill of the proposed building must be provided. A lateral earth pressure earth pressure diagram is included in the Appendix at the end of this report.

A lateral passive earth pressure of 350 psf per foot of soil may be used for design. The passive resistance should be neglected to a depth of 2.5 feet in areas exposed to freezing conditions and in areas where there is a possibility that the soil in front of the wall will become disturbed or be excavated at any time in the future. Considering the relatively fine-grained soils, which may constitute the wall foundation bearing subgrade, a friction factor of 0.4 is recommended for sliding resistance analysis.

To achieve a desirable balance between minimizing excessive pressures against the below grade walls and reducing the settlement of the wall backfill, we recommend that the wall granular backfill be compacted to 95% of the maximum dry density obtained in accordance with ASTM Specification D-698, Standard Proctor Method.

Backfill materials should consist of inorganic materials classified ML, SM, SC, or more granular per ASTM D-2487 that are free of debris. A majority of the on-site natural soils should be suitable for use as wall backfill. The fill placed adjacent to the below grade walls should not be over compacted. Heavy earthwork equipment should maintain a minimum horizontal distance away from the below grade walls of 1 foot per foot of vertical wall height. Lighter compaction equipment should be used close to the below grade walls.

Please note that the design parameters given in this section are NOT applicable to sheeting and shorting design.

Retaining Walls

Retaining walls, which are free to rotate at the top and mobilize more of the shear strength of the soil, can be designed for an active lateral pressure of 40 psf per foot of wall height, where the backgrades are horizontal. Retaining walls with angular joints or corners that limit the free rotation of the stem should be designed for at-rest lateral earth pressures of 60 psf. Where the wall backgrades are sloping the wall design should consider the surcharge effect of the extra earth retained. For resistance purposes, passive lateral pressures at the face of the footing can be 350 psf per foot of soil height. These values are based on cohesion value of zero, and a friction angle of 30°, which is typical of the soils observed. The frictional resistance factor against sliding should be considered as 0.4. These values are based on use of on-site material used as backfill. If select granular material is used, they may be adjusted accordingly.

If any walls are constructed on fill material placed in accordance with our recommendations in "Fill Placement", the passive resistance shall be decreased to 200 psf per foot of depth, and a frictional resistance coefficient of 0.35 can be utilized for the sliding resistance in the design. If utility lines will be constructed in front of any wall, the retaining wall footing should be stepped-down to invert elevations of the deepest pipe, and the passive resistance of the soil above the invert level should be neglected.

Retaining walls should also account for surcharge loads within a 45° slope from the base of the backside of the wall. In addition, the design pressure outlined above should be modified if a sloping backfill is required. The passive resistance should be neglected in the stability calculations if there is a possibility that the soil in front of the wall footing will be excavated at any time in the future and reduced if the wall is sited on a significant foreslope. Retaining walls should have a minimum factor of safety of 1.5 or greater against sliding and overturning. The values given above have not been corrected for that safety factor. Their final design should be performed by a qualified geotechnical engineer. ECS can provide the design for these walls if requested.

The recommendations contained above assume that backfill with Sandy SILT (ML) or more granular soils are used, and that the backfill behind the retaining wall is properly drained. A majority of the on-site natural soils should be suitable for use as wall backfill. Drainage of the backfill may be accomplished through the use of 3-inch diameter weep holes at 10 feet spacing, through the wall, immediately above the proposed grade in front of the wall. Alternatively, a longitudinal drain line may be placed behind the retaining wall, sloped to discharge by gravity. The drain should consist of a 6 inch perforated pipe surrounded by a minimum of 6 inches of AASHTO #57 stone. The #57 stone should be completely wrapped in a filtration geotextile such as Mirafi 140N with an AOS of 70. The geotextile used should be reviewed and approved by the geotechnical engineer.

Site retaining walls may be designed for a net allowable bearing pressure of 2,500 psf.

Please note that the design parameters given in this section are NOT applicable to sheeting and shorting design.

Earthwork Operations

Proper monitoring of newly placed fill with respect to lift thickness and compaction of each lift is expected to be necessary at this site. The following paragraphs detail our recommendations regarding earthwork operations.

Fill, Floor and Pavement Subgrades

The existing ground surface in the proposed structural areas should be stripped of all vegetation, rootmat, topsoil, asphalt, gravel, previous building debris, and any soft or unsuitable material. The stripping within the proposed structural areas should be extended to at least 10 feet, where possible, beyond the planned limits.

After stripping to the desired grade, performing all necessary excavation, and prior to fill and/or

stone base placement, the exposed soils should be carefully examined to identify any localized loose, yielding, or otherwise unsuitable materials by an experienced Geotechnical Engineer or their authorized representative. After examining the exposed soils, loose and yielding areas should be identified by proof rolling with an approved piece of equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Any soft or unsuitable materials encountered during this proof rolling should be removed and replaced with an approved engineered fill compacted to the criteria given below.

The preparation of fill subgrades, as well as proposed building and pavement subgrades, should be observed by an experienced geotechnical engineer, or their representative, to verify that all unsuitable materials have been removed, and that the subgrade is suitable for support of the proposed construction and/or fills. In some areas, excessively soft and/or wet soils are expected for fill subgrades, especially in the winter or early spring months. Soft, yielding areas shall be over-excavated and replaced. Since groundwater is expcted at lowest basement slab levels, loose, wet soils which will not be suitable for slab support should be expected. These soils should be undercut to a depth of 18 inches and replaced with 12 inches of #2 stone followed by 6 inches of #57 gravel. The #2 stone should be compacted into the soft subgrade to provide additional stabilization.

Fill Placement

Compacted engineered fill and backfill for utilities or undercuts should consist of soils classified as ML, SM, SC or more granular per ASTM D-2487 and have a liquid limit less than 45 and plasticity index less than 20. Unacceptable backfill materials include topsoil, organic materials (OH, OL) and high plasticity silts and clays (MH, CH). All such materials removed during grading operations should be either stockpiled for later use in landscape fills, or placed in approved disposal areas either on site or off site.

An examination of the soils recovered during our current exploration and our previous experience in the area indicates that a majority of the on site natural soils generally will be suitable for reuse as controlled, compacted fill with moisture adjustment during placement. The existing fill soils should be suitable for reuse as controlled, compacted fill as long as they are free of any deleterious material and meet the criteria outlined above.

All fill should be placed in loose lifts, not exceeding 8 inches in thickness, and should be compacted to at least 95 percent of the maximum dry density, as determined by the Standard Proctor Compaction Test (ASTM D-698). Generally, the moisture content of the fill materials should be maintained within ±2 percent of the optimum moisture content for the fill material, as determined by ASTM D-698. Fill placed in non-structural areas (e.g. grassed areas) should be compacted to at least 90 percent of the maximum dry density according to ASTM D-698, in order to avoid significant subsidence. The upper 12 inches of soil supporting slabs-on-grade and pavements should be compacted to a minimum of 100% of the maximum dry density obtained in accordance with ASTM D-698.

Excavation Support Requirements

Excavation to the lowest floor level will require cuts on the order of 30 to 35 feet. Sheeting and shoring is expected to be required as suitable layback area is not expected to be available. The following recommendations regarding sheeting and shoring for deep excavations should be followed.

A free drainage sheeting system with H beams, wood lagging, and appropriate bracing is considered feasible. Rakers and heel blocks will probably be necessary in areas where tiebacks are not feasible. H beams would normally be spaced at about 8 feet on center and driven to at least 5 feet below lowest excavation levels. Wood lagging should be at least 3 inches in thickness. Tiebacks would be feasible for most of the excavation. Soldier beams must be designed for vertical loads developed from the prestressed tiebacks.

A detailed specification shall be prepared for the installation testing of earth tiebacks. Specifications shall contain the following general requirements. Performance tests should be conducted on at least five tiebacks selected by the geotechnical engineer. Loads shall be applied by means of a hydraulic, center-hole jack in steps of 25, 50, 75, 100, 120, and 133 percent of the design load. Deflections during loading shall be measured. The capacity shall be considered adequate when a stable condition is obtained under the particular test load duration of about 15 minutes.

In addition, each tieback shall be proof-tested to 133 percent of the design load and locked at 80 percent of the design load. The test shall be performed after primary grouting for bond has set. Secondary grouting to fill the hole to the sheeting face shall be performed after the successful proof test. The maximum stress at working load in tendons or bars shall not exceed 60 percent of the guaranteed yield strength of steel.

It is recommended that structural drawings for sheeting and bracing be prepared by a specialty contractor who has at least 5 years experience in design and construction of this particular work. Plans for the system should be sealed by a professional engineer licensed to practice in the State of Maryland. The drawings should be prepared by a registered professional engineer and should be submitted to the structural engineer and the geotechnical consultant for review.

It should be noted that careful inspection and attention to detail during construction must be maintained to ensure satisfactory support of the excavation faces. We recommend that the geotechnical engineer be engaged for observation of both installation of soldier piles and testing of anchors and tiebacks. Additionally, we recommend soldier beams near grade should also be surveyed for horizontal and vertical movements. Monitoring of movements of the sheeting and shoring system should be performed at intervals selected by the geotechnical engineer.

The lateral earth pressures presented in the below grade and retaining wall sections of this report should NOT be used in the design of sheeting and shoring.

WMATA Adjacent Construction

An existing WMATA rail line is present on the west side of the property. It is anticipated that the proposed construction will fall within the WMATA Zone of Influence (ZOI). The WMATA ZOI is defined as a distance of the greater of H+2 (where H is the depth of excavation) or 25 feet. Excavation support should be designed according to the Adjacent Construction Project Manual (dated September 16, 2013 – Revision 5), Section 3.3, and Appendix 3, Plate A-1A.

Additionally, a monitoring program may be required for the excavation support system. Once final design plans are available for the proposed buildings, ECS can assist with review of the excavation support system and implementation of the monitoring system.

Construction Considerations

Precautionary measures should be taken to ensure that preparation of the subgrade and footing bearing surfaces are accomplished by the recommended procedures. These precautions are necessary, as the materials observed in the borings will become weakened if exposed to water. Therefore, we recommend that all excavations be properly dewatered, if necessary, using conventional sump pit and pumping operations. The site should be graded such that surface water runoff is directed away from the excavations.

Exposure to the environment may weaken the soils at the footing bearing level if foundation excavations remain open for extended periods of time. Therefore, foundation concrete should be placed the same day that footings are excavated. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, we recommend that a 1-to 3-inch thick "mud-mat" of "lean" concrete be placed on the bearing soils before the placement of reinforcing steel.

The on-site soils contain fines which are considered highly erodible. The Contractor should provide and maintain good site drainage during earthwork operations to help maintain the integrity of the surface soils. The surface of the site should be kept properly graded in order to enhance drainage of the surface water away from the proposed construction areas during the earthwork phase. Other practices would involve sealing the exposed soils daily with a smooth drum roller to reduce the potential for infiltration of surface water in the exposed soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current County requirements.

In their undisturbed state, the upper soils at the site will generally provide good subgrade support for fill placement and construction operations. However, when disturbed or wet, these soils will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations, which will help maintain the integrity of the soil.

Closing

This report has been prepared to aid in the evaluation of this site and to assist the design team with the design of the proposed residential development. No final site plans exist at this time, and once such plans are available, a thorough review of the recommendations provided herein should be completed. This report is limited to the locations and construction described.

We have appreciated the opportunity to be of service to you and hope to continue our involvement on the project during the final design and construction phases. ECS-Mid-Atlantic, LLC (ECS) is capable of providing all construction materials testing services for the project, and we would appreciate the opportunity to offer our services.

APPENDIX

Site Location Diagram

Lateral Earth Pressure Diagram

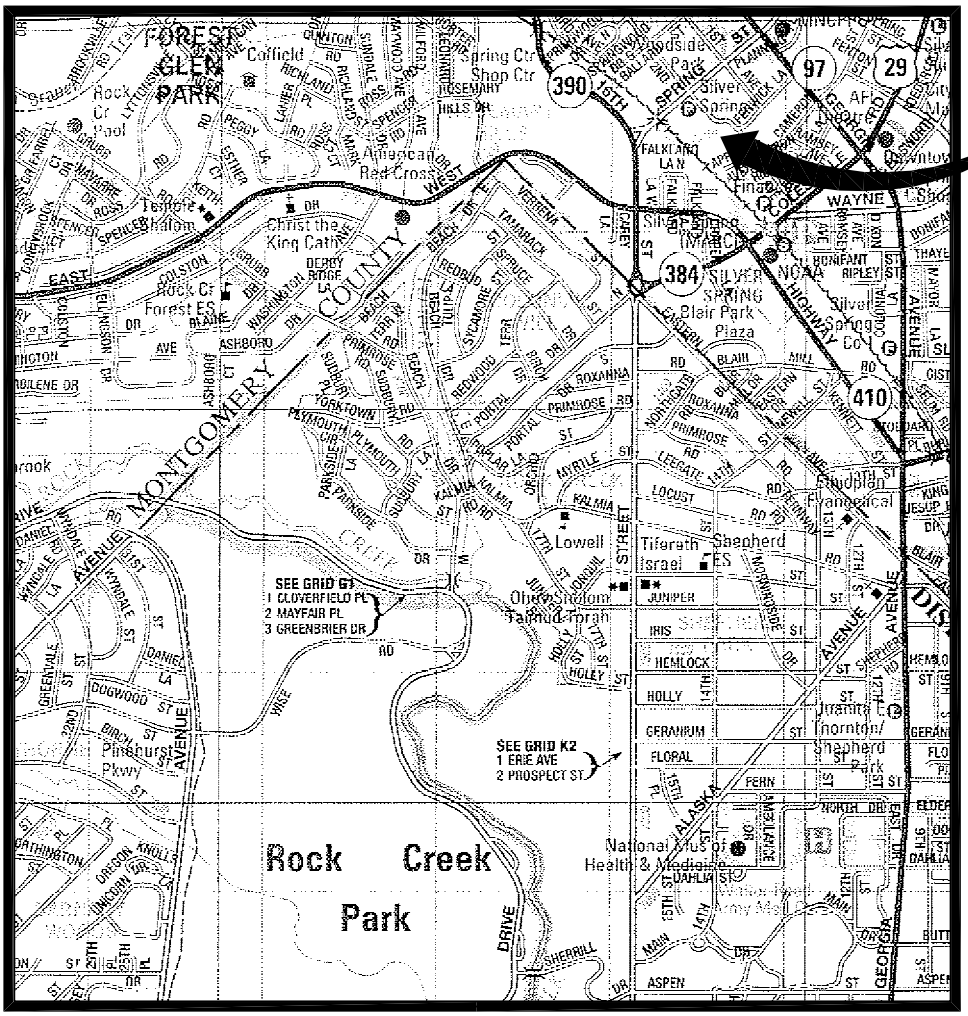
Unified Soil Classification System

Reference Notes for Boring Logs

ECS Boring Logs (GSB-1, GSB-3 through GSB-15)

ReMi Survey Results

Boring Location Diagram

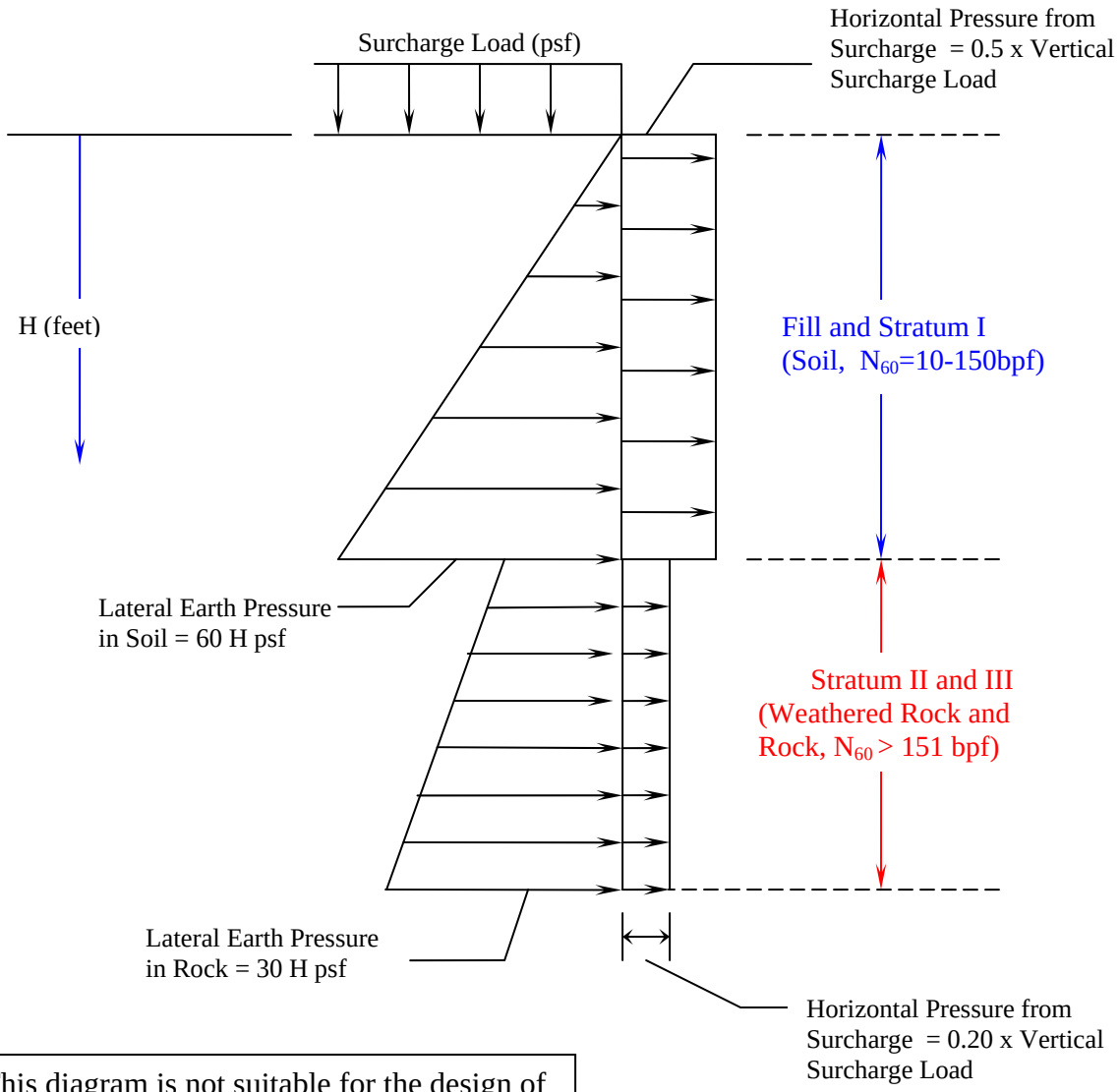


SITE LOCATION DIAGRAM

ELIZABETH HOUSE

LEE DEVELOPMENT GROUP

AMH	GAR	07-03-14	NTS	13-6318	1 OF 1

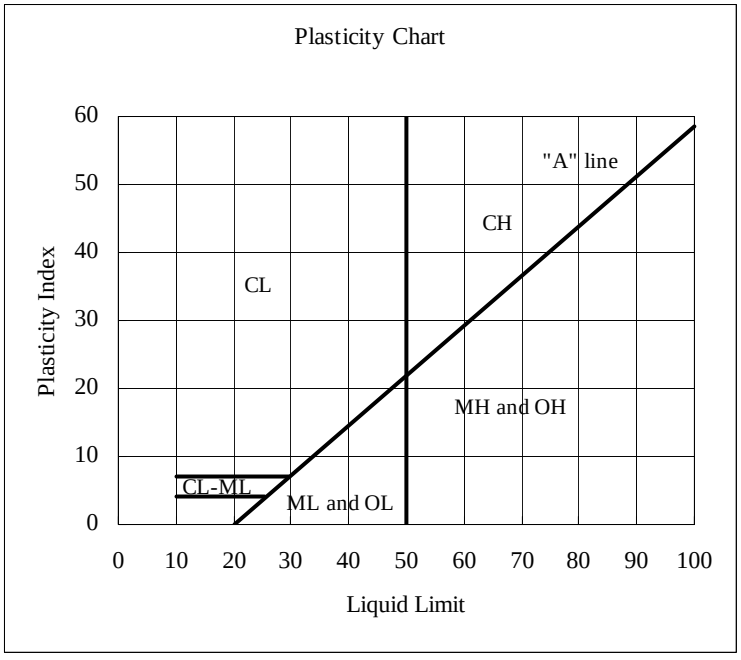


This diagram is not suitable for the design of Support of Excavation or temporary shoring systems

LATERAL EARTH PRESSURE DIAGRAM – SOIL AND ROCK PROFILES, DRAINED

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4; $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM [a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6; $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM [a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

Particle Size Identification		
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	⊽	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

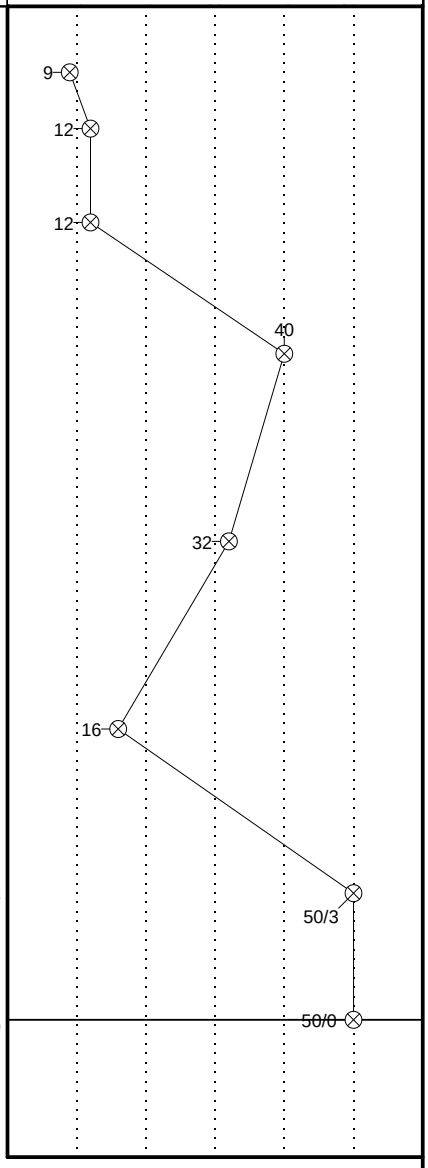
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [4"], Gravel Depth [6"]		
	S-1	SS	18	6	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Loose (SM FILL)		3 4 5
	S-2	SS	18	18	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Medium Dense (SM)		5 6 6
5	S-3	SS	18	12			4 5 7
	S-4	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock and Rock Fragments, Brown, Moist, Dense (SM)		14 17 23
10							
	S-5	SS	18	18			12 16 16
15							
	S-6	SS	18	18	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Medium Dense (SM)		8 8 8
20							
	S-7	SS	3	3	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		50/3
25							
	S-8	SS	0	0	AUGER REFUSAL @ 27.00'		50/0
30							



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23.00 WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) 23.00 WL(ACR)	BORING COMPLETED 06/21/14	CAVE IN DEPTH 15.00
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-3	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

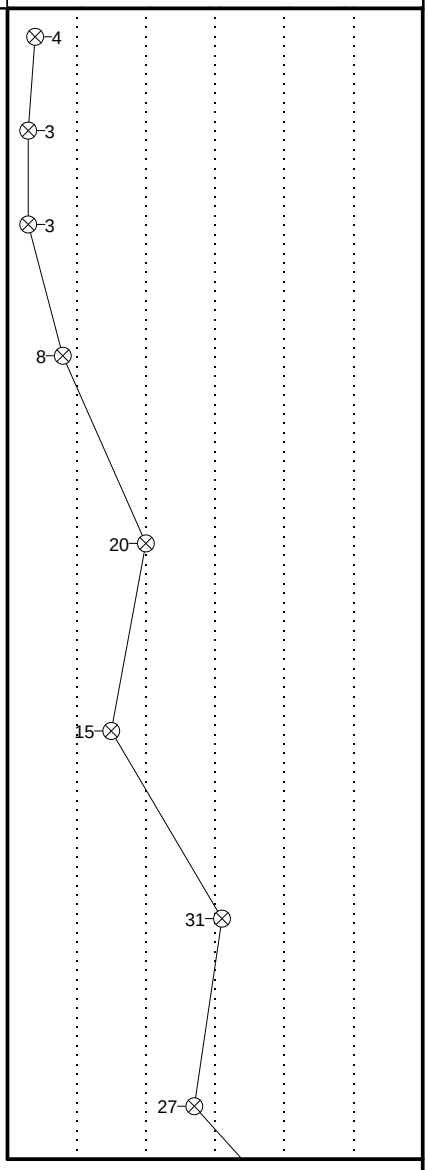
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	18	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Loose (SM FILL)			2 2 2
	S-2	SS	18	18	Micaceous Silty SAND, Brown, Moist, Very Loose to Loose (SM)			2 1 2
5	S-3	SS	18	18				2 1 2
	S-4	SS	18	18				2 3 5
10	S-5	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense to Dense (SM)			5 8 12
15	S-6	SS	18	18				5 7 8
20	S-7	SS	18	18				9 12 19
25	S-8	SS	18	18				6 8 19
30								



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) DRY WL(ACR)	BORING COMPLETED 06/22/14	CAVE IN DEPTH 16.00
WL DRY	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-3	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

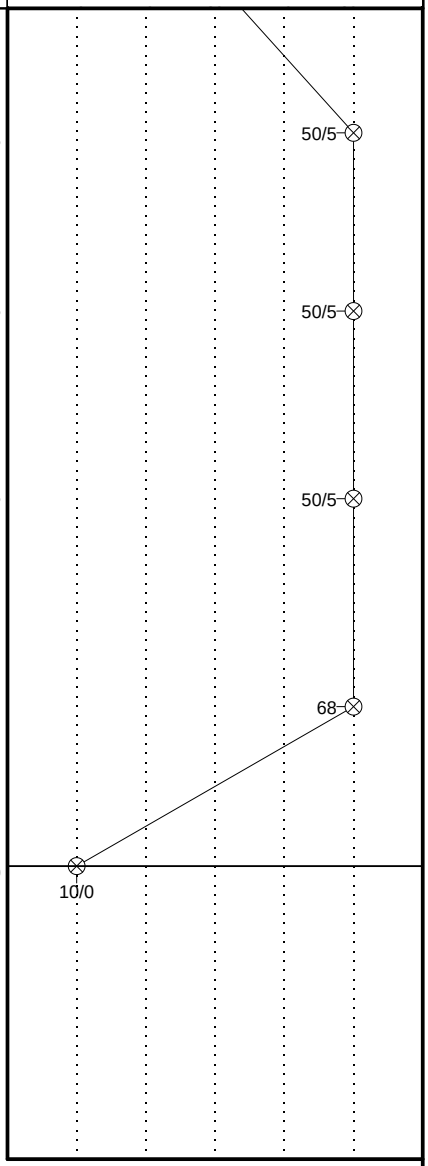
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense to Dense (SM)			
35	S-9	SS	11	11	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			25 50/5
	S-10	SS	5	5				50/5
40	S-11	SS	5	5				50/5
45	S-12	SS	18	14				28 35 33
50	S-13	SS	0	0	AUGER REFUSAL @ 53.50'			10/0
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) DRY WL(ACR)	BORING COMPLETED 06/22/14	CAVE IN DEPTH 16.00
WL DRY	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-4	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

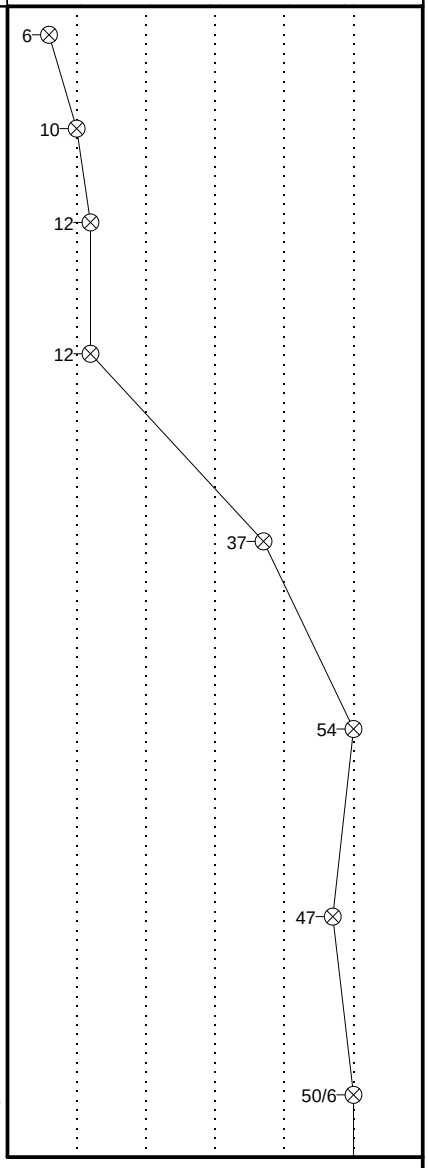
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	12	SILT, With Sand, Trace Mica, Brown, Moist, Loose (ML)		3 3 3
	S-2	SS	18	18	Sandy SILT, With Mica, Brown, Moist, Loose (ML)		5 5 5
5	S-3	SS	18	14	Micaceous Silty SAND, Brown, Moist, Medium Dense (SM)		4 5 7
	S-4	SS	18	18			5 6 6
10	S-5	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Light Brown, Moist, Dense (SM)		13 17 20
15	S-6	SS	18	15	Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Very Dense to Dense (SM)	▽	18 27 27
20	S-7	SS	18	18			15 19 28
25	S-8	SS	12	11	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		23 50/6
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL DRY WS ☐ WD ☐	BORING STARTED 06/23/14	
▽ WL(BCR) ▼ WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 22.5
▽ WL 20.5 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-4	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

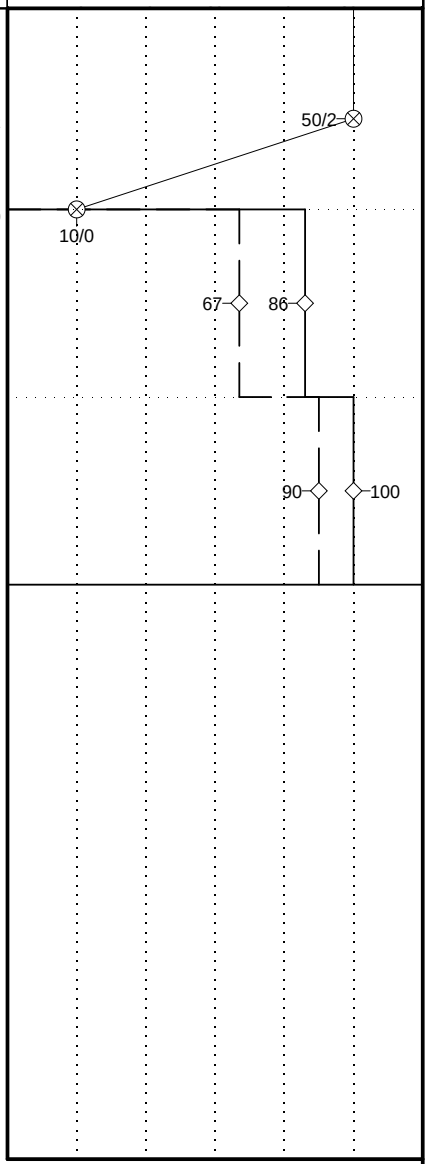
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
35	S-9	SS	2	2	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			50/2
	S-10	SS	0	0	SCHIST, Very Hard, Slightly Weathered, Moderately Fractured, Light Gray [REC 86%, RQD= 67%]			10/0
40	S-11	RC	60	52				
45	S-12	RC	60	60	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 100%, RQD= 90%]			
					END OF BORING @ 46.00'			
50								
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/23/14	
WL(BCR) WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 22.5
WL 20.5 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-5	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

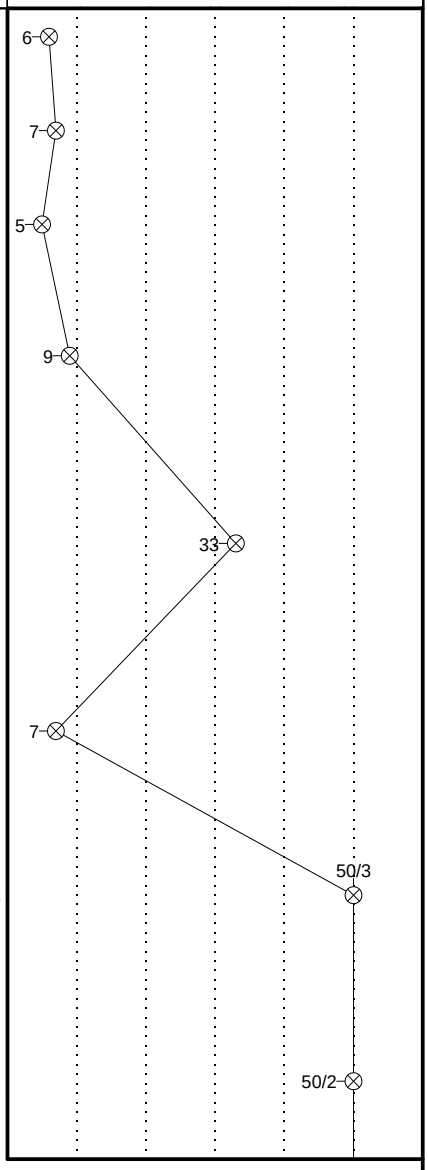
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	10	Topsoil Depth [4"] Sandy SILT, With Mica, Trace Roots, Brown, Moist, Loose (ML)			3 3 3
	S-2	SS	18	12	Micaceous Silty SAND, Brown, Moist, Loose (SM)			3 3 4
5	S-3	SS	18	16				2 3 2
	S-4	SS	18	18				4 4 5
10	S-5	SS	18	18	Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense (SM)			11 14 19
15	S-6	SS	18	18	Micaceous Silty SAND, Brown, Moist, Loose (SM)			3 4 3
20	S-7	SS	3	3	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			50/3
25	S-8	SS	2	2				50/2
30								



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/21/14	CAVE IN DEPTH 19.1
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-5	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION | SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	BLOWS/6"
35	S-9	SS	2	2	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		50/2
	S-10	SS	1	1			50/1
40	S-11	SS	0	0	AUGER REFUSAL @ 39.00'		10/0
45							
50							
55							
60							

50/2 50/1 10/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/21/14	CAVE IN DEPTH 19.1
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-6	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

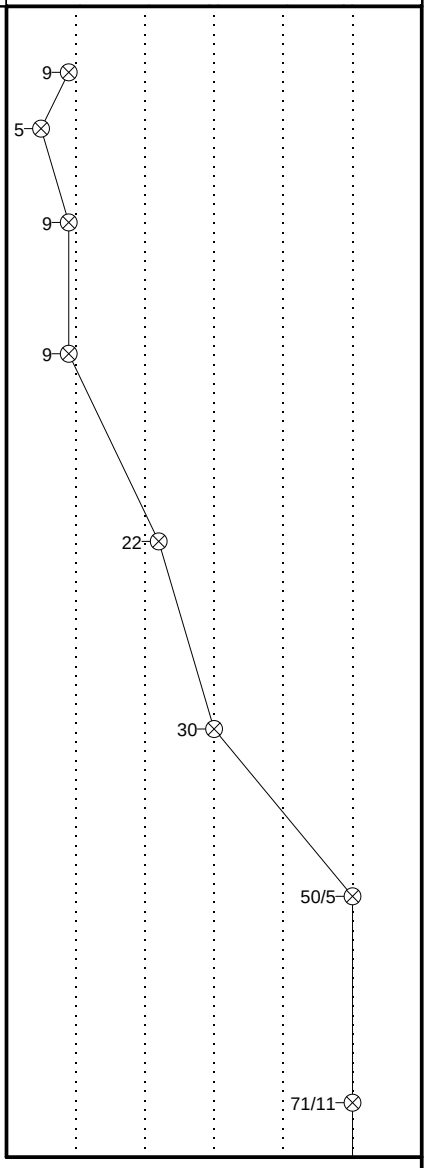
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [6"], Gravel Depth [6"]		
	S-1	SS	18	6	Silty SAND, With Mica, Trace Rock Fragments, Dark Brown, Moist, Loose (SM FILL)		8 6 3
	S-2	SS	18	10	Micaceous Silty SAND, Brown, Moist, Loose (SM)		3 2 3
5	S-3	SS	18	10			5 4 5
	S-4	SS	18	16			3 4 5
10	S-5	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		4 8 14
15	S-6	SS	18	18			10 12 18
20	S-7	SS	5	5	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		50/5
25	S-8	SS	17	17			20 21 50/5
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/21/14	CAVE IN DEPTH 14.8
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-6	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

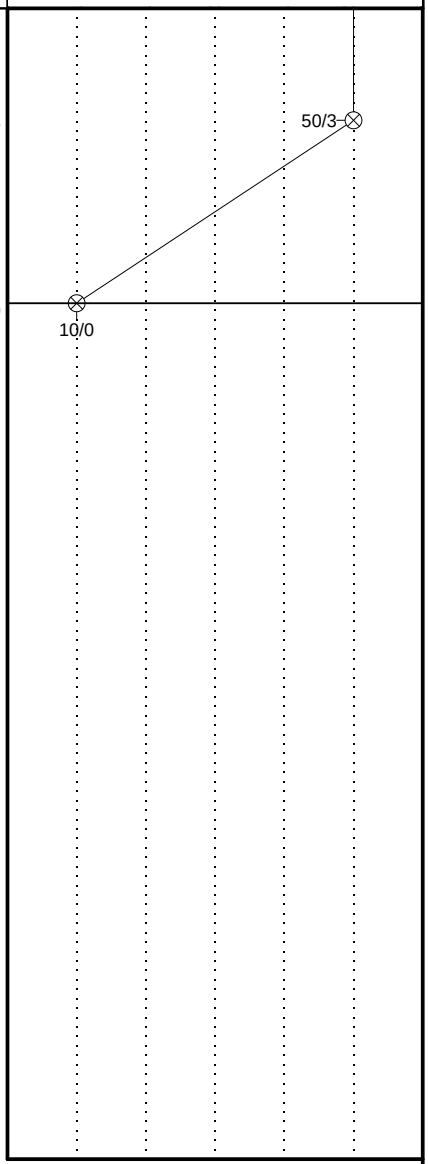
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
35	S-9	SS	3	3	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			50/3
40	S-10	SS	0	0	AUGER REFUSAL @ 38.50'			10/0
45								
50								
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/21/14	CAVE IN DEPTH 14.8
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-7	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

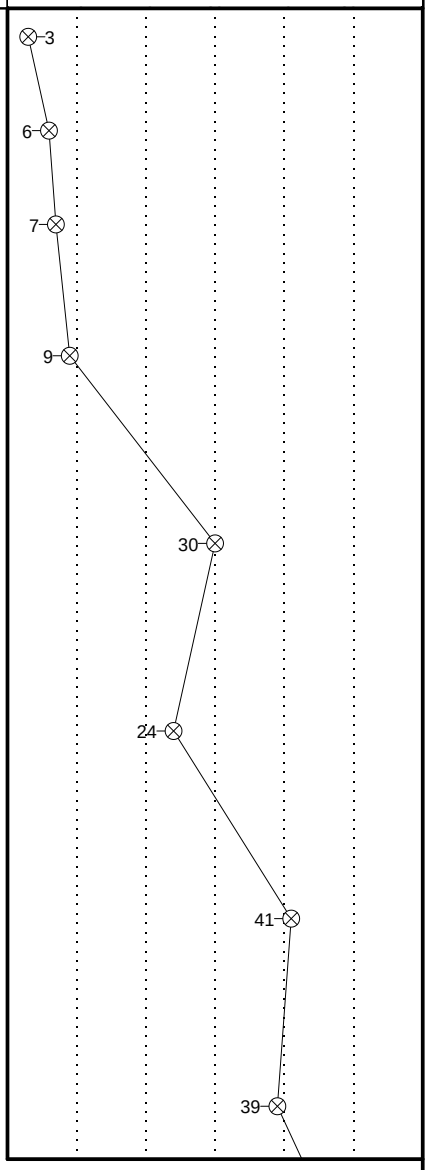
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	14	Topsoil Depth [6"] Silty SAND, Trace Roots, Mica, and Rock Fragments, Brown, Moist, Very Loose (SM FILL)		1 1 2
	S-2	SS	18	18	Micaceous Silty SAND, Brown, Moist, Loose (SM)		3 3 3
5	S-3	SS	18	18			2 3 4
	S-4	SS	18	18			2 4 5
10	S-5	SS	18	18	Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense (SM)		10 13 17
15	S-6	SS	18	18			9 4 20
20	S-7	SS	18	18			11 20 21
25	S-8	SS	18	18			12 18 21
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 28.00 WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/22/14	CAVE IN DEPTH 27.4
WL	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-7	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

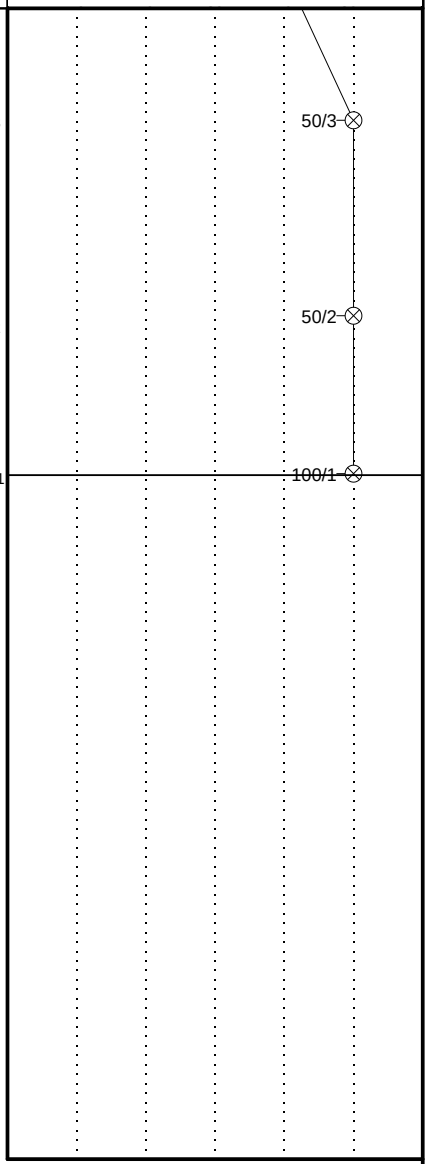
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense (SM)			
	S-9	SS	3	3				50/3
35					Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			
	S-10	SS	8	7				39 50/2
40								
	S-11	SS	1	1	AUGER REFUSAL @ 43.08'			100/1
45								
50								
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 28.00 WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/22/14	CAVE IN DEPTH 27.4
WL	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-8	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

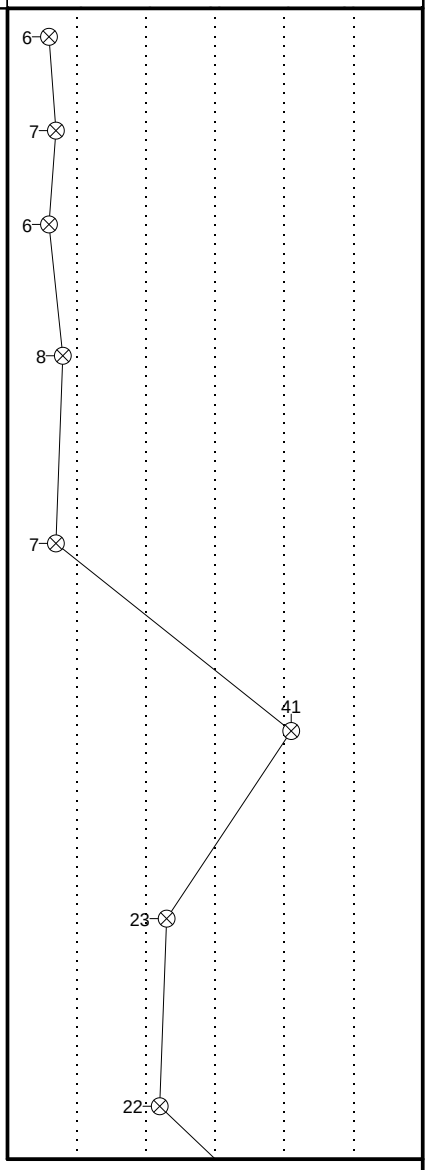
PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION | SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	18	Topsoil Depth [5"] Micaceous Silty SAND, Trace Clay, Brown, Moist, Loose (SM)		2 3 3
	S-2	SS	18	18	Micaceous Silty SAND, Brown, Moist, Loose (SM)		2 3 4
5	S-3	SS	18	10			2 3 3
	S-4	SS	18	18			3 4 4
10	S-5	SS	18	18			3 3 4
15	S-6	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Dense to Medium Dense (SM)		16 19 22
20	S-7	SS	18	18			6 10 13
25	S-8	SS	18	18			4 10 12
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 32.00 WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) 15.00 WL(ACR) DRY	BORING COMPLETED 06/22/14	CAVE IN DEPTH 8.9
WL	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-8	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS; BOTTOM OF CASING; LOSS OF CIRCULATION; SURFACE ELEVATION)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
					Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Dense to Medium Dense (SM)		
35	S-9	SS	16	13	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		12 19 50/4
40	S-10	SS	3	3			50/3
	S-11	SS	0	0	AUGER REFUSAL @ 41.50'		100/0
45							
50							
55							
60							

69/10

50/3

100/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 32.00 WS ☐ WD ☐	BORING STARTED 06/22/14	
WL(BCR) 15.00 WL(ACR) DRY	BORING COMPLETED 06/22/14	CAVE IN DEPTH 8.9
WL	RIG CME 55 FOREMAN Sam Connelly	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-9	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

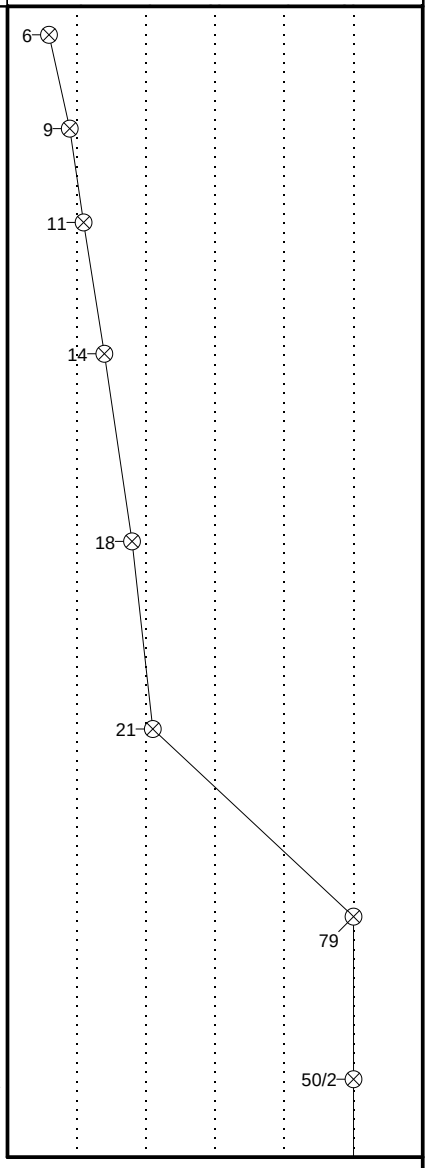
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	15	Sandy SILT, With Mica, Trace Rock Fragments, Brown, Moist, Loose (ML FILL)		2 3 3
	S-2	SS	18	18	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Loose (SM FILL)		2 4 5
5	S-3	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		5 6 5
	S-4	SS	18	18			6 7 7
10	S-5	SS	18	18			8 7 11
15	S-6	SS	18	18			6 11 10
20	S-7	SS	18	18	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		13 33 46
25	S-8	SS	2	2			50/2
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS☐ WD☐	BORING STARTED 06/23/14	
WL(BCR) WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 21.0
WL 17.0 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-9	2 OF 2

PROJECT NAME: Elizabeth House

ARCHITECT-ENGINEER:

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING: | EASTING: | STATION:

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

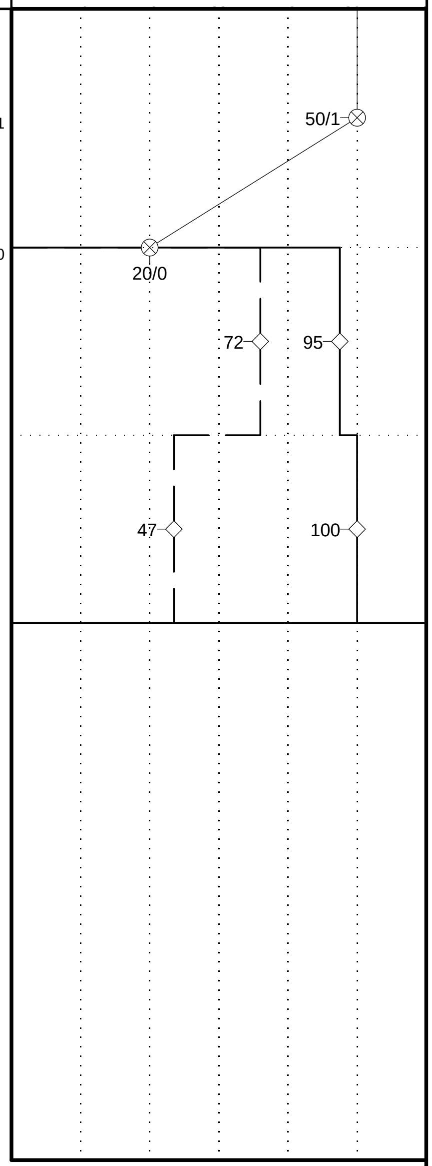
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			
	S-9	SS	1	1				50/1
35								
	S-10	SS	0	0	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 95%, RQD= 72%]			20/0
40	S-11	RC	60	57				
					SCHIST, Very Hard, Slightly Weathered, Moderately Fractured, Light Gray [REC 100%, RQD= 47%]			
45	S-12	RC	60	60				
					END OF BORING @ 47.00'			
50								
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/23/14	
WL(BCR) WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 21.0
WL 17.0 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

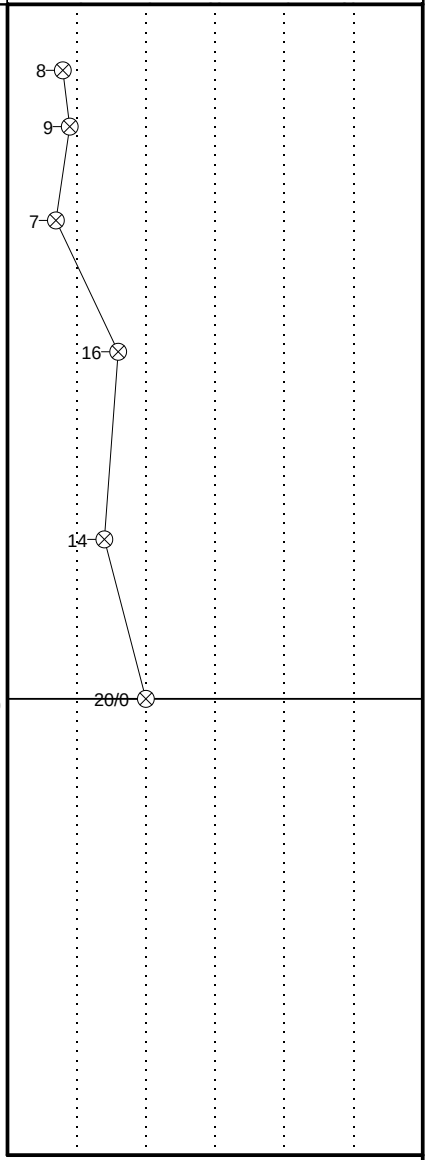
PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION | SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Depth [4"], Gravel Depth [8"]			
	S-1	SS	18	12	Micaceous Sandy SILT, Brown, Moist, Loose (ML)			3 4 4
	S-2	SS	18	12				4 5 4
5	S-3	SS	18	12	Micaceous Silty SAND, Brown, Moist, Loose to Medium Dense (SM)			4 4 3
	S-4	SS	18	14				4 8 8
10	S-5	SS	18	18				6 8 6
15	S-6	SS	0	0	AUGER REFUSAL @ 18.50'			20/0
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 17.00 WS ☐ WD ☐	BORING STARTED 06/21/14	
WL(BCR) 17.00 WL(ACR)	BORING COMPLETED 06/21/14	CAVE IN DEPTH 6.5
WL	RIG CME 55 FOREMAN J. Lewis	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-11	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

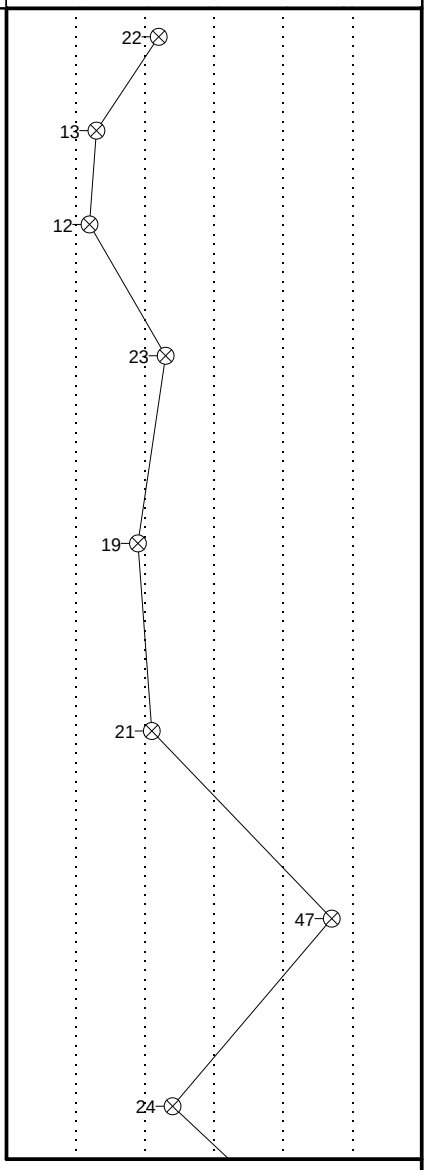
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	15	Sandy SILT, With Mica, Trace Clay, Organics, and Rock Fragments, Dark Brown, Moist, Medium Dense (ML FILL)		6 8 14
	S-2	SS	18	16	Micaceous Sandy SILT, Trace Clay, and Rock Fragments, Brown, Moist, Medium Dense (ML FILL)		4 6 7
5	S-3	SS	18	12			5 6 6
	S-4	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		8 12 11
10	S-5	SS	18	18			12 10 9
15	S-6	SS	18	18			10 11 10
20	S-7	SS	18	18	Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense (SM)		13 27 20
25	S-8	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		10 10 14
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23.50 WS ☐ WD ☐	BORING STARTED 06/23/14	
WL(BCR) 27.00 WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 21.5
WL 17.0 @ 24 Hours	RIG CME 55 FOREMAN Kevin	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-11	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
					Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		
35	S-9	SS	6	6	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		50/6
	S-10	SS	1	1			50/1
40					AUGER REFUSAL @ 40.50'		
45							
50							
55							
60							

BOTTOM OF CASING ▰ LOSS OF CIRCULATION (100%)

SURFACE ELEVATION

50/6

50/1

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23.50 WS ☐ WD ☐	BORING STARTED 06/23/14	
WL(BCR) 27.00 WL(ACR)	BORING COMPLETED 06/23/14	CAVE IN DEPTH 21.5
WL 17.0 @ 24 Hours	RIG CME 55 FOREMAN Kevin	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-12	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

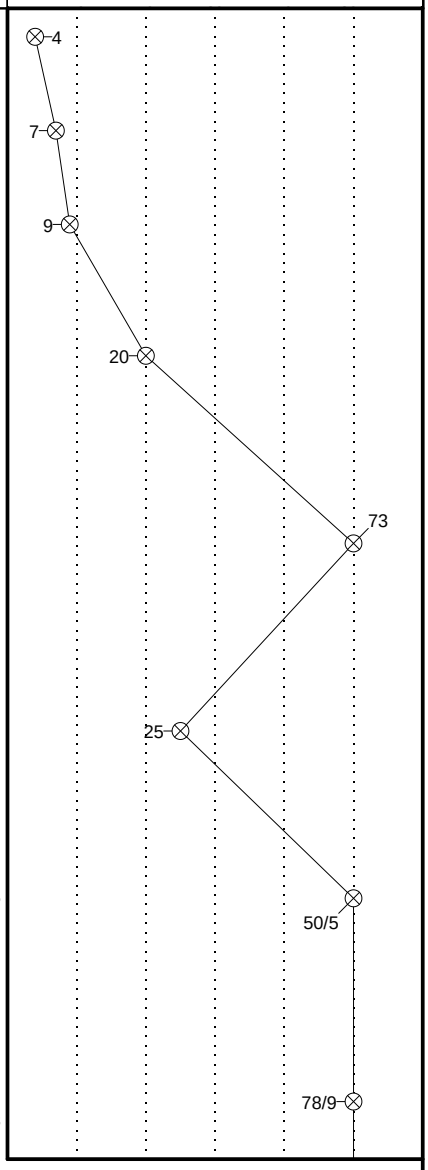
PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION | SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	14	Sandy SILT, Trace Rock Fragments, Brown, Moist, Loose (ML FILL)			1 2 2
	S-2	SS	18	18	Micaceous Silty SAND, Brown, Moist, Loose (SM)			3 3 4
5	S-3	SS	18	18				3 4 5
	S-4	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)			7 10 10
10	S-5	SS	18	18	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			13 30 43
15	S-6	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)	▼		7 11 14
20	S-7	SS	5	5	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense	▼		50/5
25	S-8	SS	15	14				17 28 50/3
30								



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 32.50 WS ☐ WD ☐	BORING STARTED 06/24/14	
WL(BCR) 32.50 WL(ACR) 23.00	BORING COMPLETED 06/24/14	CAVE IN DEPTH 29.0
WL 18.5 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-12	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

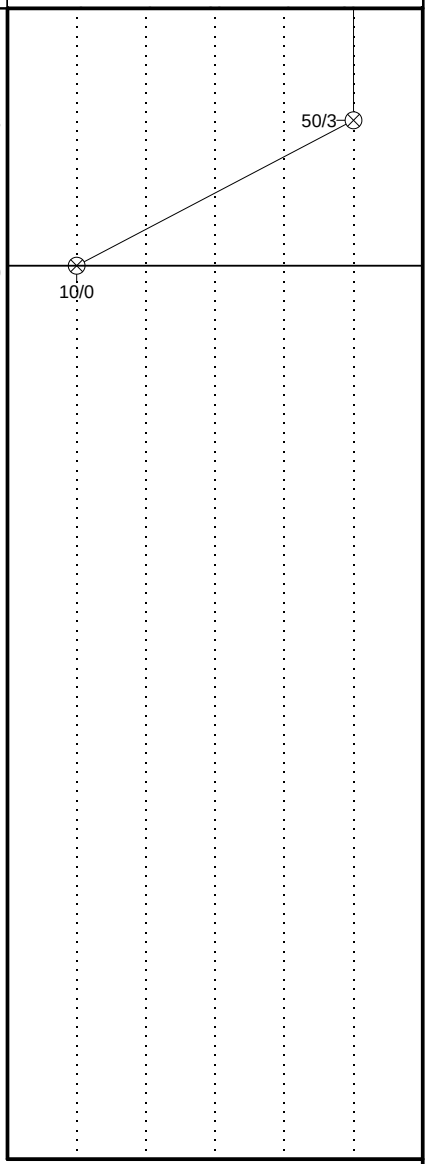
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
35	S-9	SS	3	2	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense	▽		50/3
40	S-10	SS	0	0	AUGER REFUSAL @ 37.50'			10/0
45								
50								
55								
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL 32.50 WS ☐ WD ☐	BORING STARTED 06/24/14	
▽ WL(BCR) 32.50 ▼ WL(ACR) 23.00	BORING COMPLETED 06/24/14	CAVE IN DEPTH 29.0
▽ WL 18.5 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-13	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

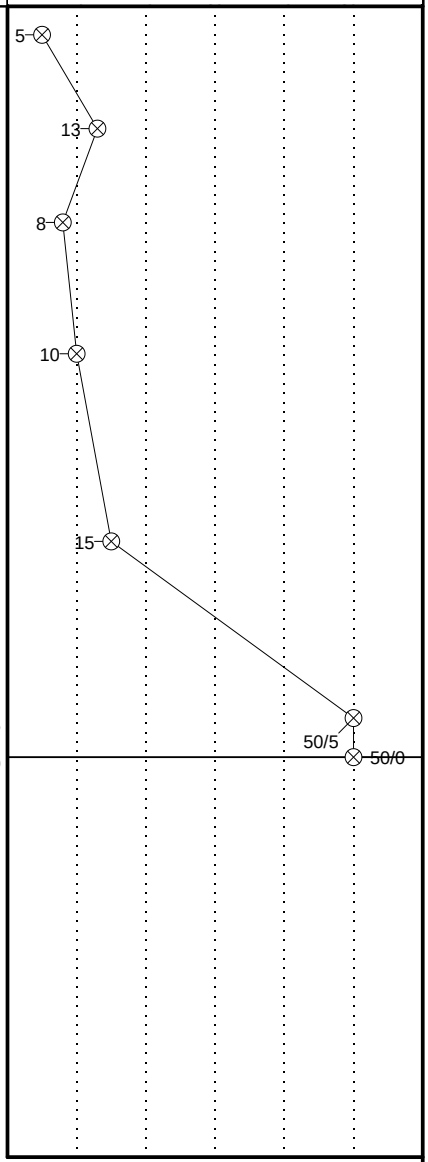
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	10	CLAY, Trace Silt, Sand, Roots, Organics, and Rock Fragments, Brown, Moist, Medium Stiff to Stiff (CL FILL)			2 3 2
	S-2	SS	18	14				5 6 7
5	S-3	SS	18	14	Micaceous Sandy SILT, Trace Rock Fragments, Brown, Moist, Medium Dense to Loose (ML)			3 4 4
	S-4	SS	18	8				5 4 6
10								
	S-5	SS	18	18				4 6 9
15								
	S-6	SS	11	11	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			27 50/5
20	S-7	SS	0	0	AUGER REFUSAL @ 20.00'			50/0
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL DRY WS ☐ WD ☐	BORING STARTED 06/23/14	
WL(BCR) DRY WL(ACR) DRY	BORING COMPLETED 06/23/14	CAVE IN DEPTH 16.0
WL	RIG CME 55 FOREMAN Kevin	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-14	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

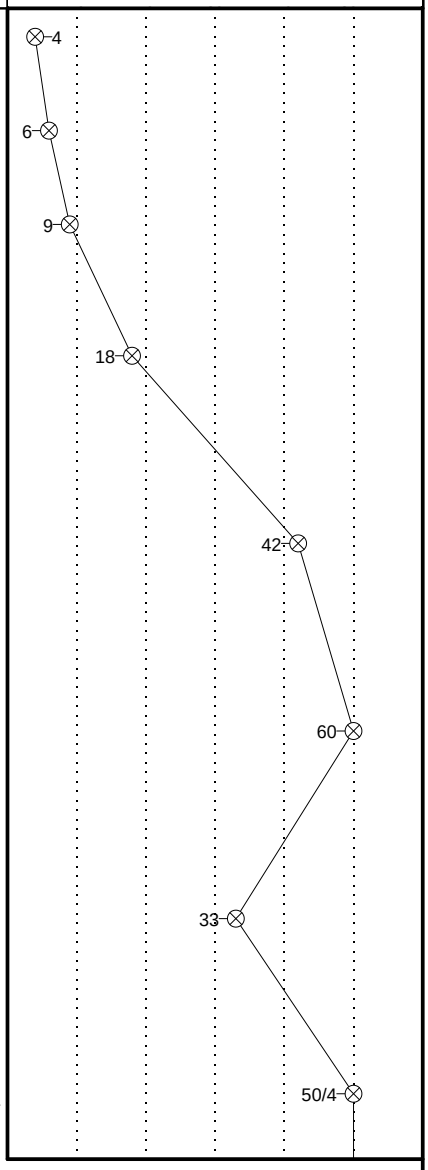
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	12	CLAY, With Silt, Trace Sand, Rock Fragments, and Organics, Brown, Moist, Soft to Medium Stiff (CL FILL)		1 2 2
	S-2	SS	18	18			3 2 4
5	S-3	SS	18	18	Micaceous Sandy SILT, Trace Rock Fragments, Brown, Moist, Loose (ML FILL)		3 4 5
	S-4	SS	18	18	Micaceous Silty SAND, Trace Rock Fragments, Brown, Moist, Medium Dense (SM FILL)		6 11 7
10	S-5	SS	18	18	Micaceous Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense to Very Dense (SM)		17 20 22
15	S-6	SS	18	18			18 25 35
20	S-7	SS	18	18			8 13 20
25	S-8	SS	10	10	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		35 50/4
30							



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 33.00 WS ☐ WD ☐	BORING STARTED 06/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 06/24/14	CAVE IN DEPTH 30.0
WL 20.0 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-14	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION: 1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

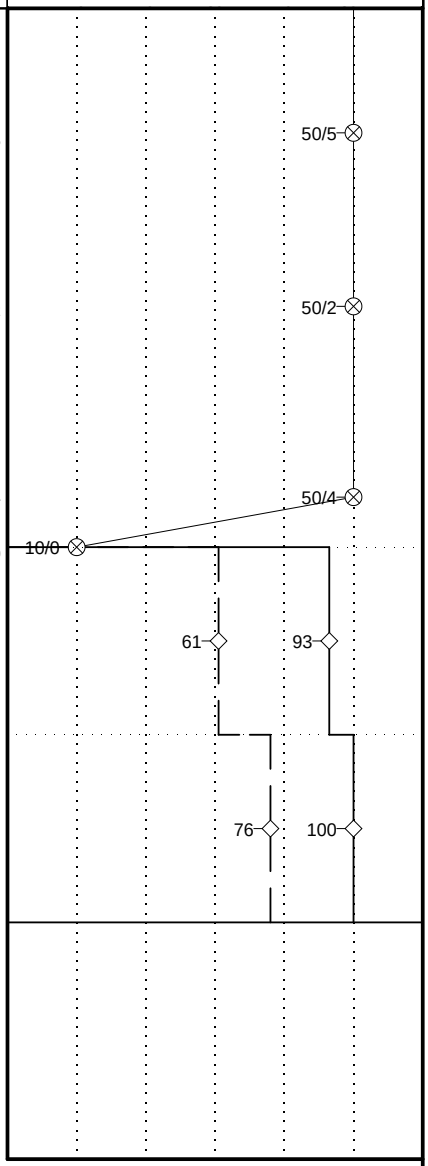
PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION | SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
					Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense			
	S-9	SS	11	11				8 50/5
35								
	S-10	SS	2	2				50/2
40								
	S-11	SS	4	4				50/4
45	S-12	SS	0	0				10/0
	S-13	RC	60	56	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 93%, RQD= 61%]			
50								
	S-14	RC	60	60	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 100%, RQD= 76%]			
55					END OF BORING @ 45.00'			
60								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 33.00 WS ☐ WD ☐	BORING STARTED 06/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 06/24/14	CAVE IN DEPTH 30.0
WL 20.0 @ 24 Hours	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-15	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

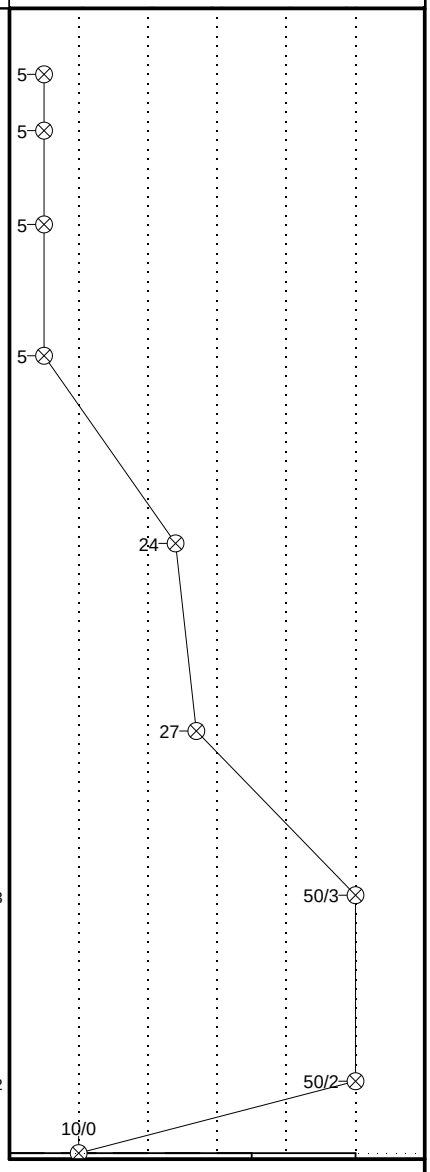
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	BLOWS/6"
0					Concrete Depth [8"]		
	S-1	SS	18	12	Silty CLAY, With Mica, Trace Sand, and Rock Fragments, Light Brown, Moist, Medium Stiff (CL FILL)		1 2 3
	S-2	SS	18	18			2 2 3
5	S-3	SS	18	18	Clayey SILT, With Mica, and Sand, Brown, Moist, Loose (ML)		3 3 2
	S-4	SS	18	18	Micaceous Silty SAND, Brown, Moist, Loose (SM)		4 3 2
10	S-5	SS	18	18	Micaceous Silty SAND, Trace Decomposed Rock Fragments, Brown, Moist, Medium Dense (SM)		7 9 15
15	S-6	SS	18	18			12 13 14
20	S-7	SS	3	3	Decomposed Rock, With Rock Fragments, and Sand, Trace Silt, Brown, Moist, Very Dense		50/3
25	S-8	SS	2	2	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 100%, RQD=70%]		50/2
30	S-9	SS	0	0			10/0



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23.00 WS ☐ WD ☐	BORING STARTED 06/25/14	
WL(BCR) 15.50 WL(ACR) DRY	BORING COMPLETED 06/25/14	CAVE IN DEPTH 14.0
WL	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Lee Development Group	6318	GSB-15	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth House	

SITE LOCATION

1315 Apple Avenue, Silver Spring, Montgomery County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% WATER CONTENT% LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

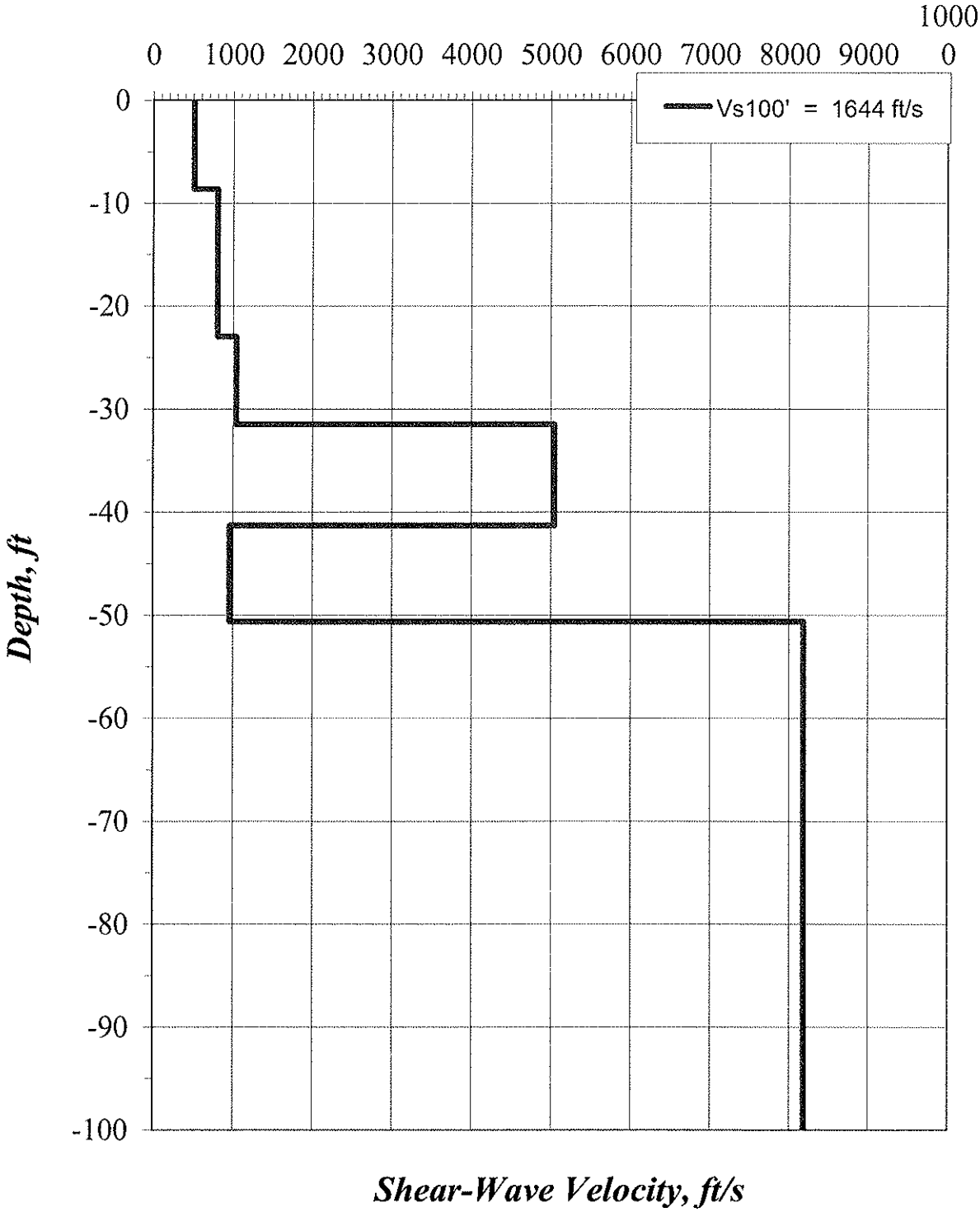
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS; BOTTOM OF CASING; LOSS OF CIRCULATION; SURFACE ELEVATION)	WATER LEVELS ELEVATION (FT)	BLOWS/6"
35	S-10	RC	60	60	SCHIST, Very Hard, Slightly Weathered, Moderately to Slightly Fractured, Light Gray [REC 100%, RQD=70%]		10/0
40	S-11	RC	60	57	SCHIST, Very Hard, Slightly Weathered, Slightly Fractured, Light Gray [REC 95%, RQD= 75%]		
					END OF BORING @ 40.50'		
45							
50							
55							
60							

70 100 75 95

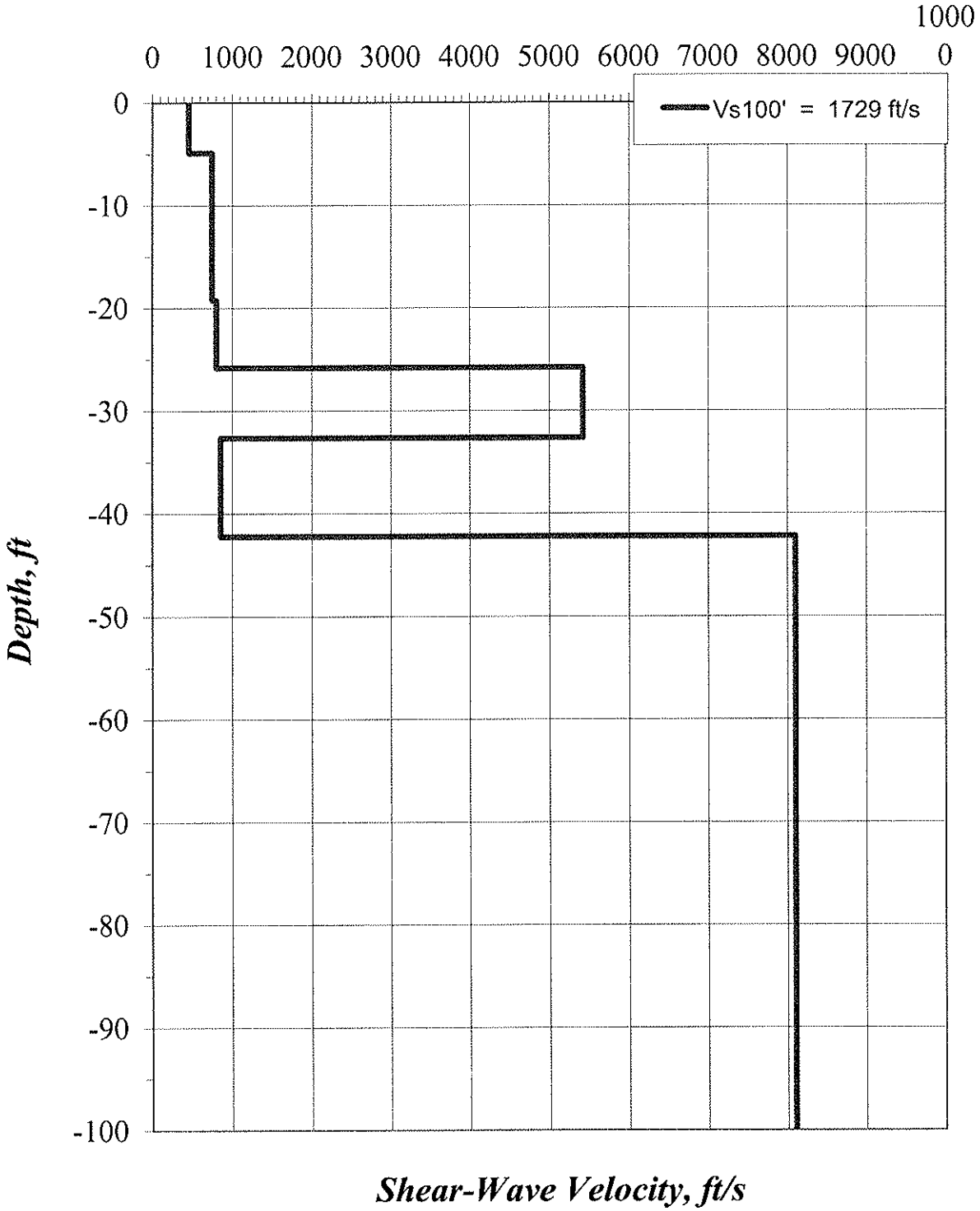
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

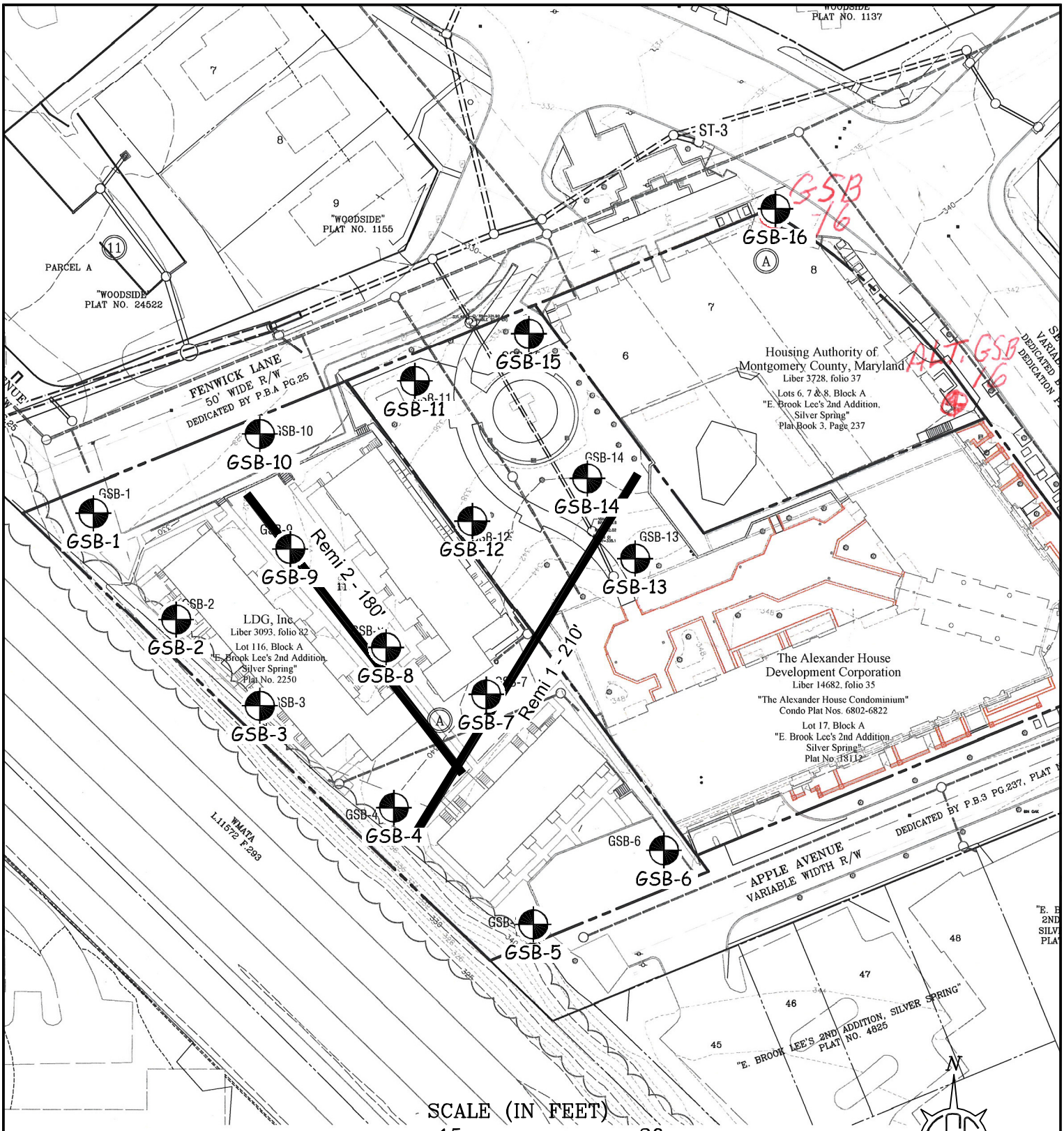
WL 23.00 WS ☐ WD ☐	BORING STARTED 06/25/14	
WL(BCR) 15.50 WL(ACR) DRY	BORING COMPLETED 06/25/14	CAVE IN DEPTH 14.0
WL	RIG CME 55 FOREMAN Tyler R.	DRILLING METHOD HSA

Line 1: Vs Model



Line 2: Vs Model





LEGEND

APPROX. BORING LOCATION

APPROX. REMI LOCATION

BORING LOCATION DIAGRAM

LEE DEVELOPMENT GROUP

ECS

ELIZABETH HOUSE

SILVER SPRING, MARYLAND

ENGINEER GAR	SCALE 1" = 30'
DRAFTSMAN AMH	PROJECT NO. 13-6318
REVISIONS	SHEET 1 OF 1
	DATE 07-03-14

February 27, 2018

Mr. Hyunsuk Choi
HOC of Montgomery County
10400 Detrick Avenue,
Kensington, Maryland 20895

ECS Project No. 02-8681

Reference: Letter Report of Supplemental Geotechnical Subsurface Exploration, **Elizabeth Square III**, Silver Spring, Montgomery County, Maryland

Dear Mr. Choi:

As authorized by your acceptance of ECS Proposal No. 02-17986 dated February 7, 2018, ECS Mid-Atlantic, LLC (ECS) has completed the additional geotechnical engineering services. We have included with this letter a summary of our additional exploration and results.

Scope of Services

Our scope of service included drilling three additional borings in the area of previous ECS Boring GSB-13. These additional borings, designated as Borings ECS-1 through ECS-3, are located near grid line L.6/31.2 of the proposed Elizabeth Square III building. The purpose of the additional borings was to further explore depth to relatively competent rock, as auger refusal was previously encountered at Boring GSB-13 at a depth of 20 feet below ground surface (approximately EL. 325 feet).

Subsurface Exploration Procedures

The soil borings were drilled with an ATV-mounted drill rig, using continuous-flight, hollow-stem augers to advance the boreholes. Drilling fluid was not used during advancement of the boreholes. The boring locations were located in the field by ECS personnel referencing existing site features, and ground surface elevations at the boring locations were interpolated from the provided site plans.

Representative soil samples were obtained by means of the split-barrel sampling procedure in general accordance with ASTM D 1586. In the split-barrel sampling procedure, a 2-inch O.D. split-barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches.

The number of hammer blows required to drive the sampler through the second and third 6-inch drive increments is termed the Standard Penetration Test (SPT) value (blow count, or N-value) and is indicated for each sample on the Boring Logs. In the borings, split-barrel sampling was performed at 2.5 ft intervals to depths of 10 ft and at 5.0 ft intervals thereafter.

N-values can be used to provide a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, N-values also provide an indication of consistency for cohesive soils. The indications of relative density and consistency are qualitative, since many factors can significantly affect N-values and prevent direct correlations, including differences among drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the subsurface conditions encountered in the borings was maintained by the Drill Crew during the drilling operations. Each recovered soil sample was removed from the sampler and visually classified by the Drill Crew. Representative portions of soil samples were sealed in glass jars and returned to the ECS laboratory for further visual examination and possible laboratory testing.

Findings and Evaluations

In general, the subsurface conditions encountered during our field exploration consisted of approximately 4 inches of topsoil overlying natural soils.

The natural soils were generally brown in color and consisted of Silty SAND (SM) soil, which gradually increased in relative density before transitioning to weathered rock. The N-values recorded in the natural granular soils ranged from 4 blows per foot (bpf) to 50 blows per six inches of sampler penetration, indicating very loose to medium dense relative densities. The N-Values recorded in the weathered rock materials ranged from 85 blows per 11 inches of sampler penetration to 50 blows per inch.

Auger refusal was encountered in Boring ECS-1 within the upper two to three feet of ground surface. Two unsuccessful attempts were made at advancing the boring deeper from offset locations. The obstruction is most likely to be a buried vault or other utility.

Boring ECS-2 at a depth of 40 feet below ground surface (EL. 303 feet) and at Boring ECS-3 at a depth of 45 feet (EL. 299 feet). Auger refusal was encountered at greater depths than was previously at Boring GSB-13, however a layer of denser soil or material resembling weathered rock was encountered in Boring ECS-2 at a depth of approximately 17 to 22 feet below ground surface; this correlates generally with the auger refusal elevation in Boring GSB-13. It is worth noting that the top of relatively competent bedrock in Piedmont geology can be highly irregular. Boulders of relatively unweathered rock can commonly occur within the soil profile which are underlain by more weathered rock or even residual soils. Veins of quartz which are relatively resistant to weathering are also common, and larger veins of quartz can cause auger refusal to occur at a depth that is shallower than the top of relatively unweathered rock.

More detailed descriptions of the encountered subsurface conditions are provided on the boring logs attached with this letter. A Boring Location Diagram is also attached.

If you have any questions regarding the information and contained in this letter, or if we may be of further assistance to you, please contact us.

If you have any questions regarding the information and contained in this letter, or if we may be of further assistance to you, please contact us.

Respectfully,

ECS Mid-Atlantic, LLC

Hashim K. Yousif
Project Manager

Joseph Meiburger, PE
Principal Engineer

2/27/2018

STATE OF MARYLAND
JOSEPH A. MEIBURGER
41542
PROFESSIONAL ENGINEER

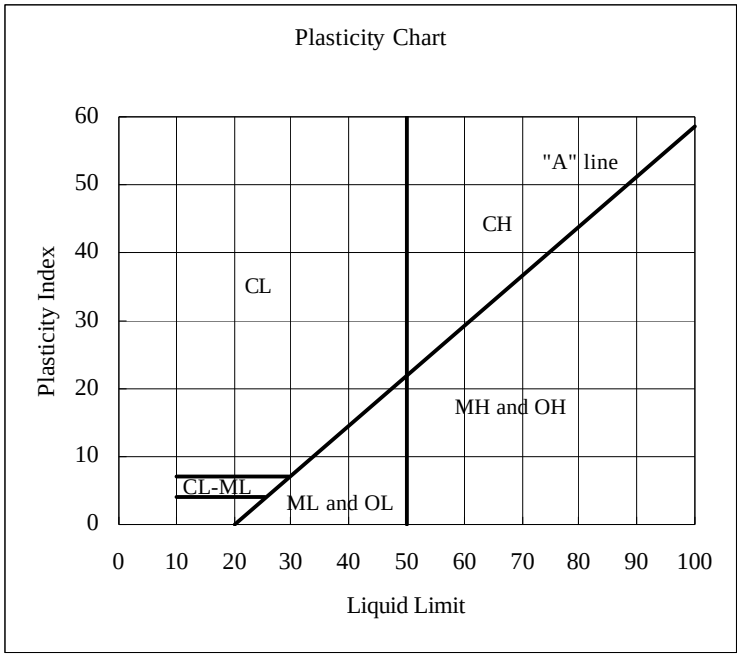
Professional Certification: I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.

License No *41542*. Expiration Date: *02/10/2019.*

Attachments: Unified Soil Classification System (USCS)
Reference Notes for Boring Logs
Boring Logs: ECS 2, ECS-3
Boring Location Diagram

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4; $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM [a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6; $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM [a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	FILL[3] MAN-PLACED SOILS
GW	**WELL-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GP	**POORLY-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GM	**SILTY GRAVEL** gravel-sand-silt mixtures
GC	**CLAYEY GRAVEL** gravel-sand-clay mixtures
SW	**WELL-GRADED SAND** gravelly sand, little or no fines
SP	**POORLY-GRADED SAND** gravelly sand, little or no fines
SM	**SILTY SAND** sand-silt mixtures
SC	**CLAYEY SAND** sand-clay mixtures
ML	**SILT** non-plastic to medium plasticity
MH	**ELASTIC SILT** high plasticity
CL	**LEAN CLAY** low to medium plasticity
CH	**FAT CLAY** high plasticity
OL	**ORGANIC SILT or CLAY** non-plastic to low plasticity
OH	**ORGANIC SILT or CLAY** high plasticity
PT	**PEAT** highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION		**PARTICLE SIZES**
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	**SPT[5] (BPF)**	**CONSISTENCY[7] (COHESIVE)**
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Medium Stiff
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT[5]	**DENSITY**
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)	FINE GRAINED (%)
Trace	<5	<5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15-25
Adjective *(ex: "Silty")*	25 - <50	30 - <50

WATER LEVELS[6]		
	WL	Water Level (WS)(WD)
		(WS) While Sampling
		(WD) While Drilling
	SHW	Seasonal High WT
	ACR	After Casing Removal
	SWT	Stabilized Water Table
	DCI	Dry Cave-In
	WCI	Wet Cave-In

[1] *Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.*

[2] *To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.*

[3] *Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] *Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).*

[5] *Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).*

[6] *The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.*

[7] *Minor deviation from ASTM D 2488-09.*

CLIENT	Job #:	BORING #	SHEET
Housing Opportunities Commission - HOCMC	02:8681	ECS-2	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth Square Additional Borings	Housing Opportunities Commission - HOCMC

SITE LOCATION

1315 Apple Ave, Silver Spring, Montgomery County, MD

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

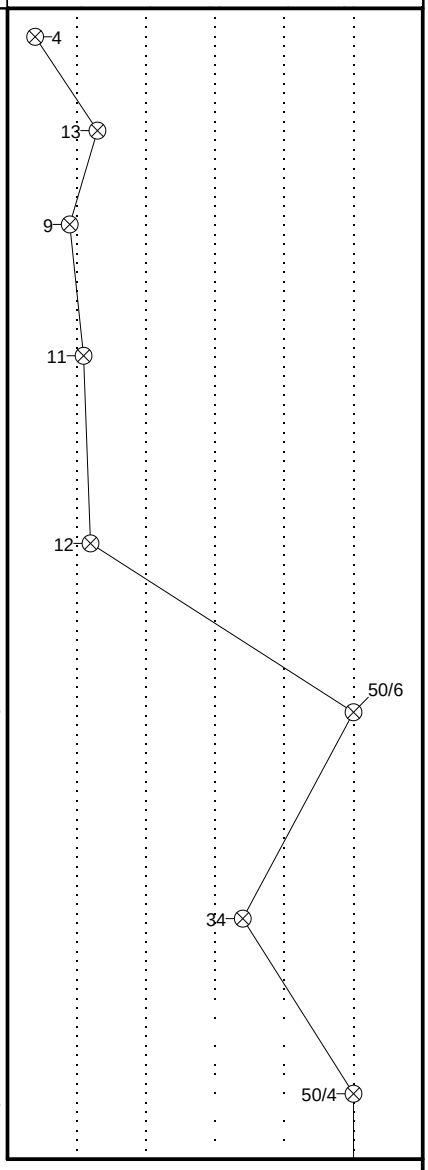
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 343

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	6	Topsoil Depth [4.00"] (SM) SILTY SAND, contains mica, brown, moist, loose to very dense			1 1 3
	S-2	SS	18	18			340	4 6 7
5	S-3	SS	18	11				4 4 5
	S-4	SS	18	18			335	5 6 5
10								
	S-5	SS	18	18			330	4 5 7
15								
	S-6	SS	6	4			325	50/6
20								
	S-7	SS	18	18			320	28 17 17
25								
	S-8	SS	10	10	(WR) WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, brown, moist, very dense [Weathered ROCK]		315	33 50/4
30								



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 02/12/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 02/12/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN	DRILLING METHOD

CLIENT	Job #:	BORING #	SHEET
Housing Opportunities Commission - HOCMC	02:8681	ECS-2	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth Square Additional Borings	Housing Opportunities Commission - HOCMC

SITE LOCATION

1315 Apple Ave, Silver Spring, Montgomery County, MD

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 343

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
35	S-9	SS	2	2		310	50/2
	S-10	SS	1	1		305	50/1
40							
						300	
45							
						295	
50							
						290	
55							
						285	
60							

(WR) WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, brown, moist, very dense [Weathered ROCK]

AUGER REFUSAL @ 40'

50/2

50/1

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 02/12/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 02/12/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN	DRILLING METHOD

CLIENT	Job #:	BORING #	SHEET
Housing Opportunities Commission - HOCMC	02:8681	ECS-3	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth Square Additional Borings	Housing Opportunities Commission - HOCMC

SITE LOCATION

1315 Apple Ave, Silver Spring, Montgomery County, MD

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

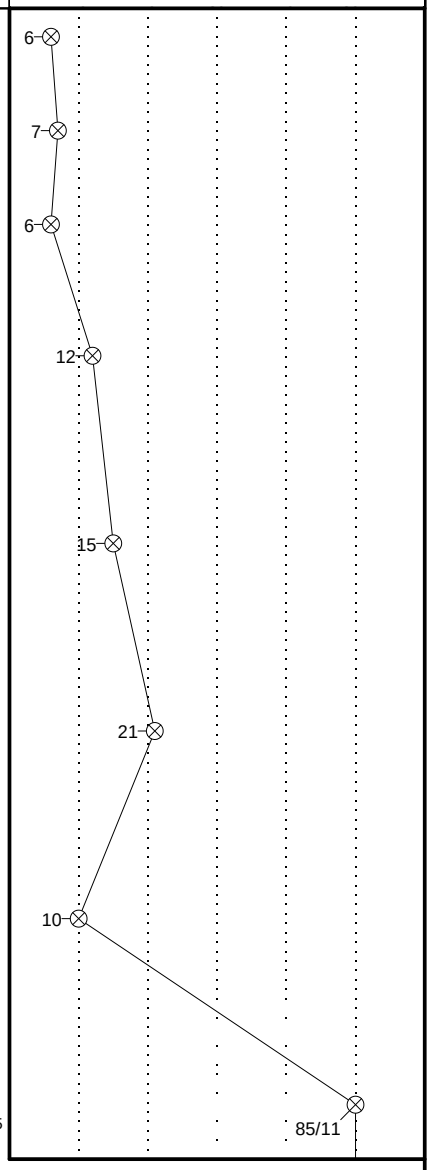
SURFACE ELEVATION 344

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	12			2 3 3
	S-2	SS	18	10		340	2 3 4
5	S-3	SS	18	4			2 3 3
	S-4	SS	18	12		335	4 5 7
10	S-5	SS	18	18		330	5 7 8
15	S-6	SS	18	18		325	4 9 12
20	S-7	SS	18	12		320	4 4 6
25	S-8	SS	17	17		315	18 35 50/5
30							

Topsoil Depth [4.00"]

(SM) SILTY SAND, contains mica, brown, moist, loose to medium dense

(WR) WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, brown, moist, very dense [Weathered ROCK]



CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 02/12/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 02/12/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN	DRILLING METHOD HSA

CLIENT	Job #:	BORING #	SHEET
Housing Opportunities Commission - HOCMC	02:8681	ECS-3	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Elizabeth Square Additional Borings	Housing Opportunities Commission - HOCMC

SITE LOCATION: 1315 Apple Ave, Silver Spring, Montgomery County, MD

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 344

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
	S-9	SS	16	16		310	28 35 50/4
35							
	S-10	SS	18	18		305	13 27 35
40							
	S-11	SS	7	7		300	36 50/1
45							
						295	
50							
						290	
55							
						285	
60							

(WR) WEATHERED ROCK SAMPLED AS SILTY SAND, contains mica, brown, moist, very dense [Weathered ROCK]

AUGER REFUSAL @ 45'

85/10

62

50/1

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 02/12/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 02/12/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN	DRILLING METHOD HSA

Boring Location ECS (June 2014)

Boring Location ECS (February 2018)

REVISIONS

Boring Location Plan
Elizabeth Square III

HOC of Montgomery County

HKY	JM	02/27/2018	NTS	8681	1 OF 1

APPENDIX B

MARYLAND DHCD

DHCD
Maryland Department of Housing and Community Development

Multifamily Rental Financing Program Guide

Attachment to Maryland Qualified Allocation Plan for the Allocation of Federal Low Income Housing Tax Credits

Attachment to the August 9, 2016 Qualified Allocation Plan

Maryland Department of Housing and Community Development
Community Development Administration
7800 Harkins Road
Lanham, Maryland 20706
(301) 429-7854 Phone
(800) 543-4505 Toll Free
(800) 735-2258 TTY
www.dhcd.maryland.gov

EQUAL HOUSING OPPORTUNITY

TABLE OF CONTENTS

Overview and Policy Statement: The State Context

The last major update of the Maryland Qualified Allocation Plan for the Allocation of Federal Low Income Housing Tax Credits (QAP) and Multifamily Rental Financing Program Guide (Guide) in 2014 established a series of Priority Project Categories to limit the award of competitive Low Income Housing Tax Credits (LIHTC) and Rental Housing Program and HOME Investment Partnership Program, together, the Rental Housing Financing Programs (RHFP). After reviewing the results of this approach over the past several years, the Department of Housing and Community Development (DHCD) has determined that a broader set of priorities is necessary to ensure the availability of important resources to all areas and populations in the State of Maryland (the State). Additionally, it has been determined that the established Priorities should serve to guide -- not limit -- competitive funding awards by DHCD. The scoring criteria outlined in this Guide provide incentives for developments that meet these Priorities.

Accordingly, with this 2016 update of the QAP and Guide, DHCD has established the following set of Priorities to guide the award of competitive funding:

1. **Family Housing in Communities of Opportunity**
2. **Housing in Community Revitalization and Investment Areas**
3. **Integrated Permanent Supportive Housing Opportunities**
4. **Preservation of Existing Affordable Housing**
5. **Elderly Housing in Rural Areas of the State Outside Communities of Opportunity**
6. **Housing for the Homeless**

The scoring criteria outlined in this Guide provide incentives for developments that meet these Priorities, with the greatest priority placed on incentivizing the development of family housing in Communities of Opportunity.

The QAP and Guide were crafted after the consideration of public comments received from a wide range of housing partners, stakeholders, consultants, housing advocates and others during the review process.

In addition, in considering changes for the Guide and QAP, DHCD continued to be guided by PlanMaryland. PlanMaryland is a fundamental element of Maryland's Smart, Green & Growing Initiative, and is the State's strategic plan for long-term sustainability and a road map for smart growth and development during the coming years when Maryland's population is expected to increase and demographics are expected to change. The following statement from the Executive Order sets forth the purpose of PlanMaryland:

1. PLANMARYLAND SHALL BE RECOGNIZED AS THE STATE DEVELOPMENT PLAN FOR THE STATE AND SHALL SERVE AS A GUIDE TO THE ECONOMIC AND PHYSICAL DEVELOPMENT OF THE STATE IN ORDER TO:

a. ..... SPUR ECONOMIC DEVELOPMENT, REDEVELOPMENT, REVITALIZATION, AND INFILL DEVELOPMENT;

b. ..... INCENTIVIZE RESOURCES AND AGRICULTURAL BASED INDUSTRIES; AND

c. ..... PROTECT THE RURAL, AGRICULTURAL, NATURAL, ENVIRONMENTAL, AND CULTURAL LANDS AND RESOURCES.

2. PLANMARYLAND SHALL MAKE STATE POLICIES ON DEVELOPMENT TRANSPARENT, SO LOCAL GOVERNMENTS CAN MOST EFFICIENTLY ACCESS STATE RESOURCES.

3. STATE AGENCIES SHALL REVIEW AND CONSIDER PLANMARYLAND WHEN MAKING DECISIONS ABOUT ACTIONS THAT AFFECT DEVELOPMENT IN THE STATE.

At all times during the review process, it has been DHCD's intent to ensure that Maryland's affordable housing development resources are fairly deployed in a manner that best serves Maryland residents, including families, seniors, and persons with disabilities or special needs, and the continuing demand for quality, affordable rental housing across the State.

1 Introduction

DHCD administers a variety of State and federal programs that finance the development of affordable rental housing. These programs include, but are not limited to, the Low Income Housing Tax Credit Program (LIHTC), the Rental Housing Financing Programs (RHFP) – a combination of the State-funded Rental Housing Program and the federally-funded HOME Investment Partnership Program, Rental Housing Works (RHW), and the Multifamily Bond Program (MBP). DHCD may, from time to time, establish new development financing programs to advance its mission.

While there are variations between these programs based on the underlying source of funds, State and federal requirements applicable to specific funding sources, and State policy goals, DHCD seeks to align many of the administrative processes that accompany these programs. This alignment makes these programs more user-friendly and contributes to operating efficiencies for DHCD and its partners, including owners, investors, and managers of properties financed by DHCD resources.

This Guide is an attachment to the QAP and, unless otherwise noted, the requirements herein apply to any transaction seeking allocations of LIHTC from DHCD, whether those come from the State's population-based credit ceiling or from the use of tax-exempt bonds. Additionally, unless otherwise noted, this Guide applies to MBP, RHW, and RHFP (which includes the State funded Rental Housing Program and federal HOME funds as noted above). Unless otherwise noted, all references to timeframes in the QAP and Guide refer to calendar days.

2 Application Process

This section provides information on application and funding processes. For projects requesting MBP financing, RHW financing, and non-competitive LIHTC only, some of the following steps may not apply, but more information for these programs may be found in the text boxes throughout this Guide.

Applications for competitive LIHTC and RHFP will be solicited by DHCD by public notice (the Public Notice) in one round per year. If needed, additional rounds of competition may be held until all available resources have been reserved.

Multifamily Bond Program and Rental Housing Works

Projects requesting MBP financing, with or without non-competitive LIHTC or RHW, may submit an application at any time. Processing is subject to certain fees that are subject to change. The current fees are described in Appendix C of this Guide. See Section 6.2 for additional information on MBP. Updates to fees are provided on DHCD's website at www.dhcd.maryland.gov.

2.1 Pre-Round Communication

2.1.1 Information Session

In advance of each competitive round, DHCD will hold a pre-round information session during which it will discuss resources available for the round, explain any changes to the QAP, Guide, or process, provide additional information about how State Bonus Points (described in Section 4.7) will be utilized in the round and provide an opportunity for questions and answers. The date, time, and location of the information session will be established in the Public Notice.

2.1.2 Optional Pre-Application Meetings

Applicants may request a pre-application meeting to receive preliminary feedback regarding project specifics as well as a meeting to discuss their proposed projects with DHCD staff.

2.1.3 Waiver Requests

Chapter 5 provides information on the submission of waiver requests, including appropriate justifications. Certain waivers must be submitted in advance of the application deadline.

2.2 Local Governments- Notice and Opportunity to Comment

DHCD's process for notifying local governments and providing an opportunity to comment on applications for financing are as follows:

(1) Upon receipt of an Application Submission Package for LIHTC or for a loan under MBP, RHFP, or RHW, DHCD shall provide written notice of the application and a reasonable opportunity to comment to the political subdivision in which the project is located. If the project is located in a municipal corporation, the notice shall be sent to the municipal corporation and not to the county. The written notice shall be sent to the political subdivision's highest elected public official and to the head or president of the political subdivision's legislative body. The written notice shall include the following information about the project:

(a) Date of application;

(b) Name and description of the project;

(c) Address of the project;

(d) Developer of the project and the Developer's contact information;

(e) Amount and type of funding and/or LIHTC requested;

(f) Amount, type, and provider of other sources of financing;

(g) Total number of units;

(h) Number of units reserved for families of limited income, including the income and rent limits; and

(i) Such other information as DHCD deems relevant.

(2) The political subdivision shall have forty-five (45) calendar days from the date the written notice is sent to review the project and DHCD's proposed financing for the project and provide comments, if any.

(3) If a political subdivision provides comments under paragraph (2) above, DHCD will consider the comments in its review of the application

2.3 Application Review Process

Projects seeking competitive financing will be considered only upon DHCD's receipt of a complete application by the application deadline. Applications will be evaluated first against the Threshold Criteria described in Chapter 3. Projects passing the threshold review will be evaluated against the Competitive Scoring Criteria described in Chapter 4.

These criteria are intended to select viable projects that meet DHCD's identified priorities as well as all federal and State requirements. Except for requirements of the programs' governing

statutes, the Threshold Criteria may be waived by the Secretary of DHCD for compelling reasons or in an emergency situation. See Chapter 5 for waiver provisions and requirements.

If an application is incomplete or does not meet the Threshold Criteria it will be rejected and the applicant will be notified in writing by DHCD. The rejection notice shall state the reason the application has been rejected. A sponsor may request reconsideration of a rejection within seven (7) calendar days of the date of the notice of rejection. The request for reconsideration shall be in writing and submitted to the Director of Multifamily Housing. The request may not include new or additional information and must establish that DHCD has made a mistake or error in its initial decision. DHCD will review the request and respond within seven (7) calendar days. If DHCD determines that its initial decision was incorrect, the project will be re-entered into processing. If DHCD upholds the initial decision, the applicant will be notified and the application will be withdrawn from processing. Rejected applications may be resubmitted in a subsequent round. An initial decision or reconsideration of a decision is not a contested case within the meaning of the Administrative Procedure Act or COMAR 05.01.01. DHCD reserves the right to redirect a project from the competition to the MBP if DHCD, in its sole discretion, determines that the project would be financially feasible using tax-exempt bond proceeds with or without other DHCD resources.

Multifamily Bond Program and Rental Housing Works Threshold Requirements

Projects requesting MBP and RHW financing, with or without non-competitive LIHTC, must also meet all Threshold Criteria unless specified otherwise. Projects requesting MBP and RHW financing that do not meet all Threshold Criteria or have incomplete applications also will be withdrawn from processing. Requests for reconsideration may be filed in accordance with COMAR 05.05.02.08. See Section 6.2 for additional information on MBP. Additional RHW application requirements are outlined below and at the following website: http://dhcd.maryland.gov/HousingDevelopment/Documents/RHW_application.pdf

Generally, RHW funding is governed by the laws (statutes, regulations and the Guide) applicable to MBP with the following changes:

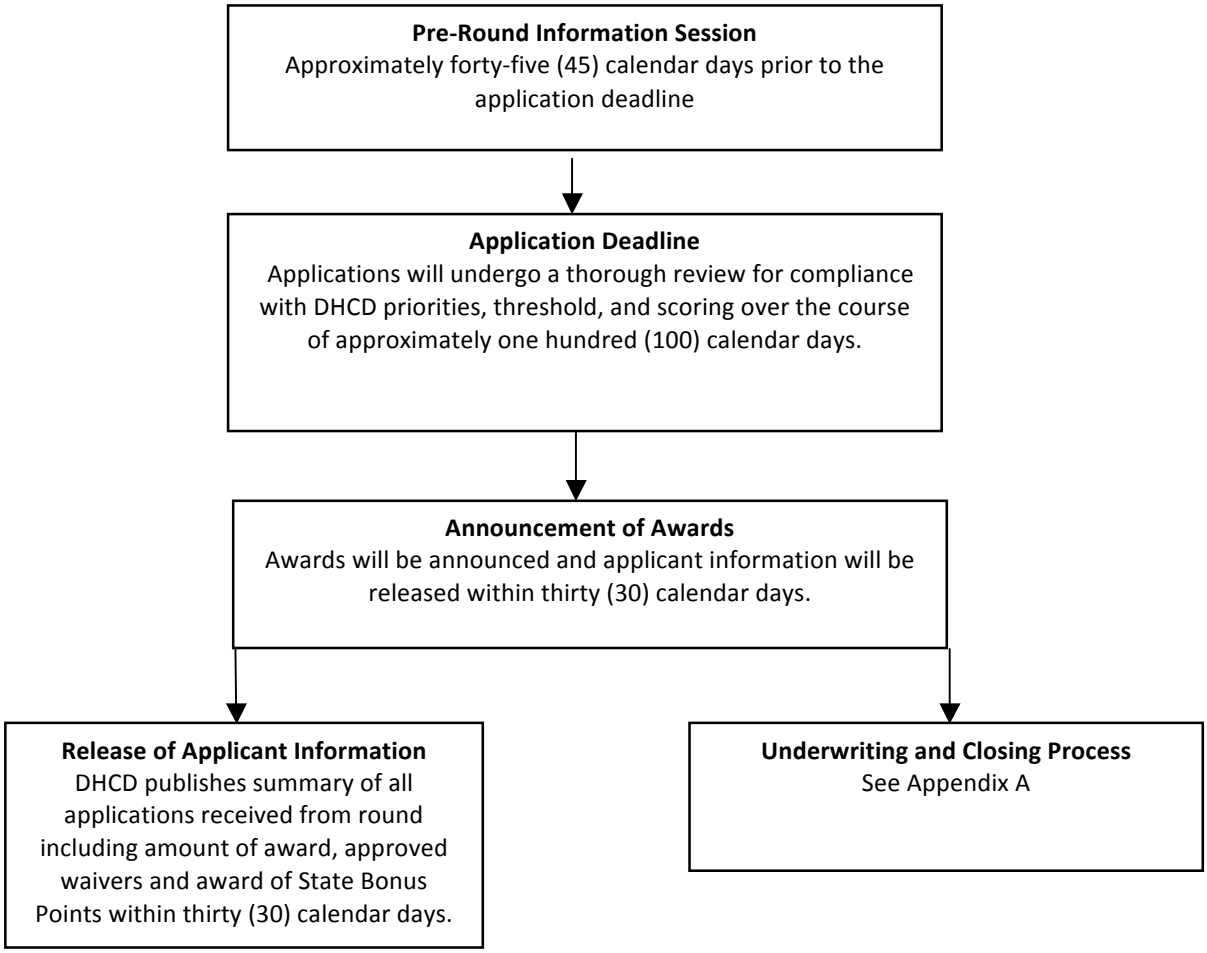
- RHW loans shall be subordinate loans with the terms and conditions described below
- RHW loans must be used in conjunction with MBP and 4% LIHTC. RHW applications must be submitted in conjunction with an MBP application.
- RHW loans may not be used as cash collateral for short-term bonds.
- RHW loans are not subject to the requirements of the MBP that are strictly applicable to the issuance of tax-exempt bonds.
- RHW applications must satisfy the following additional criteria:

- Required zoning for use and density of development must be in place at the time of application and properly documented. A letter from the local zoning office would be proper documentation. An approved Planned Unit Development resolution or a local jurisdiction's equivalent to a Planned Unit Development resolution also satisfies this requirement. Development or site plan approval is not required at application. Conditional use or special exception approval also is not required at application but must be obtained before closing.
- The award of any competitive public and private sources of funding necessary for the project's financial feasibility must have been made; and
- The project's projected Full Time Equivalent jobs must be documented using the Full Time Equivalent Job Calculator located on DHCD's website: http://dhcd.maryland.gov/HousingDevelopment/Pages/rhw/default.aspx

- The Maryland Board of Public Works must approve all RHW funding awards if the source of the RHW funding is general obligation bonds.

A complete application evaluation consists of a review of the application and supporting documentation as well as a preliminary site visit. DHCD staff will present their evaluations to an internal DHCD committee for further review and evaluation. Recommendations for reservations of competitive RHFP and/or LIHTC will be made by the internal committee based on the evaluation of projects pursuant to the Competitive Scoring Criteria, the award of State Bonus Points under Section 4.7, and the availability of resources. These recommendations will be made to DHCD's Housing Finance Review Committee (HFRC) for review. After evaluating the recommendations, HFRC will make final recommendations to the Secretary of DHCD who will, in his or her discretion, approve projects for a reservation of RHFP or LIHTC and further processing. Under certain circumstances reservations may be contingent on the approval of Maryland's Board of Public Works (BPW). After a reservation has been issued, projects that do not continue to meet all Threshold Criteria outlined in this Guide will be withdrawn from processing.

The flowchart below provides an overview of the competitive application and award process:



2.4 Application Form and Fees

2.4.1 Application Form

Competitive applications must be submitted by the deadlines provided in the Public Notice using the Application Submission Package, which contains more detailed instructions regarding many of the requirements in this Guide. Information in the Application Submission Package supplements this Guide and should be reviewed carefully to ensure compliance with these requirements. The Submission Packages are available through DHCD's website at:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

Applicants must submit two complete copies of the application form including all attachments and exhibits. Application forms shall not be re-typed, changed, or modified in any manner. DHCD reserves the right to require electronic submission of applications. All information on the

application must be completed or marked as not applicable. All required exhibits must be included and all required documentation must meet the criteria specified in the Application Submission Package. Incomplete or late applications will not be considered.

For projects seeking competitive financing, applicants may not submit new application material concerning the project after the application deadline date unless DHCD, in its discretion, has requested applicants to submit clarifying information.

Generally, with the exception of market studies which must be less than six (6) months old, all documents submitted with applications, including environmental assessments must be less than twelve (12) months old.

2.4.2 Fees

All sponsors must pay a nonrefundable fee of $2,500 for each application requesting RHFP, RHW, MBP, or LIHTC. Only one application fee is required for each project, regardless of the number of funding resources requested. The application fee must be paid simultaneously with or before submission of an application. Application fees must be sent under separate cover to the address below, with a copy of the check included with the application.

All application submissions, including repeat submissions, must include evidence that the application fee has been paid. Applications received without the required fee will not be evaluated. The application fee is retained by DHCD even if the application is unsuccessful. Projects failing to receive a reservation of competitive LIHTC or RHFP may reapply in another round, but a new application fee will be required. Appendices B and C summarize the fee requirements.

Unless advised otherwise by official DHCD notices, all fees must be made payable to the Community Development Administration or CDA and remitted directly to the attention of:

DHCD Central Cashier
Post Office Box 2521
Landover Hills, MD 20784

2.5 Release of Application Information

DHCD will release information on all applications seeking competitive LIHTC and/or RHFP within fourteen (14) calendar days of the competitive funding round deadline. The information will be published on DHCD's website and will include:

- Name of applicant;
- Project sponsor;
- Site location and address;

- Primary population served (family or elderly);
- Total number of units;
- Number of units reserved for persons with disabilities(PWD) or specials needs tenants;
- Amount and type (RHFP or LIHTC or both) of funds requested; and
- Total project cost.

In addition, DHCD will release a summary of competitive funding round award decisions within thirty (30) calendar days of announcing awards. This summary will be published on DHCD's website and will include the information listed above, as well as the distribution of LIHTC and RHFP to projects, disclosure of all waivers granted to applicants, and identification of projects which received State Bonus Points pursuant to Section 4.7 along with a rationale for why these points were awarded.

DHCD will periodically post information to its website regarding all applications for financing (both competitive and non-competitive), as well as information regarding the status of financing applications:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

2.6 Coordination with Other State Resources

DHCD will coordinate the allocation of LIHTC, RHFP, and RHW with the decision to allocate other State resources under the control of DHCD.

2.7 Loan Processing

If projects include RHFP or RHW loan financing, the processing requirements outlined in Section 6.1 apply.

3 Threshold Criteria

Projects must meet all of the following Threshold Criteria to ensure basic program guidelines are met and DHCD resources are reserved for projects that are viable and ready to proceed. Projects meeting all criteria listed in this section, or successfully obtaining waivers for such criteria, will be evaluated against the Competitive Scoring Criteria in Chapter 4.

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3.1 Development Team Requirements

As used within this Guide, the term Developer refers inclusively to the project sponsor, project owner, guarantor, and general partner/managing member with an ownership interest in the project's ownership entity whether such roles are held by individuals, corporate entities, partnerships, or limited liability companies. The term Developer specifically excludes the investor/syndicator partner(s) or member(s) of the ownership entity.

The Development Team refers inclusively to the Developer and the team of professionals under contract to the Developer to assist with the overall development of a project. The Primary Development Team consists of the Developer and the project's general contractor, architect, and property manager. The Secondary Development Team includes the project's civil engineer, attorney, accountant, and/or other specialized professional service providers.

All corporations, limited liability companies, or partnerships that make up the Developer or that will provide guarantees to the transaction must submit audited, reviewed, or compiled financial statements, as well as interim statements acceptable to DHCD. If possible, financial statements should be prepared according to Generally Accepted Accounting Principles (GAAP). Any individuals providing guarantees or who will be a managing member or general partner in the Developer must submit personal financial statements, including certifications acceptable to DHCD. The required financial statements must include calculations of total assets, total liabilities, current assets, and current liabilities. Complete financial statement requirements may be found in the Application Submission Package.

If the financial statements, including associated management letters, raise concerns about material misstatements, lack of internal controls, or doubts about an entity's ability to remain a going concern, the application may, in the sole discretion of DHCD, be rejected on a threshold basis.

3.1.1 Previous Project Performance

Within five (5) years prior of the application date, members of the Primary Development Team may not have received a reservation or commitment of funding from DHCD for a project that was not carried out for any of the following reasons:

- For LIHTC, entities that (1) received a reservation but were unable to place the project in service in the year of the reservation or unable to meet the requirements to receive a Carryover Allocation; (2) received a Carryover Allocation but could not meet the 10% expenditure test deadline necessary to keep a Carryover Allocation; (3) received a Carryover Allocation or other Allocation but could not place the project in service within the time required by the LIHTC Program; or (4) demonstrate a history or pattern of non-corrected serious health and safety issues as documented by IRS form(s) 8823.
- For RHFP, RHW and MBP, entities that received a reservation or commitment of loan funds but were unable to close the financing.

This criterion does not apply to the voluntary return of a LIHTC, RHFP, RHW, or MBP reservation or commitment by a Developer based on a determination that the project as originally proposed was no longer feasible, provided that DHCD was willing to accept the return and there was no loss to DHCD of State resources. Additionally, DHCD will evaluate the role of

Primary Development Team members relative to their role. For example, an architect would not be prevented from participating in a new transaction simply because they had been the architect on a project where the developer subsequently developed a pattern of noncompliance leading to issuance of IRS form 8823.

In addition, within the five years prior to the application date, Primary Development Team members may not have:

- Participated as an owner or manager in the development or operation of a project that has defaulted on a DHCD or other government or private sector loan;
- Consistently failed to provide documentation required by DHCD in connection with other loan applications or the management and operation of other existing projects;
- Been involuntarily removed as a general partner or managing member from any affordable housing project whether or not financed or subsidized by the programs of DHCD;
- Received a limited denial of participation from the U. S. Department of Housing and Urban Development (HUD);
- Been debarred, suspended, or voluntarily excluded from participation in any federal or state program;
- Been directly involved with any project placed on DHCD's defaulted loans watch list due to actions which, in the opinion of DHCD, are attributable to the sponsor or the Development Team member;
- Unpaid fees, loan arrearages, or other obligations due to DHCD on other projects; or
- Been found by any state or federal agency or court of competent jurisdiction to have acted in violation of the Fair Housing Act, the Civil Rights Act, or any other state or federal law prohibiting discrimination, or failed to comply with the terms of any agreement or court order related to any settlement, conciliation, or legal action related to such a violation.

This evaluation will be based on mandatory disclosures by Primary Development Team members, including submission of financial statements meeting the criteria specified in the Application Submission Package, as well as a review of DHCD records, personal credit histories, commercial credit reports, and other available information. Knowingly providing false information to DHCD on the application or otherwise may subject the applicant to penalties under Maryland law.

3.1.2 Credit History

Members of the Development Team acting in the role of Developer, general contractor, or property manager will not be considered for funding if they have unpaid state or federal

income, payroll, or other taxes as of the application date or a record within the past five (5) years of any of the following that are unacceptable to DHCD:

- Chronic past due accounts;
- Substantial liens or judgments;
- Three or more instances of unpaid taxes (even if cured prior to the application date);
- Foreclosures or bankruptcies; or
- Deeds in lieu of foreclosure.

This evaluation will be based on mandatory disclosures by Development Team members, including submission of financial statements meeting the criteria specified in the Application Submission Package, as well as a review of DHCD records, personal credit histories, commercial credit reports, and other available information. Knowingly providing false information to DHCD on the application or otherwise may subject the applicant to penalties under Maryland law.

3.2 Occupancy Requirements

3.2.1 Minimum Income and Rent Restrictions

At a minimum, applicants must agree that low-income units in the project will be rented to households with incomes and at rents that do not exceed the levels required under the proposed funding source(s).

3.2.2 Definition of Elderly Housing

Any application for funding that reserves units for the elderly must meet DHCD's definition of elderly housing or must request a waiver.

DHCD defines Elderly Housing as any project that proposes to restrict occupancy to one or more of the units in the project based on age. DHCD defines an Elderly Household as one in which at least one household member is age sixty-two (62) or over. These definitions apply to all projects applying for LIHTC, RHFP, RHW, or MBP financing as Elderly Housing.

FHA Insurance Threshold Requirement

For projects financed under FHA Insurance programs including FHA Risk Sharing, DHCD will follow the requirements of Chapter 3-2H of Handbook 4590.1 – Elderly Projects which defines Elderly Housing as: "*An elderly family means any household where the head or spouse is 62 years of age or older, and also any single person who is 62 years of age or older.*"

The Market Study provided in accordance with Section 3.12 must demonstrate demand for the project among the elderly population proposed. In all cases, Elderly Housing must comply with all applicable federal laws, including the Fair Housing Act.

3.2.3 Long Term Use Restrictions and Homeownership Opportunities

All projects requesting competitive LIHTC, RHFP, and/or RHW must agree to at least forty (40) years of low-income occupancy restrictions, unless a structured fifteen (15) year transition to homeownership is presented and accepted. All projects requesting non-competitive LIHTC and/or MBP loan funds must agree to at least thirty (30) years of low-income occupancy restrictions.

Properties intended for eventual homeownership must be physically designed to facilitate marketing for and conversion to homeownership. At application submission, projects must present a strategy that shows how funding will be made available from the project or other dedicated sources to prepare and assist residents for the transition of the project to homeownership at the close of the initial fifteen (15) year compliance period.

3.2.4 Relocation and Displacement

Generally, DHCD will not participate in a project if it results in the permanent displacement of more than 5% of elderly or disabled residents or 10% of family residents dwelling on the site of the proposed project. If the project will result in the relocation of any residential tenants, DHCD expects the applicant will comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (42 U.S.C. 4601) (URA) and §104(d) of the Housing and Community Development Act of 1974 (42 U.S.C. §5304(d)) regarding resident notice and compensation. These requirements apply to all funding requests regardless of the ultimate source of the funds.

All applicants should make themselves familiar with URA and §104(d) requirements, including required notices from both the purchaser and seller that may apply to the project. DHCD will consider waivers to its cap on permanent displacement only to the extent that the displacement complies with URA and leverages substantial federal investment. Information on federal relocation requirements and the rights of affected tenants may be found at:

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/training/web/relocation/notices

3.3 Marketing Requirements

3.3.1 Public and Assisted Housing Waiting List

All projects must establish a priority for households on waiting lists for public housing or other federal or State assisted low-income housing. The applicant also must demonstrate that the entity maintaining the waiting list is willing to refer tenants to the project.

3.3.2 Affirmative Fair Housing Marketing

The State of Maryland has a compelling interest in creating fair and open access to affordable housing and promoting compliance with state and federal civil rights obligations. Fair Housing requirements apply to the full spectrum of housing activities, including, but not limited to, outreach and marketing, the qualification and selection of residents, and occupancy. This Guide and the QAP continue DHCD's long-standing commitment to affirmatively furthering fair housing.

All applications must include a certification that the project will develop and implement an Affirmative Fair Housing Marketing Plan (AFHMP) using form HUD-935.2A available online at:

http://portal.hud.gov/hudportal/documents/huddoc?id=935-2a.pdf

To provide the greatest access to housing opportunities by Maryland's residents, all AFHMPs also must include, at a minimum, the following provisions:

- Prohibit income requirements for prospective tenants with Housing Choice Vouchers or similar vouchers, including, but not limited to, VASH, Shelter Plus Care, Bridge Subsidy and Continuum of Care;
- Eliminate local residency preferences;
- Ensure access to leasing offices for persons with disabilities;
- Provide flexible application and office hours to permit working families and individuals to apply; and
- Encourage credit references and testing that take into account the needs of persons with disabilities or special needs.

In the event HUD updates form HUD-935.2A or DHCD later publishes additional AFHMP requirements, applicants will be required to use the newest versions of such forms and/or criteria available.

Prior to closing DHCD will review the AFHMP to ensure the AFHMP is in conformance with all HUD and DHCD requirements, and will reject any AFHMP not in conformance. Additionally, projects must review and update their AFHMP at least every 5 years or when required by DHCD. Failure to comply with an approved AFHMP will result in negative points in future applications as described in Section 4.1.2.

3.4 Tenant Services

All projects must provide services appropriate to the population served by the project. To be considered for financing, an application must include a certification by the applicant that it will provide appropriate services throughout the compliance period or loan term, as applicable, that address the following:

- Family projects must deliver or coordinate services that improve building and unit maintenance, stabilize occupancy by improving residents' abilities to uphold their lease obligations, and enhance quality of life and self-sufficiency for residents, including children;
- Elderly occupancy projects must deliver or coordinate services that stabilize occupancy by improving residents' abilities to uphold their lease obligations throughout the aging process and enhance quality of life through improved access to or information concerning services and benefits, health promotion, community building, and socialization;
- Projects that include populations with disabilities or special needs must ensure that the targeted population served is able to benefit and access the services provided to the general population at the property; and
- All projects must, at a minimum, provide passive links to appropriate community services for tenants.

3.5 Persons with Disabilities (PWD)

3.5.1 Uniform Federal Accessibility Standards Requirements

All projects must ensure that persons with physical disabilities have priority for occupancy of any units qualified under the Uniform Federal Accessibility Standards (UFAS). To ensure that persons with disabilities who require the features of a UFAS unit receive priority for UFAS qualified housing, when a UFAS unit becomes available, it must be offered first to a prospective tenant whose disabilities require such a unit even if other applicants who do not require accessible units have higher placement on the general waiting list. However, owners are not required to disregard occupancy restrictions imposed by any applicable financing program, State or federal law, or lease. Additionally, when renting UFAS units to households that do not require an accessible unit, owners are required to include provisions in the lease that require the household to move to another comparable unit (should there be a comparable unit available) within the project in order to make the UFAS unit available for a household that requires such a unit.

All projects must comply with UFAS and any other applicable laws or requirements, including without limitation Section 504 of the Rehabilitation Act of 1973 (Section 504), the regulations implementing Section 504 at 24 CFR Part 8, the Americans with Disabilities Act (ADA), and the 2010 ADA Standards (as modified by HUD).

3.5.2 Family Housing Developments – Units Reserved for Persons with Disabilities

All family projects must reserve at least five percent (5%) of all units for households at or below 60% AMI and headed by a non-elderly PWD. Non-elderly disabled units provided under the

Bailey Consent decree in Baltimore City will satisfy this requirement. However, this requirement is also satisfied by serving non-elderly PWD who do not meet the City's non-elderly disabled definition. Projects that exceed the requirements of this section may qualify to receive points under the Competitive Scoring Criteria detailed in Section 4.4.2.

Units reserved under this threshold requirement must be reserved exclusively for targeted populations for a period of not less than sixty (60) calendar days both at initial lease-up and upon turnover. The sixty (60) calendar day time period at lease-up will be measured from the date upon which the project achieves 80% occupancy and at turnover will be measured from the date upon which the unit is determined ready for occupancy following move-out by the prior tenants and completion of any cleaning, repairs, or maintenance. In addition to other marketing or referrals for the units, projects with non-elderly PWD units must agree to provide notice of unit availability to and accept referrals from the Maryland Department of Disabilities (MDOD) and/or the Maryland Department of Health and Mental Hygiene (DHMH).

3.6 Other Financing Commitments

Letters of intent to provide financing must be furnished for all funding sources identified in the application. At a minimum, letters of intent must state that the project appears feasible and must show the amount of anticipated funding, general repayment terms, and any financial conditions. Letters of intent from the intended first mortgagee also must include the lender's acknowledgement of DHCD's financing regulations and policies and the lender's agreement to cooperate with the applicable RHFP, RHW, LIHTC, and MBP processes, as appropriate.

In addition, if financing will be subsidized or insured, evidence must be provided that the appropriate applications have been prepared and have been or are ready to be filed. For projects proposing financing with an FHA-insured first mortgage and an RHFP or RHW loan, the lender must acknowledge in its letter of intent that it will accept the use of the FHA/DHCD Intercreditor Agreement without modification. Lenders for FHA-insured first mortgages must also detail the proposed schedule for Multifamily Accelerated Processing (MAP). This schedule must correspond with the Developer's schedule as set forth in the application.

For projects applying for LIHTC, applicants must provide a proposal from at least one syndication firm showing the amount of expected LIHTC, the investor type, expected net proceeds, syndication costs, pay-in schedule, and willingness to comply with DHCD's regulations. The syndicator's letter must provide a proposed schedule for completing its due diligence and indicate the current status of its review of the application and project, including whether a site visit has been completed.

Letters that fail to explicitly include the acknowledgements and information listed above will be rejected as incomplete and will result in the application failing threshold review and being removed from processing.

3.7 RHFP and RHW Loan Requirements

This section sets forth the terms applicable to RHFP and RHW loans. A sponsor of a project that has been awarded RHFP or RHW funds may generally choose the repayment option set forth in either Section 3.7.1 or 3.7.2, unless the underwriting for the project indicates that the project can bear a must-pay loan as described in Section 3.7.3. Sponsors must select a repayment option prior to execution of a loan commitment with DHCD. In all cases, DHCD reserves the right to adjust loan terms for a particular project based on its underwriting and subsidy layering reviews.

3.7.1 General Terms

The following terms are generally applicable to all loans:

- Maximum Awards: Generally the maximum RHFP loan per project may not exceed $2 million except as permitted in COMAR. RHW loans may not exceed $2.5 million.
- Prepayment Restrictions: RHFP and RHW loans are subject to certain restrictions upon prepayment, including, but not limited to, continuing occupancy restrictions, tenant notices and relocation requirements.
- Loan Term: The RHFP and RHW construction loan period (generally the construction contract term plus three months for cost certification) plus 40 year permanent loan period. Maturity will be accelerated due to sale, refinancing or other transfer of the project, or occurrence of an event of default.

Standard Surplus Cash Repayment Terms. The terms set forth below reflect DHCD's traditional surplus cash repayment terms. This option is most commonly used for RHFP and RHW loans in conjunction with LIHTC. A form of the Note used in connection with this form of loan is available on the DHCD website:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

- Interest: 0% interest during the construction loan period; 2% simple interest during the permanent loan period.
- Construction Loan Period: No payments during construction loan period.
- Payment Dates: Annual payments are due three months after the end of the borrower's fiscal year.
- First Payment: First payment is interest only based on the lesser of (i) 75% of surplus cash; or (ii) the amount of interest accrued from the end of the construction loan period to the end of the borrower's fiscal year.

- Regular Payments: Thereafter, payments of principal and interest are based on the lesser of (i) 75% of surplus cash; or (ii) an amortized amount of principal and interest that would pay off the loan in 40 years.
- Surplus Cash Definition: The definition of surplus cash for purposes of repayment of a RHFP or RHW loan is set forth in the Note and generally does not permit payments to partners or members to be paid ahead of loan payments to DHCD (except for a $3,000 annual investor services fee).

3.7.2 Contingent Interest Surplus Cash Repayment Terms

Below are alternative repayment terms that DHCD has approved where DHCD agrees to limit the amount of interest that would otherwise accrue on a traditional surplus cash loan. A form of the Note used in connection with this form of loan is available on the DHCD website:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

- Interest: 0% stated interest for both construction loan period and permanent loan period.
- Construction Loan Period: No payments during construction loan period.
- Regular Payments: Annual payments are due three months after the end of the borrower's fiscal year commencing three months after the end of the year in which the construction loan period ends.
- Regular Principal Payments: Principal payments shall be paid based on a percentage of surplus cash (see below regarding calculation of this percentage) determined as of the end of borrower's fiscal year.
    - Note: The amount paid is not limited by an amortizing amount as in the standard terms under Section 3.7.1.
    - The definition of surplus cash for principal payments is the same as that used for the standard surplus cash repayment terms under Section 3.7.1.
- Regular Contingent Interest Payments: Once principal is repaid, "contingent interest" payments shall be made from a percentage of "contingent interest surplus cash". The definition of "contingent interest surplus cash" allows this payment to be made later in the project's cash flow "waterfall" behind the payment of deferred Developer's Fees, partner loans, deferred investor services fees, and tax credit adjustment payments.
- Maximum Contingent Interest Amount: The maximum amount of contingent interest to be paid will be capped to an amount equal to the amount of interest that would have accrued at the rate of 4% on the outstanding principal balance of the loan.
- Surplus Cash Percentage: The following principles apply with respect to the DHCD surplus cash percentage used for principal payments:

- Until deferred Developer's Fees are paid, DHCD's percentage will not exceed 50%.
- If a local government is also making a loan to the project greater than $250,000, so long as the local government agrees to the same terms and conditions as apply to DHCD's contingent interest surplus cash loan, DHCD may allow a local government to share a percentage of the surplus cash, proportionately, up to 25%.
- If the local government's capital contribution is greater than 60% of the project's total public subordinate debt, DHCD will share the available surplus cash evenly with the local government.

Appendix E sets forth examples of surplus cash splits in a variety of scenarios. In addition, the DHCD website includes a calculator that may be used to determine the relative surplus cash percentages of the parties for a particular project:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

- Contingent Interest Percentage (used for contingent interest payments): DHCD's contingent interest percentage (used for contingent interest payments) will be the greater of (i) the percentage that the loan comprises of the total costs of the project; or (ii) 20%. The calculator on the DHCD website may also be used to determine the contingent interest percentages applicable to the parties involved in financing a project.
- Capital Event Contingent Interest Payment: In the event of a capital event, such as a sale or transfer of the project, refinancing of the loan, or the maturity of the loan, a payment shall be due to DHCD from the net proceeds of the capital event. The amount due shall be determined based on DHCD's contingent interest percentage of the net proceeds provided that the aggregate amount of contingent interest payments does not exceed the maximum contingent interest amount described above.

3.7.3 Amortizing Loans

In some cases, a project's anticipated cash flow and debt service are such that it is reasonable to expect the borrower to make regular monthly payments of principal and interest on the RHFP or RHW loan. The general requirements set forth in Section 3.7.1 would also be applicable to such loans.

Multifamily Bond Program Terms and Conditions
Loans provided under the MBP must be amortized at an interest rate set by DHCD. The term of the loan may be up to forty (40) years for either taxable or tax-exempt bond funded loans. All projects must be credit-enhanced so that the bonds sold to fund the loans can receive a

rating of "AA" or better from DHCD's rating services, unless an alternative structure is approved by DHCD. See Section 6.2 for additional information on MBP.

3.8 LIHTC Award Limits

The maximum amount of competitive LIHTC reservation or allocation will be limited to not more than $1.5 million to any single project. Reservations and/or allocations may be split over two (2) or more calendar years.

Allocations of non-competitive LIHTC pursuant to §42(h)(4)(B) of the Internal Revenue Code (federally subsidized tax-exempt bond transactions) are not subject to the $1.5 million cap noted above and are limited only by the amount required, at the sole determination of DHCD, for the long term feasibility of the project.

3.9 Underwriting Standards

To pass threshold, all applications must be submitted meeting the underwriting standards listed in Sections 3.9.1 through 3.9.9.

Consistent with its obligations under §42(m)(2) of the Internal Revenue Code, which requires that LIHTC allocations not exceed what is necessary for financial feasibility, and in consideration of best practices promoted by the National Council of State Housing Agencies, DHCD will underwrite all applications for LIHTC, RHFP, MBP, and RHW. In so doing, DHCD must balance the efficient use of resources with the need to develop housing that is viable and sustainable for the entire compliance and extended use periods.

Projects without project-based Section 8 assistance that are subject to federal subsidy layering requirements under §911 of the Housing and Community Development Act of 1992 are subject to the Memorandum of Understanding between DHCD and HUD. Additionally, projects with project-based housing choice vouchers must comply with the standards in the HUD Administrative Guidelines: Subsidy Layering Review for Proposed Section 8 Project-Based Voucher Housing Assistance Payments Contracts, as published in the Federal Register, July 9, 2010.

3.9.1 Maximum Rents

Low-income units in a project must be rent restricted as required by the most restrictive funding source. Applications that anticipate the use of project-based rental assistance must show a breakdown of the actual rent to be paid by tenants and the estimated rental subsidy that will be received by the project owner.

In all cases, the Market Study and appraisal must demonstrate the proposed rents are achievable. Rents must allow for a reasonable affordability window so that tenants below the

maximum income for targeted units are not paying a disproportionate percentage of their income for rent (i.e. in excess of 30% for family projects or 35% for elderly projects).

Maximum unit rents (inclusive of tenant paid utilities) may not exceed 30% of the imputed gross income limit applicable to each unit based on an assumption of 1.5 persons per bedroom for units with one or more bedrooms and 1.0 persons per bedroom for efficiency or Single Room Occupancy (SRO) units. For example, the maximum rent calculation for a two-bedroom unit targeted to households at 40% of the area median income would be calculated by dividing 40% of the area median income for a three (3) person household by twelve (12) and multiplying by 30%.

For units restricted to Elderly Households, the imputed household size may not exceed three (3) persons regardless of the number of bedrooms. For example, in a family project, the rent for a three-bedroom unit would be based on a 4.5 person household, but if designated as an elderly unit the maximum rent must be calculated based on a three (3) person household.

Area Median Income charts, including adjustments for household size, are published annually by HUD and posted on DHCD's website at:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

3.9.2 Vacancy

All projects will be underwritten with a minimum vacancy rate of 5%. Additionally, the Market Study must fully support the proposed vacancy level. DHCD reserves the right to reject as infeasible any project that requires a vacancy rate of 10% or more.

Multifamily Bond Program Terms and Conditions

Loans financed using the FHA Risk Sharing Program generally will be underwritten using a 7% vacancy rate. See Section 6.2 for additional information on MBP.

3.9.3 Operating Expenses

Annual operating expenses, including all real estate taxes but excluding replacement reserve deposits, should be no less than $4,000 per unit per year and no more than $7,000 per unit per year. Waivers may be requested for small projects of up to forty (40) units, projects with master-metered (i.e. project paid) utilities, or other unusual circumstances.

3.9.4 Reserves for Replacement

All projects must budget at least $300 per unit per year in reserves for replacement (RFR) deposits. Additionally, RFR deposits must be adequate to support the project as determined by a capital needs assessment (CNA) prepared by a qualified third party. DHCD reserves the right,

in its sole discretion, to require a new CNA every five (5) to ten (10) years and adjust RFR deposits based upon such new CNA.

3.9.5 Operating Reserves

Each project must establish an operating reserve equal to between three (3) and six (6) months of underwritten operating expenses, debt service payments, and required deposits to other reserves. At a minimum, capitalized operating reserves must remain in place until the project has achieved a minimum 1.15 debt service coverage ratio, economic break-even operations for one complete fiscal year as confirmed by the project's annual audit, and reached and sustained 90% occupancy for twelve (12) consecutive months. In the discretion of DHCD, the operating reserve may be released over the next three (3) years provided the project continues to achieve economic break-even operations and sustains 90% occupancy.

Upon release, operating reserves generally may be used to pay any outstanding deferred Developer's Fee, reduce any State loan, fund other reserves, fund project betterments, or otherwise be applied as approved by DHCD.

3.9.6 Trending

In evaluating the long term viability of the project, DHCD requires that rents and other revenue from the project be projected to increase by no more than 2% annually. Operating expenses (including property taxes) must be projected to increase by not less than 3% annually.

3.9.7 Debt Service Coverage Ratio

All projects must be underwritten to a minimum debt service coverage ratio (DSCR) of 1.15 in the first year of stabilized operations. The DSCR will be calculated including all must-pay debt service payments. For projects with amortizing debt service on a RHFP or RHW loan, the minimum DSCR is 1.1.

3.9.8 Development Costs and Fees

Consistent with §42(m)(2) of the Internal Revenue Code and industry best practices, DHCD limits funding awards to the amount necessary to make a transaction viable. Even if a specific line item is not being paid with LIHTC equity or DHCD funds, any excessive cost, regardless of the source of financing, increases the gap and affects the public subsidy needed by a transaction. As a result, DHCD reserves the right to require any applicant to provide a justification of any development cost line item regardless of the source of funding. The following standards will be applied to specific cost items.

3.9.8.1 Acquisition

In all cases and regardless of which proposed funding source will pay for the acquisition price, an appraisal will be used to assess the reasonableness of the acquisition price in the project budget. In most cases, independent professional appraisers under contract with DHCD will

perform the appraisal and the applicant will pay the costs of any required appraisals; provided, however, DHCD, in its sole discretion, may accept an appraisal that is required by another lender and prepared by an independent professional appraiser for that lender. For LIHTC transactions involving acquisition credits, DHCD may, as a condition of a reservation and at its discretion, request an opinion from an independent CPA or tax attorney confirming that the planned acquisition conforms with §42(d)(2)(B) of the Internal Revenue Code (i.e. the Ten-Year Rule).

The acquisition price is defined as the consideration offered for the transfer of title and legal ownership. The acquisition price does not include:

- Reasonable and necessary soft costs related to the acquisition, such as legal expenses associated with zoning, title expenses, relocation costs, and engineering fees; or
- Off-site improvements, such as extensions of infrastructure necessary to prepare the site for its intended use, provided that the absence of such improvements is clearly noted and accounted for within the appraisal's estimate of "as is" value.

The acquisition price must meet the following requirements:

- In the case of an Arms-Length Transaction (as defined below), the acquisition price must be less than or equal to the "as is" appraised value of the property.
- In the case of a transaction involving a change of use, the acquisition price must not exceed the lesser of the "as is" appraised value or the "as completed" appraised value based on the project's projected end use.
- In the case of a Related Party Transaction (as defined below) where the property was acquired less than two years before the application date, the acquisition price must not exceed the lesser of the "as is" appraised value or the applicant's original acquisition price plus carrying costs acceptable to DHCD.
- In the case of a Related Party Transaction where the property was acquired two or more years before the application date, the acquisition price does not exceed the "as is" appraised value of the property.

For purposes of this section, an Arms-Length Transaction is one between parties made freely and independently of each other, and without a special relationship such as family relationship, other business relationship, or the existence of a controlling interest between the parties. In contrast, a Related Party Transaction includes one between parties where familial, business, controlling interests, or other close ties exist prior to the transaction.

Except for family housing projects located in a Community of Opportunity, any portion of the acquisition price in excess of the "as is" value may not be financed or reimbursed by RHFP,

RHW, or other project sources; may not be used in calculating the Developer's Fee; and may not be reimbursed from cost savings at final closing. The excess must be paid with non-project sources such as proceeds of the Developer's Fee. For a family housing project located in a Community of Opportunity, the acquisition price may be up to 120% of the "as is" value before being subject to the limitations outlined in this paragraph.

Exceptions to the acquisition price standards may be submitted to DHCD on a case by case basis under the waiver process described in Section 5.2.10. Waivers to the acquisition price limitations will be in DHCD's sole discretion, and DHCD expects the approval of such excess acquisition prices to be extremely limited.

Additionally, DHCD loan funds may not be used directly to purchase schools or school sites owned by local governments or religious institutions for conversion to housing, except as permitted by waiver as provided in Section 5.2.4.

DHCD will allow real estate taxes and other carrying costs associated with owning the site for up to twelve (12) months prior to application and during the period after acquisition and application to be counted towards the allowed acquisition price of the property for the purpose of meeting the 10% expenditure tests associated with awards of LIHTC.

3.9.8.2 Syndication Costs

For projects seeking LIHTC awards, the projected net equity from syndication should be based on current market conditions. Net equity will take into account syndication and partnership fees included in the project budget. When analyzing the LIHTC market, DHCD may adjust the equity rate for purposes of determining the appropriate award of credits.

Because the market for LIHTC equity is variable, DHCD intends to provide notice ahead of each funding round about its current assumptions for equity pricing and reserves the right to establish both minimum and maximum pricing. Further, DHCD reserves the right to require an applicant to submit documentation from equity providers justifying the reasonableness of the applicant's equity pricing assumptions.

Payment of an investor service's fee will be restricted to $3,000 annually prior to payment of the DHCD loan.

3.9.8.3 Professional Fees

Subject to the further definitions and restrictions below, the following limits on professional fees will apply to all projects:

Summary of Professional Fee Limitations		
	Large Projects	***Small Projects (up to 40 units)***
Builder's Fees - Aggregate limit % of net construction costs	New construction: 15% Rehabilitation: 17%	New construction & Rehab:20%
Builder's Profit	10%	
Builder's Overheard	3%	
General Requirements	10%	
Civil Engineering % of net construction costs	5%	7%
Architect—Design % of construction contract	5%	7%
Architect—Administration % of construction contract	3%	4%
Developer's Fee % of aggregate basis	10-15% as further defined below	

- Applicants may request waivers to the professional fee limitations described above for small projects (those with up to forty (40) units) and/or projects that require specialized consultants or services. Waivers must be requested in accordance with Chapter 5 and will be granted at the sole discretion of DHCD and upon a determination that the increased costs are necessary and reasonable given unique features of the proposed project.

- **Developer's Fee** – The Developer's Fee is inclusive of all fees paid to the Developer, processing agents, and development consultants, and includes deferred fees. The range of allowable Developer's Fees is from 5% to 15% of total development costs as approved by DHCD based on the table below. For purposes of this calculation, total development costs include the following: expenses related to the construction or rehabilitation of the project; fees related to construction or rehabilitation such as architecture, engineering and legal expenses; financing fees and charges such as construction interest, taxes, insurance, and lender fees; and acquisition related costs which may include master planning costs. Total development costs do not include the following: hard or soft cost contingencies; syndication related costs; funded guarantee and reserve accounts that are required by lenders or investors; and the Developer's Fee.

For projects with competitive RHFP and LIHTC, the Developer's Fee may not exceed $2.5 million.

Developer's Fee Limits		
	Fee on Development Costs	***Fee on Acquisition Costs***
First $10 million	15%	10%
Amount in excess of $10 million	10%	5%

Sponsors may request up to an additional five (5) percent above the calculated Developer's Fee (i.e. up to 20% of Development Costs and up to 15% of Acquisition Costs) if 80% of the entire additional fee is escrowed with DHCD or another lender to fund a rent subsidy for Targeted Population (See Section 4.4.2) units set aside for persons at or below 20% of area median income for the initial 15 year LIHTC compliance period. The remaining 20% of the additional fee will be made available to the project sponsor as an incentive for providing units to Targeted Populations. Funds deposited in the rent subsidy will be used to fund the difference between the 20% AMI rent and 60% AMI rent. DHCD will work with sponsors to determine the exact mechanism necessary and appropriate to ensure funding on the subsidy. Additionally, during the initial fifteen (15) year LIHTC compliance period, DHCD will review, approve and monitor use of the rental subsidy. Provisions for the rent subsidy will be incorporated into DHCD's loan documents, as appropriate. The additional five (5) percent above the calculated Developer's Fee will not be subject to the $2.5 million limit stated above.

Note that while this section describes the limits on the allowable Developer's Fee, Section 6.1.9 addresses expectations on the disbursement of the Developer's Fee.

3.9.9 Phased Projects

Applications for subsequent phases of projects already in receipt of a reservation of RHFP or LIHTC allocations must show evidence that the original phase(s) of the project has achieved Sustaining Occupancy. For this purpose, Sustaining Occupancy means a minimum of three (3) months of break-even operations and occupancy at 90% or greater.

3.10 Readiness to Proceed and Financial Feasibility

As part of the Application Submission Package, sponsors must complete the Anticipated Development Schedule in CDA Form 202. This schedule should be consistent with DHCD's underwriting and construction review process as outlined in Appendix A of this Guide as well as LIHTC requirements. If a project is approved for a LIHTC, RHFP, and/or RHW reservation, it is expected to meet the development schedule as proposed. In cases where a zoning change,

variance, or exception is necessary, schedules must be consistent with the analysis provided by the Development Team's zoning attorney or engineer. In all cases, the Anticipated Development Schedule should reflect the project's readiness to use current calendar year LIHTC and current fiscal year RHFP or RHW funds. If a project envisions utilizing other than current calendar year LIHTC and/or current fiscal year RHFP or RHW loan funds, the application must provide sufficient explanation and supporting information for the alternate development schedule.

Additionally, all projects must be financially feasible in accordance with DHCD underwriting standards and generally accepted industry practices.

3.11 Site Requirements

3.11.1 Site Control

Sponsors must have sufficient site control to allow projects to move forward if they receive a reservation of funds. At the time of application, site control should extend for at least one-hundred and eighty (180) calendar days after the application deadline date (including extension options). Acceptable evidence of site control includes deeds, contracts of sale, leases, purchase options, Land Disposition Agreement and other similar agreements from a local government, or other evidence at DHCD's discretion.

3.11.2 Utility Availability

Evidence that public water, sewer, electric, gas, telephone, internet, and cable services are at project sites or will be available during the construction or rehabilitation period must be provided. Acceptable evidence of utility availability may include a letter from the Development Team's civil engineer, the utility company providing the service, a responsible local official, or, for existing buildings, copies of recent utility bills. Alternatively, the applicant may provide a certification in the form provided in the Application Submission Package.

3.11.3 Zoning

Sites must be properly zoned for their intended use. If a zoning change, variance, or exception is required, sponsors must provide the following information in the application:

- Documentation illustrating the present status of the proposed zoning change and the local planning and zoning process;
- Contact information for a local official familiar with the project and responsible for the approval process; and
- A detailed schedule with projected dates for obtaining the required approvals corresponding to the project schedule in the Application Submission Package.

3.11.4 Environmental Assessments

Each project must comply with applicable requirements of local, State, and federal environmental laws and regulations. As part of the Application Submission Package, an environmental assessment checklist or environmental report, if available, must be included. Environmental assessments must not be more than one (1) year old as dated from application submission.

3.11.5 Scattered Sites

Except for family housing located in a Community of Opportunity, projects which involve either the rehabilitation of existing scattered site homes or new construction on non-contiguous vacant infill lots, whether as a stand-alone project or as part of a larger scattered site redevelopment project, must include in the application a current community revitalization plan. The community revitalization plan must be prepared in accord with the requirements of Section 4.2.1 of this Guide.

Except for family housing located in a Community of Opportunity, no targeted unit in any scattered site project may be adjacent to a vacant unit that is not part of the project or is not otherwise specifically targeted for redevelopment in a community revitalization plan.

3.11.6 Exceptions

The requirements for site control, availability of utilities, environmental, and zoning compliance, and scattered sites are not applicable to projects that involve the purchase of completed residential units constructed under a density bonus, affordable zone, or other comparable program. Additionally, site control requirements are not applicable for a sponsor of a scattered site family project in a Community of Opportunity. Sponsors of both of these types of projects must provide a detailed proposal for identifying specific sites and indicating how and when they will obtain site control.

3.11.7 New Construction - Priority Funding Areas (Smart Growth)

All projects involving any new construction must be located in a Priority Funding Area (PFA) under Maryland's Smart Green and Growing Initiative. PFAs include:

- All incorporated municipalities including Baltimore City, with some exceptions related to water, sewer and density for areas annexed after January 1, 1997;
- All areas between the Baltimore beltway and the Baltimore City limits and the Washington, DC beltway and the Washington, DC boundary;
- All areas designated as Sustainable Communities, as defined by the Maryland Annotated Code, Housing and Community Development Article, Section 6-201(l) (see Section 4.2.3);
- Federal and State enterprise zones;

- All areas designated by county governments as PFAs, including rural villages designated in county comprehensive plans as of July 1, 1998; and
- Certified heritage areas within locally designated growth areas.

All applications for projects involving any new construction must include a letter from the local government that certifies the project is located in a PFA. Information regarding PFAs may also be found at the link below:

http://www.mdp.state.md.us/OurWork/SmartGrowthTrendsAndAnalysis.shtml

3.12 Market Study

Applications must provide a Market Study commissioned by the applicant that must demonstrate the need for affordable rental housing in the local market and must meet the following criteria:

1. The Market Study must be prepared by an independent professional who has experience with affordable multifamily rental housing in Maryland and whose firm appears either on the list of acceptable market analysts maintained by DHCD or on the list of firms who have undergone peer review by the National Council of Housing Market Analysts (NCHMA).. Additional information on recommended practices for market studies and standard terminology as well as the NCHMA-approved list of analysts is available through the NCHMA website. DHCD's list of acceptable market analysts is posted on the DHCD website at:

   http://dhcd.maryland.gov/HousingDevelopment/Documents/rhf/AppraiserList.pdf

2. The Market Study shall be no more than six (6) months old as dated from application submission;

3. The Market Study must provide a concise executive summary of the data, analysis, and conclusions of the report covering the items listed below, with easy references to find the detailed information provided in the summary; and

4. The Market Study must address and satisfy the standards described in Section 3.12.1. The Market Study must be consistent with the most recent version of the NCHMA Model Content Standards for Rental Housing Market Studies, which is available on the NCHMA website at:

   https://www.housingonline.com/councils/national-council-housing-market_analysts/model-content-standards/

5. The Market Study must provide:

- A detailed project description including the proposed number of units by number of bedrooms, unit size in square feet, utility allowances for tenant-paid utilities, and rents. This project description must match the information provided on the CDA Form 202 submitted with the Application;
- A geographic definition (other than a simple radius) of the primary market area (PMA) and secondary market area (SMA) including maps of the PMA and SMA; and
- A complete and accurate description of the site and the immediate surrounding area, including:
    - Information and statistics pertaining to school performance including Maryland School Assessment (MSA) test results compared to the State's average; graduation rates compared to the State's average; and an analysis of how this information might affect the market performance of the project.
    - Information about opportunities for recreation, education, convenient access to mass transit or rail systems, and community activities for the building, project site, and nearby surroundings. A chart and map that shows proximity to public services, grocery, medical facilities, and public transportation must be included; and
    - Information and/or statistics on crime in the PMA relative to data for the overall area. Where the data on crime is limited, information for the broader jurisdiction may be provided.

3.12.1 Market Analysis

The Market Study must:

- Provide a summary of market-related strengths and/or weaknesses that may influence the project's marketability, including:
    - Quantifying and discussing market advantage of the subject property and impact on marketability;
    - Projecting and explaining any future changes in the housing stock within the PMA; and
    - Identifying risks (i.e. competitive properties which may come on line at the same time as the subject property, declining population in the PMA), unusual conditions, and mitigating circumstances.
- Provide an opinion of the market analyst of market feasibility including the prospect for long-term performance of the property given housing and demographic trends and economic factors;
- For properties with project-based Section 8 or USDA Multi-Family Housing Rental Assistance, provide a marketability opinion in the event the Section 8 or USDA Multi-Family Housing Rental Assistance agreement is not renewed or expires;

- Derive a market rent and an achievable rent and then compare them to the proposed rent;
- Evaluate the need for voucher support or HUD contracts;
- Provide an estimate of the number of renter households qualified by income and, if appropriate, age for the targeted program(s) (using the definition of Elderly Household in Section 3.2.2), and persons with disabilities or special needs set-asides, if any, in the PMA;
- Provide rent levels, operating expenses, comparative amenity study, turnover rates, waiting lists, and vacancy rates of comparable projects in the market area with an analysis of the competitive advantages offered by the applicant's proposed project;
- Support the applicant's proposed vacancy rate and the income targeting of the project; and
- Provide a summary of the project's positive and negative attributes and impact on existing projects already in DHCD's portfolio and projects in DHCD's current processing pipeline. To ensure that the Market Study addresses all the relevant properties, the market analyst must use the DHCD website to generate a proximity report identifying properties within up to 5 miles of the project site.

  http://dhcd.maryland.gov/Pages/dhcdmapper.aspx

3.12.2 Capture Rate

- The Market Study must provide a capture rate for the proposed project overall, as well as capture rates for each targeted income band and bedroom count;
- Rent burdens (rent plus utility allowance, if any) may not exceed 30% of gross income except in elderly projects where rent burdens may not exceed 35% of gross income; and
- The overall capture rate for a project must not exceed 10% and the maximum capture rate for individual income bands and bedroom counts must not exceed 20%.

3.12.3 Penetration Rate – New Construction Projects only

- The Market Study must provide the penetration rate for the proposed project overall, as well as for each targeted income band in accordance with NCHMA guidelines; and
- The penetration rate for a project must not exceed 100% for the overall project and for each individual income band.

3.12.4 Vacancy Rates

- The Market Study must demonstrate that the overall vacancy rate in the PMA for the type of project proposed (i.e. family/elderly) does not exceed 15% and the vacancy rate among affordable rental properties of the same type in the PMA does not exceed 10%.

3.12.5 Income Levels

- The Market Study must provide a detailed analysis of the income levels of the potential tenants for the proposed units; and
- The Market Study must state and support the minimum household income used for total housing expenses to set the lower limit of the targeted household income range.

3.12.6 Absorption Rate

- The Market Study must provide an absorption rate for the proposed project; and
- The Market Study must define and justify the absorption period and absorption rate for the subject property, which includes documentation and descriptions that show the methodology for calculations in the analysis section and relate the conclusions to the data.

3.13 Development Quality Thresholds

The following development quality thresholds are minimum mandatory standards and must be provided for a project to pass threshold.

3.13.1 Criteria Applicable to All Projects

1. All projects must demonstrate compliance with all applicable State and local building codes, which will be understood to include the latest version of the Building and Energy Code and the accessibility code adopted by the Maryland Codes Administration into the Maryland Building Performance Standards (MBPS).

2. All projects must comply with UFAS and any other applicable laws or requirements, including without limitation Section 504 of the Rehabilitation Act of 1973 ("Section 504"), the regulations implementing Section 504 at 24 CFR Part 8, the Americans with Disabilities Act ("ADA"), and the 2010 ADA Standards (as modified by HUD).

3. Provide a certification that the applicant, if funded, will employ a RESNET Certified HERS rater for new construction projects, or a RESNET or BPI Certified Professional (Multifamily Building Analyst or Envelope Professional) to work with the Development Team using accepted practices and levels of professional care to achieve applicant- stated energy goals, DHCD energy requirements, and the State of Maryland adopted energy codes. If the project is funded, the certified RESNET/BPI rater must be engaged to review and verify the design, provide construction quality assurance, and perform necessary in-progress performance testing and evaluation.

4. The project must implement an integrated pest management program equivalent to the HUD Healthy Homes Initiative.

5. High performance roofing specified for durability for new construction projects and when roofing is replaced for rehabilitation projects. Warranties must equal or exceed twenty (20) years for flat roofs and thirty (30) years for pitched shingled roofs.

6. Heavy (i.e. eighteen (18) to twenty (20) gauge) metal, solid core wood, or top quality foam filled fiberglass entry doors; unit entrance doors with durable frames and hardware for exterior entry; unit entry doors (twenty-two (22) gauge) for interior unit entry doors.

7. Laundry facilities must be adequate for the project and located for safe, convenient access. Minimum of one (1) washer and dryer for every fourteen (14) units in family projects and one (1) washer and dryer for every twenty-five (25) units in elderly projects. A common or shared laundry room must include, at a minimum, a utility sink, folding table, and seating. Additionally the common laundry room should have a means to drain should an overflow occur, dryers vented to the exterior, and meet all ADA requirements.

8. All projects must have the capacity for high-speed Internet in each unit or in a community space. Internet service provided in each unit may be the responsibility of the tenant. If service is to be provided in community spaces, the services provided must include any necessary computer hardware and software, as well as connections, and allow reasonable accommodation during evenings and weekends for tenant work and academic schedules.

9. All products and materials must be installed in accordance with the manufacturer's installation instructions.

3.13.2 Base Level Green Standards for All Projects

1. Demolition Plan – On projects where demolition will occur, submit a demolition plan which includes plans and/or specifications which identify sound practices for managing waste and hazardous materials. Specify methods which are environmentally sensitive and create less pollution. Identify opportunities for recycling.

2. Site work – Employ Maryland Department of the Environment (MDE) 2011 Standards for Soil Erosion and Sediment Control during construction. Limit area of disturbance to immediate work area. Site work at building pad, parking areas, and storm water structures must be completed with the approval and direction of the geotechnical engineer. Limit access to the site when vehicles or construction activity environmentally degrade the site.

3. Landscaping – New plantings shall utilize at least 50% native plantings. Select native, highly suitable, drought /disease tolerant plantings suitable for the project soil and microclimate. Where there are healthy large existing trees, make considerations for preserving mature trees in the site plan. Utilize shade, windbreak and screening benefits of plantings in the project design. Protect trees during construction.

4. Construction Waste Recycling/Deconstruction – The project must implement a construction waste recycling plan in which construction waste materials are collected, separated and recycled instead of being sent to a land fill. The plan shall include a record keeping function that shows the weight, type and disposition of materials processed.

5. Air Quality – The project shall make primary use of all of the following Interior Air Quality criteria: Green Label carpeting and low toxic, low volatile organic compound (VOC) paint, primer, sealers, and adhesives. The Architect must reference a national standard such as Green Seal, South Coast Air Quality Management District, Bay Area Air Quality Management District, or equivalent standard. In addition, unsealed engineered or composite wood products free of added urea formaldehyde must be used. See American National Standards Institute (ANSI) A208. The Architect will verify compliance of green products during the submittal review and construction verification process.

6. Chlorofluorocarbons (CFC) – Where new HVAC equipment is specified, there will be no use of CFC refrigerant. Where CFC refrigerant equipment is being removed, specify standards for capturing and disposal of CFC materials. For retained CFC refrigerant equipment, include a comprehensive inspection, maintenance, and phase out or conversion plan.

7. Moisture and Mildew – Correct all observed areas of mold, mildew, and moisture infiltration within the building. On existing structures, the Building Evaluation Report or environmental report will identify these areas. Plans or specifications must identify remedies and accepted practices for treatment.

8. Radon Gas – For Projects located in EPA Radon Area Zone 1 install a passive radon gas reduction pipe system with vertical venting convertible to mechanical venting unless testing indicates there is no radon gas hazard as determined by EPA standard. This requirement is only for projects where radon gas poses a legitimate hazard.

9. Recycling Plan, Post Completion – Provide space and containers on site for household recycling. Encourage residents to recycle. Address recycling in management plan.

10. Water Conserving Features – Project water fixtures and faucets are to conserve water. Toilets – 1.6 gallons per flush or less, shower heads – 2.0 Gallons Per Minute (GPM), and bath and kitchen faucets – 2.0 GPM or less.

11. Smoking Areas – Designate permitted smoking areas. Locate outside smoking areas at least twenty-five (25) ft. away from entry air intakes and residents' windows. No smoking in building interior common areas.

12. Site Location – New Construction projects are not located in FEMA Flood Zone Areas except zones C or X which are minimal risk areas.

13. Habitat Protection – Where development of the project removes prime habitat for a protected or endangered species, the developer must provide an offsite conservation lease or easement for replacement habitat which is a minimum of three times the area of habitat lost in the development of the project or consistent with State or Federal requirements, whichever is greater. The conservation lease or easement shall be perpetual or a minimum of fifty (50) years.

3.13.3 Additional Criteria Applicable Only to New Construction and Gut Rehabilitation

New construction, gut rehabilitation, and change in use projects do not need to submit an energy audit. Gut Rehabilitation is defined, for energy conservation purposes, as demolishing the building to the building's exterior wall structural framing and removing and replacing the existing MEP systems.

1. All new construction projects must be certified under the current version of Energy Star New Homes or Energy Star Multifamily High Rise rating systems.

2. The project must provide resident comfort and efficiency through installation of Energy Star central or split HVAC systems for community area(s) and units. Proposed equipment of a type or class not currently available as Energy Star-certified shall equal or exceed the efficiency of Energy Star-certified systems. Packaged, thru the wall HVAC units, if proposed, must have duct work serving all major rooms and the overall system design must include an adequate air return path.

3. All appliances must be Energy Star qualified, including vented kitchen and bathroom exhaust fans. Clothes dryers and recirculating kitchen fans are excluded.

4. Install Energy Star qualified windows in accordance with current Energy Star Standards as appropriate to project location, except high rise.

5. Except for gut rehabilitation projects, paving at the dumpster pad, the access drive to the dumpster, and any turns or return path of the garbage truck route must equal local requirements for standard duty residential roadway or provide specifications which indicate a stone base of eight (8) inches or greater with the combination thickness of the asphalt base and top coat being at least five (5) inches.

6. Bi-fold doors will not be used unless space requirements mandate.

3.14 Additional Criteria Applicable Only to Rehabilitation

1. Total hard construction costs (exclusive of fees or overhead items) of rehabilitation for projects must be at least $15,000 per unit and supported by a building evaluation report performed by an engineer or other qualified professional.

2. The scope of work must include exterior renewal by providing any needed repairs and cleaning of finishes to provide an improved visual impact on the neighborhood.

3. Project designs must include complete replacing or upgrading of aging finishes, fixtures, equipment or systems and site conditions that are nearing the end of their useful life or show signs of excessive wear, deterioration, are in need of repair, are obsolete or inefficient.

4. Newly installed mechanical ventilation must terminate at the exterior of the building, not the attic or other unconditioned or interstitial space. Best efforts must be made to extend existing mechanical ventilation to terminate at the exterior of the building.

3.14.1 Base Level Energy Standards for Rehabilitation Only

An energy audit is not required at the time of application for a rehabilitation project. If a rehabilitation project receives a competitive award of LIHTC and/or RHFP, a comprehensive energy audit must be submitted to DHCD within ninety (90) days of issuance of a Reservation Letter. For non-competitive MBP and RHW/LIHTC projects, the energy audit should be submitted on a schedule set by the underwriter and construction manager.

As determined by the comprehensive energy audit, rehabilitation projects must achieve a minimum of 15% energy savings for the rehabilitated building(s) over the existing building condition or install all energy conservation measures that have a Savings to Investment Ratio (SIR) of 2.0 or greater. The SIR standard may be used if a rehabilitation project previously completed an energy efficiency retrofit and the 15% standard cannot be achieved.

Energy audits and resulting reports must be performed by a DHCD listed Qualified Auditor and be prepared in accordance with DHCD Energy Audit Guidance.

http://dhcd.maryland.gov/HousingDevelopment/Documents/Qualified_Auditor_List.pdf

Base level energy standard regulations for rehabilitation-only projects are:

1. Install Energy Star qualified heating, ventilation, and air conditioning (HVAC) systems and components when HVAC systems and their components are replaced. Replacement HVAC units must be at least 10% greater efficiency than code minimum when Energy Star equipment is not available. The closest efficient system available to 10% must be used if a model meeting the 10% efficiency minimum is not available.

2. Install programmable thermostats where thermostats are installed or replaced. Project specifications must include thermostats to be programmed in accordance with Energy Star thermostat set-back guidance by the installer as part of equipment installation and commissioning.

3. All newly installed appliance must be Energy Star qualified, including vented kitchen and bathroom exhaust fans. Clothes dryers and combination microwave/rangehoods are exempt from this requirement.

4. Install Energy Star qualified lighting fixtures or Energy Star label compact fluorescent or LED lamps in conventional fixtures the combination of which make up 70% of the interior lighting when lighting replacement is included in the scope of work.

5. Install Energy Star qualified windows in accordance with current Energy Star Standards as appropriate to project location when windows are replaced (excluding high-rise buildings).

6. A building draft stopping and air sealing scope of work is to be included in the project specifications with minimum verification completed by sampling 10% of the units with a blower door test. Schematic drawings indicating typical air sealing details for the project building type(s) is to be included in the construction section of the Application Submission Package. Air sealing details must include, at a minimum, air sealing for unit compartmentalization as well as air sealing the buildings thermal envelope; including attic and basement/crawl space. Typical details must include sealing inherent design deficiencies specific to the building type(s). Air sealing detail should follow best practices as found in the Building Technologies Program Air Leakage Guide.

7. A building duct sealing and insulation scope of work included in the project specifications (for ducts located outside the building envelope with minimum verification completed by sampling 10% of the units, utilizing a duct blaster or similar diagnostic test). Schematic drawings for typical duct air sealing and insulation details are to be included in the construction section of the Application Submission Package. It may not be feasible to insulate ducts that are not accessible. See Energy Star or the Department of Energy *Building America Best Practice*, Volume 4.

8. Heating and cooling equipment must be sized in accordance with the Air Conditioning Contractors of America (ACCA) Manuals, Parts J and S, or ASHRAE handbooks for the post-rehabilitation building condition. The smallest available size may be used when the calculated size is smaller than the available equipment. Calculation worksheets must be submitted to DHCD before Viability Commitment if the project is approved for funding.

9. A project specific Operations and Maintenance (O&M) manual shall be created to optimize the energy efficiency of the equipment installed in the project. The O&M

manual will include: evaluation criteria, operation parameters, maintenance schedules, checklists for systems and equipment on the project. The building maintenance staff will utilize the O&M manual as an operational standard.

10. The project management staff will provide continuing tenant education and reminders on how to conserve energy. Minimal intervals will be at tenant turnover and heating/cooling changeovers in the spring and fall. Property Management Staff will have written material containing energy saving tips distributed to tenants.

3.14.2 Lead Hazard Elimination

Upon completion of any rehabilitation, all existing buildings must be certified by the Maryland Department of the Environment (MDE) as lead-safe and meet HUD/EPA clearance standards. All abatement and clean-up must be carried out in accordance with MDE requirements (COMAR 26.02.07, Procedures for Abating Lead Containing Substances in Buildings). All abatement contractors or subcontractors must be certified and accredited by MDE.

All projects originally constructed before 1978 must register with MDE's lead poisoning prevention program to obtain certain limited liability from lead-related claims.

Additionally, all contractors and subcontractors engaging in the following activities on projects built before 1978 must be Lead-Safe Certified, as mandated by the EPA Lead-Based Paint Renovation, Repair and Painting (RRP) Rule:

- Remodeling and repair/maintenance;
- Electrical;
- Plumbing;
- Painting;
- Carpentry; and
- Window Replacement.

For more information regarding licensing procedures and guidelines please contact the EPA Lead Safe Hotline, 1-800-424-5323 or refer to:

http://www.epa.gov/getleadsafe

For information on abatement contractors or subcontractors, registration forms, requirements, and fees for the MDE lead poisoning prevention program contact the MDE Lead Hotline, 1-800-776-2706 or refer to:

http://www.mde.state.md.us/programs/Land/LeadPoisoningPrevention/Pages/Programs/LandPrograms/LeadCoordination/index.aspx

4 Competitive Scoring Criteria

Projects that meet all Threshold Criteria will be evaluated against the Competitive Scoring Criteria. The results of this competitive scoring process will determine the award of competitive LIHTC and RHFP within a funding round.

The scoring criteria are designed to ensure that awards are made to project proposals that have strong sponsors, serve critical housing needs for households with very low income and persons with disabilities or special needs, contribute positively to their communities, leverage non-state resources, and achieve balance between costs and development quality, sustainability, and durability.

Multifamily Bond Program and Rental Housing Works Terms and Conditions

Applicants seeking only MBP and RHW financing and associated non-competitive LIHTC must meet all Threshold Criteria in Chapter 3. Such projects are not required to compete with others but will be scored using the Competitive Scoring Criteria and **must achieve a minimum total score of ninety-two (92) points** to be awarded MBP and RHW funds and non-competitive LIHTC. Additionally, projects must achieve **at least thirty (30) points within the Development Team Experience category** in Section 4.1.1, **at least twelve (12) points within the Developer Financial Capacity category** outlined in Section 4.1.3, and **at least ten (10) points within the Development Quality Standards** in Section 4.6.

Projects seeking FHA Risk Sharing Insurance for MBP financing must meet all Threshold Criteria. Such projects are not required to compete with others but will be scored using the Competitive Scoring Criteria and **must achieve a minimum total score of ninety-two (92) points including at least thirty-two (32) points in the Development Team Experience category** in Section 4.1.1 **(with no individual team member earning less than three (3) points below the respective maximum score), at least fourteen (14) points within the Developer Financial Capacity category** outlined in Section 4.1.3**, and at least twelve (12) points within the Development Quality Standards in Section 4.6 below.**

See Section 6.2 for additional information on MBP.

Scoring Summary Table	Maximum Possible Points
4.1 Capacity of Development Team	**74 Total Points**
4.1.1 Development Team Experience	42 points
4.1.2 Deductions from Team Experience Score	Negative 10 points
4.1.3 Developer Financial Capacity	18 points
4.1.4 Nonprofits (NPs), Public Housing Authorities (PHAs) and Minority/ Disadvantaged Business Enterprises (MBE/DBEs)	14 points
4.2 Community Context	**16 Total Points**
4.2.1 Community Impact Projects	16 points*
4.2.2 Communities of Opportunity	16 points*
4.2.3 Defined Planning Areas	12 points*
4.3 Transit Oriented Development	**8 Total Points**
4.4 Public Purpose	**48 Total Points**
4.4.1 Income Targeting	14 points
4.4.2 Targeted Populations: Non-Elderly PWD or Special Needs	10 points
4.4.3 Family Housing	8 points
4.4.4 Tenant Services	8 points
4.4.5 Mixed Income Housing	4 points
4.4.6 Preservation of Existing Affordable Housing	4 points
4.5 Leveraging and Cost-Effectiveness	**20 Total Points**
4.5.1 Direct Leveraging	10 points
4.5.2 Operating Subsidies	10 points
4.5.3 Construction or Rehabilitation Cost Incentives	Negative 8 points
4.6 Development Quality	**31 Total Points**
4.6.1 Green Features	12 points
4.6.2 Energy & Water Conservation & Sustainability	6 points
4.6.3 Project Durability and Enhancements	13 points
4.7 State Bonus Points (maximum of 10 points)#	**See note**
Total	**197**

***** Project cannot receive points under Community Impact, Communities of Opportunity, and Defined Planning Area categories.
# State Bonus Points may be awarded outside of the 197 point scale.

4.1 Capacity of Development Team

To balance the value of experience and the importance of providing opportunities for participation by community based organizations and historically disadvantaged businesses, DHCD considers both the capacity and the composition of the Development Team that will undertake a project.

4.1.1 Development Team Experience (42 maximum points)

DHCD will award up to forty-two (42) points based on an assessment of Development Team capacity as further described below. Capacity will be based on the demonstrated relevant experience and qualifications of the Primary Development Team. DHCD will evaluate the Primary Development Team (see Section 3.1 for Primary Development Team members) based on their record of accomplishment during the past five (5) years with projects that are similar in size, scope, and complexity to the proposed project. Primary Development Team members without appropriate experience should establish partnerships with experienced entities. In the case of a joint venture, points will be awarded based on the capacity and experience of the controlling member of the joint venture.

Points will be available as detailed on the following chart:

Development Team Capacity				
Criteria	***Developer***	***General Contractor***	***Architect***	***Property Manager***
The entity has a consistent and successful track record during the past five (5) years with projects that are similar to the proposed project and has shown the ability to remedy problems.	14-18 points	6-9 points	5-6 points	6-9 points
The entity has an overall successful track record during the past five years (5) but may not have sufficient experience, has not always promptly addressed problems, or may not have sufficient experience with similar projects.	9-13 points	3-5 points	3-4 points	3-5 points
The entity has an inconsistent track record during the past five years (5), may not have sufficient experience, has not promptly addressed some problems, or may not have sufficient experience with similar projects.	4-8 points	1-2 points	1-2 points	1-2 points
The entity has limited or no experience has a record of problems that were not promptly addressed, or has limited or no experience with similar projects.	0-3 points	0 points	0 points	0 points

4.1.2 Deductions from Team Experience Score (Negative 10 maximum points)

Points will be deducted from the Development Team Capacity score for any Developer (up to six (6) points) or property manager (up to four (4) points) with a record of the following within the past five (5) years:

Processing Timeframes:

- For projects currently in DHCD's pipeline, failure to meet DHCD's loan processing schedules, construction progress, or completion timeframes.

Compliance Issues:

Consistent failure to promptly resolve compliance matters as evidenced by outstanding IRS Form 8823 or other compliance enforcement action by DHCD, including, but not limited, to the following:

- Failure to maintain income targeting as required under any MBP, RHFP, RHW, LIHTC, or other DHCD funding agreements;
- Failure to maintain adequate documentation of tenant eligibility or qualified basis;
- Failure to timely recertify tenant incomes or continued occupancy by unqualified households; or
- Failure to promptly resolve compliance matters arising from commitments in prior applications that led to the award of points under a prior QAP, Guide, or funding round, including, but not limited to, failures to:
  - Provide promised tenant services;
  - Maintain promised preferences within the set-aside of units or tenant selection criteria for persons with disabilities or special needs populations;
  - Obtain non-State leveraged funding as committed in a prior application; or
  - Deliver promised development features, amenities, or as-built specifications without prior approval of DHCD.

Asset Management Issues:

- Untimely submission of required DHCD asset management documents (including, but not limited to, annual audits, operating statements, and budgets);
- Properties with annual physical inspection or management performance evaluations with ratings of "Below Average" or "Unsatisfactory";
- Consistent history or pattern of failing REAC scores after the HUD inspection and cure period;

- Failure to maintain a current management agreement on file with DHCD;
- Failure to comply with an approved AFHMP; and
- Late payments of any type including cash flow billings.

Construction Management Issues:

- Failure to pay the general contractor (in accordance with the construction contract) for work-in-place;
- Inability to resolve construction related issues, which result in an unreasonable delay of project completion; and
- Construction cost increases after closing that are not approved by DHCD.

4.1.3 Developer Financial Capacity (18 maximum points)

Up to eighteen (18) points may be awarded based on the financial capacity of the Developer, which, as defined in Section 3.1, includes the project sponsor, guarantor, and general partner/managing member with an ownership interest in the project's ownership entity whether such roles are held by individuals, corporate entities, partnerships, or limited liability companies. Points will be awarded as described below. The required financial statements must include calculations of Total Assets, Total Liabilities, Current Assets, and Current Liabilities. DHCD will use these figures to assess the Developer's financial capacity, assessing whether the Developer has access to sufficient working capital to carry the project through pre-development and/or unexpected challenges, and net worth (net assets for nonprofit organizations) sufficient to provide applicable guarantees of project completion and operations.

Points will be awarded based on the combined net worth (net assets for nonprofit organizations) of the Developer (Total Assets less Total Liabilities), as follows:

- ..... Over 25% of Total Development Cost (TDC) .....eight (8) points
- ..... Less than 25% but at least 10% of TDC .....four (4) points
- ..... Less than 10% of TDC .....zero (0) points

Points will be awarded based on the combined net liquid assets of the Developer (Current Assets less Current Liabilities), as follows:

- ..... Over 10% of TDC ..... ten (10) points
- ..... Over 4% but less than 10% of TDC .....eight (8) points

- ..... Betwe
  en 2% and 4% of TDC .....four (4) points
- ..... Under
  2% of TDC .....zero (0) points

4.1.4 Nonprofits (NPs), Public Housing Authorities (PHAs) and Minority/Disadvantaged Business Enterprises (MBE/DBEs) (14 maximum points)

NPs and PHAs exist for charitable and/or mission-driven public purposes and, by their nature, bring perspectives on and accountability to the residents they serve. DHCD wants to encourage NP and PHA perspectives in the planning, development, management, ownership, and ongoing oversight of affordable housing. DHCD also wants to encourage MBE/DBE participation and perspectives in the planning, development, management, ownership and ongoing oversight of affordable housing. Therefore, DHCD will award points to project proposals with material and meaningful participation by NPs, PHAs, and/or MBE/DBEs. This participation is expected to reflect the actual capabilities of the entity. Further, DHCD is interested in helping to support and sustain the capacity of a range of NPs, PHAs, and MBEs/DBEs by providing opportunities for them to partner with experienced professionals to learn and strengthen their housing development, management, and ownership capabilities.

PHAs perform the unique mission of providing decent, safe rental housing for very low-income families, elderly, and persons with disabilities. There are over 19,000 public housing units in the State of Maryland housing over 47,000 people. These units are an important resource for some of the state's most vulnerable populations. DHCD wants to support and encourage the preservation, rehabilitation, and transformation of public housing resources and the coordination with such HUD programs as the Choice Neighborhoods/HOPE VI and Rental Assistance Demonstration.

To qualify for participation as an MBE/DBE, the applicable entity must have been certified as an MBE/DBE by either the Maryland Department of Transportation (MDOT) pursuant to the MBE/DBE programs or by a comparable certification program operated by another Maryland political jurisdiction.

Points may be awarded for the categories described below when the project involves:

- a NP that is tax-exempt under Section 501(c)(3) or 501(c)(4) of the Internal Revenue Code and independent of any for-profit entity;
- a PHA; or
- A certified MBE/DBE.

The number of points awarded will be determined based on the role of the NP, PHA, or MBE/DBE and its demonstrated capacity to undertake its role in a project of the type and scope proposed.

Projects shall be eligible for a maximum of fourteen (14) points under this section as detailed in the four (4) categories below. The same entity may receive points in multiple categories. For example an MBE/DBE, Community-Based NP (defined below), or PHA could have a 10% developer/owner role in Category 2 and also receive points in Category 4 as a service provider.

Category 1 (maximum of eight points): Eight (8) points will be awarded when the NP, PHA, or MBE/DBE has a controlling ownership interest (51% or greater) in the project and, for the NP entity, is a Qualified Nonprofit within the meaning of Section 42(h)(5)(B) and (C) of the Internal Revenue Code which, among other things, requires that the entity:

1. Materially participate in the development and management of the project throughout the compliance period;

2. As determined by DHCD, is neither controlled by nor affiliated with any for-profit entity; and

3. Has as one of its exempt purposes the fostering of low-income housing.

Category 2 (maximum of six points): Up to six (6) points will be awarded to a PHA, MBE/DBE, or a Community-Based NP if the entity has less than 50% but more than 10% interest in the general partner or managing member of the project owner

A Community-Based NP means:

- A Community Housing Development Organization (CHDO) certified by DHCD or by a participating jurisdiction; or
- A Community Development Corporation (CDC) or a nonprofit or charity organized under Section 501(c)(3) or 501(c)(4) of the Internal Revenue Code, which: (i) has at least a one-year history of serving the local community in which the project is located; (ii) has an existing physical location in the local community (or for a project that serves the homeless or veterans within a Community-Based NP's service footprint) other than space that would be provided, if any, in the proposed project; and (iii) the project is within its defined service area.

Category 3 (maximum of eight points): Up to four (4) points may be awarded to a project for each NP, PHA, or MBE/DBE that is involved as a member of the Primary Development Team as the general contractor, architect, or property management company.

Category 4 (maximum of eight points): Up to four (4) points may be awarded for the first NP, PHA or MBE/DBE entity, and up to two (2) points for each additional NP, PHA, or MBE/DBE entity that :

1. Is a member of the Secondary Development Team as a civil engineer, attorney, accountant, and/or other specialized professional service provider; or

2. Performs another important role with the goal of building its capacity to develop, manage, construct, design, or own affordable housing in the future. Examples include: (a) providing consulting or tenant services, (b) participating in the project in some other learning role, (c) performing as a joint venture partner with the contractor to perform some defined portion of the contractor role, or (d) entering into a joint venture or subcontracting with the architect to perform some defined portion of the design or supervision work. In the case of contractor or architect joint venture, points for contractor/architect capacity in Section 4.1.1 shall be based solely on the primary contractor/architect and no points shall be deducted in that category based on the lesser experience of the subcontractor/joint venture partner.

   To receive points as a Secondary Development Team member (see Section 3.1), the entity must show sufficient experience to carry out the proposed role. Such experience need not be on previous affordable housing projects.

If an NP, PHA, or a MBE/DBE is a member of the Primary Development Team (see Section 4.1) and receives less than 50% of the points under Section 4.1.1 (Development Team Experience) above, no points for participation will be awarded in this Section 4.1.4. Additionally, if the entity's prior performance results in negative points in Section 4.1.2, the same amount of negative points will be applied to the points awarded in this Section 4.1.4. Points will not be awarded under this Section 4.1.4 if DHCD determines that the role proposed for the entity is not a role that it has the experience or competence to perform.

4.2 Community Context

Consistent with the State's housing priorities and the Internal Revenue Code requirements, DHCD will award points to projects in certain geographic areas. Ideally, housing opportunities for low income households would be reasonably dispersed across the State, allowing physical mobility based on a household's own needs and preferences and, in so doing, promoting social and economic mobility for those same households. Achieving this end requires that the State invest in improving neighborhoods that already serve low income residents and providing new housing options in historically less affordable communities that provide residents access to a broad array of jobs, services, and amenities.

Projects may only receive points under one of the following categories: 4.2.1, 4.2.2, or 4.2.3.

4.2.1 Community Impact Projects (16 maximum points)

Some projects not only provide needed affordable housing, but provide synergy, contributing to and expanding upon broader State and local community development investments. DHCD recognizes such projects as outlined below.

Sixteen (16) points will be awarded to any elderly or family project, new construction or rehabilitation, in a Qualified Census Tract (QCT) or Difficult Development Area (DDA) (this does not include any State-designated DDA under the authority granted in §42, more commonly referred to as a "state-designated basis boost") that contributes to a concerted community revitalization plan.

To qualify for points in this category, a concerted community revitalization plan must meet the following requirements:

a) Officially adopted or endorsed by a Local Government or created with Local Government involvement;

b) Consistent with Maryland's Smart Green and Growing Initiatives and PlanMaryland;

c) Established to increase investment in the community or build from an existing community asset;

d) Developed and approved in accordance with local planning requirements;

e) Includes evidence of community and stakeholder engagement;

f) Has a defined geographic boundary, that includes the proposed site or is focused within a single municipality, jurisdiction, or targeted area;

g) If there is a housing component in the plan, the plan should include rehabilitation or new construction of rental housing as a goal for the community;

h) Includes details of implementation measures along with specific time frames for the achievement of such policies and housing activities; and

i) Provides a list of other investment occurring or planned within the immediate area.

A community revitalization plan will be considered ineligible if it:

a) Was formulated solely by a Development Team member. This requirement shall not exclude a plan which included Development Team member(s) as a participant in the planning process;

b) Is a comprehensive plan, consolidated plan, municipal zoning plan or land use plan; unless such plan includes a neighborhood-based or other location specific strategy that articulates where development may occur; or

c) Is not relevant to current neighborhood conditions.

Documentation must be submitted as part of the Application Submission Package that supports each of the elements above, including:

a) Certification form executed by both the applicant and the local government through the local planning department or zoning board that demonstrates that the plan meets the requirements of DHCD;

b) A copy of the full revitalization plan; and

c) A map of area targeted by the plan identifying location of project.

4.2.2 Communities of Opportunity (16 maximum points)

Sixteen (16) points will be awarded to family projects with reasonable access to jobs, quality schools, and other economic and social benefits, as demonstrated by meeting at least one (1) of the following two (2) criteria:

1. Be located in a "Community of Opportunity" as shown on the Maryland QAP Comprehensive Opportunity Maps posted to the DHCD Web site at:

   http://www.dhcd.state.md.us/GIS/multifamily/index.html

The Communities of Opportunity designated on the Maryland QAP Comprehensive Opportunity Maps are based on a "Composite Opportunity Index" developed by DHCD. The Composite Opportunity Index uses publicly-available data and is based on three major factors: community health, economic opportunity, and educational opportunity. To be designated a Community of Opportunity, and mapped as such to the Maryland QAP Comprehensive Opportunity Maps, the community must have a Composite Opportunity Index that it is above the statewide average.

The three major indicators that comprise the Composite Opportunity Index are:

- *Community Health*: The community health indicator represents the wealth and quality of life in a community relative to the State average. The community health indicator has six (6) components, as follows:
  - Median household income obtained from the U.S. Census' American Community Survey (ACS) 2007-2011, five-year estimate. Household income is positively correlated with community health. Higher household incomes support a more

diversified economic base and enhance the tax basis and services of its local government.

- Ratio of owner-occupied to all occupied housing units (a proxy for homeownership rate) obtained from the ACS 2007-2011, five-year estimate. A higher homeownership rate indicates the economic stability of a community, which is positively correlated with community health.
- Median value of owner-occupied housing units obtained from the ACS 2007-2011, five-year estimate. This statistic indicates the strength of a community's real estate market relative to the average statewide market condition and is highly correlated with community health.
- Population growth between 2010 and 2012 obtained from the Economic and Social Research Institute (ESRI) 2012 community profile. A component of population growth is the number of people relocating to a community so this measures the quality of life in a community and is positively correlated with community health.
- Poverty rate, obtained from the ACS 2007-2011, five-year estimate. The poverty rate highlights the detrimental impact of concentrated poverty on quality of life in a community. This variable is inversely correlated with community health.
- Property vacancy rate obtained from the ESRI 2012 community profile. An elevated property vacancy rate negatively impacts community health. Vacant property is often correlated with higher crime and depreciation of property values in a community.

- *Economic Opportunity*: Economic opportunity measures the extent to which a community provides employment opportunity and mobility to its residents. Employment opportunity is measured by the following variables:
  - Prevailing unemployment rate obtained from the ACS 2007-2011, five-year estimate. This variable, which measures employment opportunity in a community, is inversely related with economic opportunity.
  - Median commute time to work obtained from the ACS 2007-2011, five-year estimate. The commute time measures proximity to regional employment opportunities and is inversely related with economic opportunity.
- *Educational Opportunity*: Educational opportunity measures the outcomes of student performance and educational attainment in the community. This indicator is measured by the following variables:
  - Maryland School Assessment (MSA) scores, proficient and advanced, for elementary, middle, and high school students obtained from Maryland Department of Education for the 2011/2012 academic year. These scores play a key role in determining educational advancement as well as opportunities available to students. The MSA scores are positively correlated with educational opportunity.

- Percent of population with a college degree (both undergraduate and graduate degrees) obtained from the ACS 2007-2011, five-year estimate. This variable is positively related to educational opportunity.
- Percent of population with no high school diploma, obtained from the ACS 2007-2011, five-year estimate. This variable is inversely related with educational opportunity.

2. Be located in a geographic area defined by applicable law as a community of opportunity for affordable family housing or identified as such by an order or consent decree entered by a federal or State court of competent jurisdiction or by a settlement agreement to which DHCD or a local government in Maryland is a party. As of the publication of this Guide, DHCD is aware of two such settlements:

   1) Baltimore City: The case of *Thompson v. HUD*. The following link provides information on census tracts designated as Communities of Opportunity in the *Thompson* case:

      http://www.brhp.org

   2) Baltimore County: The Conciliation Agreement among HUD, several complainants, and Baltimore County to designate 116 census tracts in Baltimore County as Communities of Opportunity. These census tracts are outlined in Exhibit F of the Conciliation Agreement found at the following website:

      http://www.baltimorecountymd.gov/Agencies/planning/fairhousing/hudconciliation.html

As detailed in Section E.3 of the Qualified Allocation Plan, all family projects located in a Community of Opportunity will qualify for the State Basis Boost without prior CDA approval.

4.2.3 Defined Planning Areas (12 maximum points)

Projects that did not receive points in Sections 4.2.1 or 4.2.2 may receive up to a maximum of twelve (12) points in this section as detailed below.

- **Category 1:** Eight (8) points for projects in a rural area. For purposes of this section, a rural area includes any area eligible under the U.S. Department of Agriculture's Rural Development programs or any area in Allegany, Caroline, Dorchester, Garrett, Kent, Somerset, Washington, Wicomico, or Worcester Counties that are not otherwise Community Development Block Grant (CDBG) entitlement communities or HOME Participating Jurisdictions.
- **Category 2:** Six (6) points for projects located in any of the following: Certified Heritage Areas within county designated growth areas; Sustainable Communities; Empowerment Zones; Federal or Maryland Enterprise Zones; Main Street/Maple Street

Maryland communities; or rural villages designated in county comprehensive plans as of July 1, 1998 and where there is evidence of other recent public investment in the plan area.

- The Sustainable Communities Program is a place-based designation offering a comprehensive package of resources that support holistic strategies for community development, revitalization, and sustainability. The following link provides a list of approved Sustainable Communities:

  http://dhcd.maryland.gov/Communities/Pages/dn/default.aspx

- **Category 3:** Four (4) points for Elderly Housing project in Communities of Opportunity.

4.3 Transit Oriented Development (TOD) (8 maximum points)

DHCD will award up to eight (8) points to TOD projects as follows:

- Eight (8) points to a project that is part of a MDOT-designated TOD. A list of MDOT-designated TODs is available at:

  http://www.mdot.maryland.gov/newMDOT/Planning/TOD/index.html

- Eight (8) points to a project that is located within a one-half (1/2) mile radius of a passenger boarding and alighting location of a planned or existing transit rail stop or station;
- Eight (8) points to a project located within one-half (1/2) mile radius of two separate bus lines, where passengers can transfer from one line to another;
- Eight (8) points to a project located in an area defined as rural by DHCD or USDA and located within one (1) mile radius of a passenger boarding and alighting location of a planned or existing bus or transit rail stop or station;
- Eight (8) points to a project that is family housing in a Community of Opportunity and located within one (1) mile radius of a passenger boarding and alighting location of a planned or existing bus or transit rail stop or station; or
- Four (4) points to a project located in a transit-proximate development that promotes walkability and/or bike-friendly land use with easy access to mass transit and retail store locations with a WALK Score of 50 or greater (www.walkscore.com).

4.4 Public Purpose

Regardless of project location, DHCD is particularly concerned about the housing needs of tenants with the lowest incomes and those whose needs are particularly ill served by the marketplace, including both low income families with children and households with disabilities

or special needs. Also, the Internal Revenue Code expects states to provide certain preferences for LIHTC projects meeting these needs.

4.4.1 Income Targeting (14 maximum points)

All LIHTC applicants must commit to rent at least 40% of units to households with incomes at or below 60% of the area median or at least 20% of units to households at or below 50% of area median income. Additionally, any unit financed with RHFP or RHW must be rented to households at or below 60% of area median income. To encourage sponsors to income-restrict additional units and to target units to lower income households, DHCD will award points for income targeting in excess of these minimum requirements.

A project will receive four (4) points if at least 10% of the income restricted units in the project will be income-restricted at 30% of the area median or below for the LIHTC compliance period (including the extended use period). These points are available (1) if the project rent restricts those units at the 30% area median income level for the compliance period or (2) for units supported by the award of a project based housing choice voucher contract (or a DHCD approved equivalent form of project based assistance) with a term of fifteen (15) years or more. DHCD will consider project based housing choice vouchers awarded through a recognized mobility program in awarding points in this section. At this time, DHCD is aware of one (1) such program being operated by the Baltimore Metropolitan Council.

Up to ten (10) points will be awarded to any project, regardless of location, based on the weighted average of area median income targeting by bedroom in a project. For purposes of this calculation, the lowest income level used will be 30% of area median income. SRO or efficiency units will be counted as 0.67 bedrooms and all weighted averages will be rounded to the nearest full percentage point. To calculate the weighted average, applicants should use the following process.

- Determine the number of income-restricted bedrooms serving each percentage of area median income by multiplying the number of units of a given size by the number of bedrooms per unit.
- Multiply each income-restricted bedroom by the maximum income target and add the sum of those totals together.
- Divide the result by the total number of income restricted bedrooms and round to the nearest full percentage point to determine the weighted average.

DHCD will award points based on the weighted average as follows depending on whether or not the proposed project provides family housing in a Community of Opportunity:

Points	Average Area Median Income – Family projects located in a Community of Opportunity (ONLY)	Average Area Median Income – <u>All other projects</u>
10 points	30-40%	30-32%
9 points	41-45%	33-35%
8 points	45-50%	36-38%
7 points	51-53%	39-41%
6 points	54%	42-44%
5 points	55%	45-47%
4 points	56%	48-50%
3 points	57%	51-52%
2 points	58%	53-54%
1 point	59%	55%
0 points	60%	>55%+

Example

A one hundred (100) unit rental housing project consists of twenty-five (25) one-bedroom units, fifty (50) two-bedroom units and twenty-five (25) three-bedroom units. The one-bedroom units will be rented to families with incomes of no more than 50% AMI. Twenty of the two-bedroom units will be rented to families with incomes of no more than 60% AMI, twenty more will be rented to families with incomes of no more than 40% AMI, and ten (10) will be rented to families with incomes of no more than 30% AMI. Ten (10) of the three-bedroom units will be rented to families with income of no more than 50% AMI, and the remaining fifteen (15) three-bedroom units will be rented to families with incomes of no more than 40% AMI.

Step 1. Find the number of bedrooms serving each income level.

60% AMI – 20 2-bedrooms or 40 bedrooms [20 x 2 = 40]
50% AMI – 25 1-bedrooms and 10 3-bedrooms or 55 bedrooms [(25 x 1) + (10 x 3) = 55]
40% AMI – 20 2-bedrooms and 15 3-bedrooms or 85 bedrooms [(20 x 2) + (15 x 3) = 85]
30% AMI – 10 2-bedrooms or 20 bedrooms [10 x 2 = 20]

Step 2. Multiply the number of bedrooms at each income level by the maximum income level for those bedrooms and add the results.

40 bedrooms x 60% of AMI = 2,400
55 bedrooms x 50% of AMI = 2,750
85 bedrooms x 40% of AMI = 3,400
20 bedrooms x 30% of AMI = 600
Total = 9150

Step 3. Divide the result by the total number of rent restricted bedrooms to get the weighted average AMI per bedroom.

9,150 ÷ 200 = 45.75% of AMI, rounds to 46% of AMI.

Step 4. Use chart above to determine number of points for 46% of AMI.

46% AMI results in eight (8) points if it is a family project in a Community of Opportunity and five (5) points for all other types of projects.

4.4.2 Targeted Populations: PWD or Special Needs (10 maximum points)

DHCD strongly supports the creation of permanent housing opportunities integrated across the State for targeted populations, particularly those with disabilities who rely primarily on Supplemental Security Income (SSI) or Social Security Disability Income (SSDI). DHCD will award points for projects that set aside up to 25% of units in a project for targeted populations. To qualify as a targeted population set-aside unit, the housing unit must be:

- Permanent housing. Transitional housing or other facilities with limits on the term of occupancy do not qualify as permanent housing;
- Income and rent restricted at no more than 50% of the area median income; and
- Set aside for a household that is headed by one of the following (Projects may select only one targeted population):
  - PWDs;
  - Persons with special needs;
  - Homeless;
  - Youth aging out of foster care;
  - Veterans; or
  - Persons transitioning from a correctional facility or other State facility or institution.

To receive points in this category, targeted populations in elderly projects must meet DHCD's age-restrictions. The units from the 5% threshold requirement in Section 3.5.2 may be counted toward the total percentage for scoring in this section, if the threshold units are income and rent restricted at or below 50% AMI (the threshold, at a minimum, only requires targeted at or below 60% AMI). Points will be awarded as follows:

Points	Set aside for targeted population
6	15% to ≤25%*
5	13% to <15%
4	12% to <13%
3	10% to <12%
2	8% to <10%

1	6% to <8%

*Projects with more than 25% of the units for a targeted population will receive zero points in this category except that projects targeting homeless and projects targeting at risk veterans and their families under the Department of Veterans Affairs Enhanced Use Lease (EUL) Program may exceed the 25% target population limit and still qualify for 6 points.

Applicants seeking points under this section for PWD must agree to provide notice of unit availability to and accept tenant referrals from DHMH and MDOD. Applicants seeking points under this section for a target population other than PWD must specifically market set-aside units to the targeted population(s) as evidenced by a memorandum of understanding or other formal written agreement between the owner, the property manager, and one or more local public or nonprofit service providers that regularly work with the targeted populations being served by the project.

Units that receive points under this category must be reserved exclusively for the target population. If a project is unable to fill a unit with the targeted population after a sixty (60) calendar day referral period, the unit may be leased to another household with income at 50% AMI or below. The next available 50% AMI unit in the Project shall be marketed to the Project's original targeted population until the project is in compliance with percentage for which it received points. The sixty (60) calendar day period at lease-up will be measured from the date upon which the project achieves 80% occupancy and at turnover will be measured from the date upon which the unit is determined ready for occupancy following move-out by the prior tenants and completion of any unit turn cleaning, repairs, or maintenance.

4.4.2.1 Project-based Rental Assistance for Targeted Populations (4 possible points)

An additional four (4) points shall be awarded to projects with project-based subsidies for **all of** the identified targeted population units so that the units serve extremely low income households (at or below 30% AMI). Documentation must be provided to show that the project-based subsidy will be in place for a minimum of five (5) years. Project-based rental assistance may be provided by (a) a local public housing authority or (b) equity provided by the Developer for a term of fifteen (15) years per Section 4.5.2. Projects that receive four (4) points in this category may not also receive points under Section 4.4.2.2.

4.4.2.2 Section 811 Project Rental Assistance (4 possible points)

In 2013 and 2015, DHCD was awarded approximately $20 million in grant funds from HUD under the Section 811 Project Rental Assistance (PRA) Program. These HUD funds enable DHCD

to provide project-based Section 811 rental assistance for approximately 300 units that will be occupied by extremely low income non-elderly PWD referred by DHMH and MDOD.

To support implementation of the PRA Program, projects with non-elderly PWD units that meet the Section 811 requirements (as explained below) will receive four (4) points if they agree to accept, if offered by DHCD, Section 811 project-based subsidies on their non-elderly PWDs units and to comply with the requirements of the PRA Program. The PRA Program represents a federal funding stream and may trigger various federal regulations, including, but not limited to, Davis-Bacon. Section 811 PRA may not be used in any project that has more than 25% of its targeted units set aside for PWD. Information on Maryland's PRA Program is posted to DHCD's website at:

http://dhcd.maryland.gov/HousingDevelopment/Pages/section811/Section811.aspx

Additional information about the Section 811 program can be found at:

http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/mfh/grants/section811ptl

To receive these points, a project must be eligible to receive Section 811 funding and must not already have project-based rental assistance in place for the targeted units. Only family projects with one or two bedroom units for the targeted population are eligible to receive points under this section. As of March 2015, PRA Program units are available statewide.

4.4.3 Family Housing (8 maximum points)

DHCD encourages the development of housing appropriate to the needs of families with children. To qualify for additional points, a project cannot age-restrict its units and will receive points based on the provision of units suitable to larger households.

- Three (3) points will be awarded to projects where at least 60% of the units are 2-bedrooms or larger; and
- Five (5) additional points will be awarded to projects where at least 15% of the units are 3-bedrooms or larger.

Alternatively, for projects where 100% of the units have a preference for veterans or homeless, four (4) points will be awarded if at least 20% of the units are 2-bedrooms or larger.

4.4.4 Tenant Services (8 maximum points)

While all projects must, at a minimum, provide tenants with passive links to community services as outlined in the Threshold Criteria, DHCD recognizes the value that more direct service provisions bring to tenants' lives and will award additional points as follows.

Up to eight (8) points will be awarded to projects that augment the minimum Threshold Criteria by identifying one or more tenant service providers for services on-site or in the community. The provision of such services must be evidenced by a certification from the applicant detailing the services to be provided. A contract, memorandum of understanding, or other formal written agreement between the Developer, the property management company, and the service provider(s) may also be provided to evidence the tenant services. Failure to provide the tenant services as described in the certification will result in negative points on future applications as described in Section 4.1.2. Points will be awarded based on the described services, the applicability of the services to the tenant population, and the existence of a specific mechanism for resident feedback about tenant services at the project.

4.4.5 Mixed Income Housing (4 maximum points)

DHCD supports the development of mixed income housing for families, the elderly, and persons with disabilities. DHCD will award four (4) points to projects that include both affordable and Market Rate Units where the Market Rate Units represent at least 10% of the overall project units. The term Market Rate Unit refers to units without income or rent restrictions. To receive points under this section, the application must demonstrate that the owner and property manager have experience owning and managing mixed income communities. The lender and tax credit letters of intent included with the application must reference the mixed income nature of the project as described in the Market Study.

4.4.6 Preservation of Existing Affordable Housing (4 maximum points)

Up to four (4) points will be awarded to a project that involves the acquisition and rehabilitation of an existing multifamily rental housing development, whether or not it has existing rent or income restrictions, provided the project agrees to affordability restrictions for at least forty (40) years as follows:

- Family preservation projects located in a Community of Opportunity – 4 points
- All other preservation projects- 3 points

For purposes of receiving these points, rehabilitation means repair of or alterations to an existing building, or buildings, where a majority of the structural elements of the original building or buildings, at a minimum, are incorporated into the finished project. In its discretion, DHCD may permit a project to receive these points if the project involves the demolition and replacement of an existing occupied housing project if rehabilitation of the existing building or buildings is infeasible or impractical. The replacement project must comply with DHCD's policies concerning displacement and relocation of existing tenants.

4.5 Leverage and Cost Effectiveness

LIHTC and DHCD's programs are not adequate to address all of Maryland's rental housing needs. Projects that maximize support from other non-state resources, including local contributions, will receive additional consideration. Additionally, increasing development costs limit the number of projects and units produced, resulting in fewer Maryland residents who can be served by these important resources. To encourage development that balances meeting pressing housing needs, ensuring high quality construction that is attractive, efficient, and sustainable, and investing resources in responsible manner, DHCD will adjust scoring to favor cost effective transactions.

4.5.1 Direct Leveraging (10 maximum points)

DHCD will award points based on the percentage of total development costs funded by non-state resources in accordance with the chart below. For purposes of this section, State resources include:

- All equity generated from competitive LIHTC awards from the State's LIHTC ceiling except any LIHTC awarded as the result of a federally or state designated basis boost;
- DHCD-administered rental housing resources, including, but not limited to, RHFP, RHW, HOME, CDBG, the Community Legacy Program, Demolition Funds, and the Partnership Rental Housing Program.

Leveraged funding may include:

- Equity from a federal or state basis boost;
- Equity from non-competitive 4% LIHTC awards;
- The proceeds of MBP financing;
- Local contributions (as described below);
- Locally-controlled federal resources such as HOME, CDBG, or State Small Cities CDBG;
- Other non-DHCD State funding;
- Private financing; and
- Private or philanthropic funding.

Projected equity from federal Historic Tax Credits (HTC) is also considered leveraged funding. To qualify the applicant must (i) provide evidence that the Part 1-Historic Preservation Certification Application has been submitted to the Maryland Historical Trust (MHT); (ii) document that MHT has recommended approval of the Part 1 Application or documents that the project building(s) is already listed in the National Register; and (iii) certify that the

applicant will complete the HTC application process and diligently pursue HTC equity investment.

Local Contributions

A. To receive points under this section for a local contribution, the following conditions must be met:

(1) Evidence of an anticipated political subdivision contribution shall be in the form of a letter from an authorized political subdivision official and shall indicate the type and amount of the contribution that the political subdivision anticipates making.

(2) A local contribution shall be a contribution which is not contingent upon completion of tasks or improvements that are not related to the project and which:

(a) Reduces development costs, such as:

i. The donation or long-term leasing of land or improvements;
ii. Capital funds for acquisition, construction, rehabilitation, or development costs;
iii. Locally installed infrastructure or site improvements which reduce off-site costs attributable to the project; or
iv. Waiver of local fees for permits, tap fees, impact fees, and other fees and charges;

(b) Reduces operating expenses, such as:

i. Real estate tax abatement or a payment in lieu of taxes (PILOT);
ii. Operating or rent subsidies for the project; or
iii. Long-term agreements for a political subdivision to provide services at no cost to a project such as trash collection, road or grounds maintenance, or grounds care; or

(c) Otherwise supports a project such as:

i. Allocation of rent subsidies;
ii. Guarantees of deficits or completion of construction; or
iii. Long-term provision of needed social services for special use projects.

(3) Local contributions may:

(a) include terms which require repayment of the contribution if the project is sold or no longer provides low income housing; and

(b) be in the form of loans with interest rates acceptable to DHCD.

All calculations for this section will be based on DHCD underwriting of a project which may include adjustments to LIHTC equity based on DHCD assumptions about credit pricing as announced prior to a round. Additionally, for projects with market rate (i.e. non-income restricted) units and mixed-use projects, DHCD will consider only leveraged funds applicable to the affordable units by prorating both sources and uses to remove non-residential and market rate components of the project. Residential costs will be prorated based on the project's Applicable Fraction (as defined in the Internal Revenue Code) unless DHCD determines that market rate and affordable units are not comparable in which case DHCD, in its sole discretion, may require greater itemization of costs to allocate sources and uses to the affordable portion of the project.

Finally, because projects in rural areas have higher fixed transaction costs due to their relatively smaller size and have less access to locally controlled sources of leverage, DHCD will award leveraging points to rural projects as defined in Section 4.2.3 on a higher scale than for non-rural projects. Additionally, because family projects located in Communities of Opportunity are an important priority of DHCD, leveraging points will be awarded on a higher scale as well.

For purposes of this section, a rural area includes any area eligible under the U.S. Department of Agriculture's Rural Development programs or any area in Allegany, Caroline, Dorchester, Garrett, Kent, Somerset, Washington, Wicomico, or Worcester Counties that are not otherwise CDBG entitlement communities or HOME Participating Jurisdictions.

Points will be awarded as follows:

Points	Leveraged Funding: Family Projects Located in a Community of Opportunity	Leveraged Funding: Rural	Leveraged Funding: All Other Projects
10	40%+	45%+	50%+
9	35% to <40%	40% to <45%	45% to < 50%
8	30% to <35%	35% to <40%	40% to <45%
7	25% to <30%	30% to <35%	36% to <40%
6	20% to <25%	25% to <30%	33% to < 36%
5	15% to <20%	20% to <25%	30% to <33%
4	10% to <15%	15% to <20%	27% to <30%
3	5% to <10%	10% to <15%	24% to <27%

2	3% to <5%	5% to <10%	22% to <24%
1	2% to <3%	3% to <5%	20% to <22%
0	<2%	<3%	< 20%

4.5.2 Operating Subsidies (10 maximum points)

DHCD recognizes that projects may include other local investments not directly included in a project's sources and uses statement but which, nonetheless, represent significant reductions in the State resources needed to achieve feasibility. In particular, locally controlled project-based rental subsidies allow projects to serve lower income households and protect tenants against being rent burdened while sustaining a project's rental revenues. Additionally, local PILOT arrangements that reduce operating costs and other forms of operating assistance may be available.

To receive points for project-based rental assistance, the assistance must be structured to ensure that tenants in project-based units pay no more than 30% of their income towards rent and utilities. The value of project-based assistance will be calculated per the application based on estimates of the typical monthly tenant subsidy and the duration of the contract.

PILOTs and other local operating subsidies will be evaluated on the basis of the per unit impact of the subsidy and awarded points based on the table below. To receive points for a PILOT, the local taxing jurisdiction must provide a letter outlining the first year savings the PILOT represents compared to the projected standard tax assessment and stating the duration of the PILOT. DHCD will multiply that figure by the number of years the PILOT will remain in effect (PILOTs with a term in excess of fifteen (15) years will only be counted for the fifteen (15) year LIHTC compliance period) and divide by the number of affordable units in the project.

To receive points for other operating subsidies, the subsidy must directly fund project operations or be specifically designated to fund services for tenants of the project and have a term of no less than ten (10) years. The application must include documentation of the subsidy, including a written commitment and evidence satisfactory to DHCD that the source of funding is secure. This could include endowments or reserves capitalized from non-project sources, federal obligations subject to appropriations, contracts, or documented awards from other financially secure entities (e.g. a long term commitment from a foundation). Finally, the subsidy cannot be accompanied by repayment terms that diminish its value to the project or result in an effective loan. Agreements with recapture or repayment requirements resulting from noncompliance or nonperformance are acceptable. The provider of the operating subsidy must provide a letter or other documentation outlining its duration and its value to the project on an annual basis from year-one of operations. DHCD will multiply that figure by the duration of the

subsidy (not to exceed fifteen (15) years) and divide by the number of affordable units in the project.

The total value, calculated as described herein, of project- based rental assistance, PILOTS or similar tax abatements, and operating subsidies will be totaled by DHCD and divided by ten (10) to determine the average subsidy per affordable unit per year over a ten (10) year period. Points will be awarded points based on the value per affordable unit per year of the subsidy as follows:

LONG-TERM (10 YEAR) ANNUAL OPERATING SUBSIDIES PER UNIT		
Points	**Entitlement Jurisdiction**	**Non-Entitlement Jurisdiction**
10	Subsidy ≥ $400	Subsidy ≥ $200
9	= $350 to $399	= $175 to $199
8	= $300 to $349	= $150 to $174
7	= $250 to $299	= $125 to $149
5	= $200 to $249	= $100 to $124
3	= $150 to $199	= $75 to $99
1	= $100 to $149	= $50 to $74
0	< $100	< $50

4.5.3 Construction or Rehabilitation Cost Incentives (Negative 8 points maximum)

To encourage cost effective construction, DHCD has established limits on the dollar amount of construction costs per square foot. While some unique aspects of a given project may reasonably require greater investment (e.g. redevelopment of an historic building on a brownfield site), DHCD also wants to encourage selection of projects that achieve various public goals—including taking on challenging sites, building high quality projects, and serving populations with unique needs—while still doing so for competitive costs. To this end, DHCD will deduct points for projects that exceed the cost limits further described below.

DHCD will consider requests from sponsors of projects involving adaptive re-use of previously nonresidential buildings; substantial historic rehabilitation; or redevelopment/reconstruction of housing determined to be beyond repair to be evaluated against new construction cost limits rather than the rehabilitation limits below.

For the purposes of determining the per square foot cost, DHCD includes all on-site and off-site development and the total construction contract less any construction contingencies. This total is then divided by the gross square footage of all buildings being built or renovated. Buildings

with parking structures or internal parking will be evaluated on a case-by-case basis. Applications should include area and square foot cost for parking related construction separate from occupiable building on DHCD Form 212.

DHCD will review the cost limits before each competitive round and revise them as appropriate based on market conditions and information provided by published cost indices, such as McGraw Hill's Engineering News Record. Changes will be announced at the pre-round information session and posted to DHCD's website at least thirty (30) calendar days before the application deadline.

Unless a waiver has been requested and granted in accordance with Chapter 5 of this Guide, up to eight (8) points will be deducted from any large project, and up to six (6) points deducted from small projects, with construction costs per square foot in excess of the following limits:

Type of Building	New Construction	Rehabilitation
Cottage, Single Family, Semi-detached Dwellings, and Townhomes	$ 153	$ 158
Garden Apartments	$ 129	$ 98
Non-elevator Stacked Units and Elevator Buildings with 4 stories or less	$ 139	$ 114
Elevator Buildings of 5 or more stories	$ 153	$ 119

4.6 Development Quality Standards

Up to thirty-one (31) points may be awarded based on features related to a project's physical quality and its impact on the environment, including the surrounding neighborhood and the residents. These points are further broken down as follows:

4.6.1 Green Features (12 maximum points)

DHCD will award points based on the inclusion of various "green" features of a project with more points available to projects participating in recognized certification programs. A project can only receive points under one of the following criteria:

- Twelve (12) points will be awarded to projects that intend to complete and receive certification using green building criteria from one of the organizations in the table below. The certifying entity's published scoring checklist or scorecard must be submitted and completed by the project architect or a qualified third party demonstrating a sufficient level of scoring to achieve green certification as defined within the guidelines at the time of application. The certificate must be provided at the completion of the project.

Rating Entity	*Rating System*	*Website*
Enterprise Green Communities	2015 Enterprise Green Communities Criteria, as updated	www.enterprisecommunity.org/green
U.S. Green Building Council (USGBC	LEED V4 (Leadership in Energy and Environmental Design) for building type, as updated	www.usgbc.org
National Association of Home Builders (NAHB)	ICC-700 National Green Building Standard	www.nahb.org
Southface	Earthcraft Multifamily V5, as updated	www.southface.org
International Living Future Institute	Net Zero	www.living-future/netzero
Green Building Initiative (GBI)	Green Globes	www.greenglobes.com
Passive House Institute US	PHUIS+ US	www.phius.org

- Ten (10) points will be awarded to projects that do not complete the actual certification process as noted above but instead continue to meet the minimum score as indicated in the application for the certification. The program's published scoring checklist or scorecard must be submitted and signed by the project architect or a qualified third party and they must provide a statement explaining how the items listed on the checklist will be verified during construction; alternatively
- One (1) point will be awarded, up to a maximum of eight (8) points, for each bulleted feature below that contributes to a sustainable healthy environment over the extended period of the project life:
    - On new construction, through the use of innovative planning, a detailed written statement from a civil engineer shows a 20% or greater reduction in impervious surface area over conventional design through the use of permeable paving, efficient narrower compact road design, reduction in local parking requirements to a level where the project needs will still be met, permeable spill over parking areas, angled parking, shared parking and driveways, narrower sidewalks, and greater permeable open space adjacent to impervious cover. Note that implementation of certain listed examples may face local jurisdiction obstacles and must be compliant with accessibility codes and standards. While MDE supports progressive designs

which are highly suitable for specific projects, approval from local jurisdictions may require waivers or special processes.

- Site Work Management – Utilize the 2007 or current version of the Maryland Stormwater Design Manuals to select Best Management Practices (BMP) for collection and treatment of stormwater captured on site through maximizing permeable surfaces. Identify and utilize low impact treatment methods such as open channel design in conjunction with open section paving, rain gardens (bio-retention devices), urban BMP devices, disconnection of roof or non-roof runoff, or collection and reuse of water for irrigation or other approved domestic use. Criteria points awarded for projects utilizing methods identified or recognized by the Maryland Water Management Administration as Stormwater Credits for Innovative Planning:
    - Natural area conservation
    - Disconnection of rooftop runoff
    - Disconnection of non-rooftop runoff
    - Sheet flow to buffers
    - Open channel use
    - Environmentally Sensitive Development
- Recycled Materials – The project uses at least two (2) of the following: recycled paving products, recycled concrete aggregate or binders; recycled framing lumber, trim or deck materials with recycled content; mulch obtained from chipping of trees removed during on site clearing operations; donations of material from demolition such as kitchen cabinets or appliances to nonprofit organizations or other significant use of recycled materials.
- Renewable and Biodegradable Materials – The project makes significant use of renewable and biodegradable materials such as lumber, plywood flooring/walls and coatings, derived from sustainable forestry and agricultural methods.
- Local Material Procurement – The project makes use of locally available construction materials thereby reducing associated transportation costs. Submit a plan consistent with the local construction material procurement sections of any of the recognized sustainable development programs described in the Green Certification category above.
- Reflective Roofing – Install light colored/high albedo roofing Energy Star rated. On flat roof surfaces application to be at least 75% reflective roofing. On pitched roofs, reflective shingle roofing will be considered if a suitable product showing dirt and stain resistance is selected.
- Reflective Paving – Install light colored/high albedo materials with a minimum solar reflective index of 0.6 (60%) or open grid paving on at least 75% of site paved areas.

- Healthy Flooring – Install non-vinyl, non-carpet hard surface floor coverings in all rooms. Architect to review the need for adding sound attenuation elements where hard surface flooring is selected.
- Innovative Lumber Conserving Practices – Use engineered lumber or manufactured framing methods that conserve materials and do not rely on the use of full dimensional lumber and also reduce site originated waste. Identify systems to be used. Provide documentation that at least 25% (by cost) of the project wood products and materials are certified in accordance with the Forest Stewardship Council (FSC), American Tree Farm System (ATFS), Canadian Standards Association (CSA) and Sustainable Forestry Initiative (SFI). Innovative practices such as Optimal Value Engineering (OVE), other system conserving materials, or increasing energy performance over conventional framing practices also qualifies for receiving points.
- Recycled Water - The project utilizes site run-off water, roof run-off, or recycled gray water for irrigation or other code permissible uses. Water is effectively and practically stored and distributed to reduce the need for treated domestic water. This should represent at a minimum of 20% collection of roof area.
- Solar Energy - The project will utilize solar energy for any of the following: water heating; heat and cooling systems; lighting; or electric generation.
- Geothermal Heat Pumps - The project will utilize geothermal heat pumps for common area or apartment HVAC.
- Provide exterior lighting that meets the International Dark-Sky Association (IDA) guidelines for lighting. Provide lighting that discourages light pollution or lighting that is excessive or inappropriate for outdoor lighting. Provide lighting that is directed toward the ground, is fully shielded and incorporates energy saving features such as timers, dimmers, and motion sensors in all outdoor lighting.

4.6.2 Energy and Water Conservation and Sustainability (6 maximum points)

DHCD will award additional points to projects to encourage design features that provide comfort and energy efficiency over the extended period of the project life and that assist DHCD in measuring energy conservation and sustainability outcomes**.**

- Four (4) points will be awarded to rehabilitation projects if the project sponsor commits to incorporate into the scope of work all energy conservation measures (ECM) that result in an overall energy savings of 30% or greater over pre-retrofit levels as verified by a RESNET/BPI rater, or all of the ECMs having an SIR greater than 1.0 as determined by a comprehensive energy audit.
- Two (2) points will be awarded to a rehabilitation project that does not receive the four (4) points above if the project sponsor commits to incorporate into the scope of work all ECMs that result in an overall energy savings of 20% or greater over pre-retrofit levels,

or all of the ECMs having an SIR greater than 1.5 as determined by a comprehensive energy audit

- Two (2) points will be awarded for any project utilizing alternative energy (solar, geothermal, etc.) for any of the following: water heating; heat and cooling; lighting; or electric generation for common areas or tenant units.
- Two (2) points will be awarded for any project if "Water Sense" labeled products are installed or retrofitted in all units and common facilities.

4.6.3 Project Durability and Enhancements (13 maximum points)

DHCD will award points for features that add to the long-term durability and enhancement of the project for both its residents and the surrounding community. One (1) point will be awarded, up to a maximum of thirteen (13) points, for each of the following:

- The building, parking areas, and other improvements are laid out for convenient access by the residents, including those with disabilities, to site and community amenities, including public transportation.
- Building entrances are designed and located to provide security and weather protection for the targeted resident group and the project includes green space areas, play areas, courtyards, or exterior seating areas that provide recreational and social opportunities for the targeted resident community.
- The building architecture, structure, and mass complement the existing neighborhood and the project includes exterior architectural features and design elements that add interest and/or functionality, create unity with nearby architectural style, and generally improve the appearance of the building(s).
- Architectural accessories such as decorative door surrounds, larger window trim, corner eave, cornice and column details, or other special features are provided and are of composite or other durable materials.
- Paving is provided throughout the project site (parking areas and drive aisles) that equals local requirements for standard duty residential roadway or provide specifications which indicate a stone base of eight (8) inches or greater with the combination thickness of the asphalt base and top coat being at least five (5) inches and concrete paving at handicapped parking spaces, dumpster pad with apron, and for entire accessible route.
- Individual units, common areas, and community spaces are well designed for comfortable living and tenant activities. The layouts are efficient, with practical traffic flow, and provide adequate space for furniture placement. (550 - 600 net sf. area for predominantly one (1)-bedroom units and 20% more area for each additional bedroom unit, preferably with the primary bedroom not less than 10'x11' in clear size, and in multiple bedroom units the smallest bedroom shall be not less than 9'-0" in one

direction with a minimum of ninety (90) net square feet in area. Note the dimensions are for clear area and do not include the closet space).

- Building exterior is at least 75% masonry or other highly durable materials such as cement fiber siding, stucco, stone, etc..
- Storage space is reasonable with a minimum of a four (4) foot clothes closet per person in each bedroom, and at least three (3) of the following: an entry coat closet, linen closet, utility closet, or additional storage for storing seasonal or bulky items. Closets intended for appliances (i.e. washer/dryer, HVAC) cannot be included as storage space.
- A half bath is provided on the living/dining/kitchen level in layouts with more than one (1) story and the bath is visitable. For single-story units, at least one (1) bath is visitable.
- The interior doors are panel and hardware is of grade two (2) or better quality hardware with lever handles.
- Ceiling fans are provided in all bedrooms and at least one (1) living area.
- Project has a non-smoking policy applicable to all interior space, including units and common areas.
- The project meets visitability standards for at least 25% of its units and incorporates universal design features in its units and common areas.
- The project is not located in an area with nearby non-residential activities.
- Floor coverings are quality long lasting products. Any carpet products must meet the Carpet and Rug Institute's Green Label or Green Label Plus certification for carpet, pad, and carpet adhesives. Hard finish flooring must be products with a verifiable ten (10) year or longer warranty
- For family projects, the cabinetry is plywood box construction, plywood or solid wood doors, and durable finishes and hardware.
- Bathroom floors are sheet goods with a ten (10) year minimum warranty or ceramic tile with sealed grout.
- Tub/shower surrounds are ceramic tile with cementitious backer board or backer board supported by the Tile Council of North America (TCNA) installation or is better than builder grade quality fiberglass surrounds.

4.7 State Bonus Points

The QAP and Guide outline and implement important State priorities, making difficult choices about how to deploy affordable housing resources and seeking to achieve a reasonable balance among disparate opportunities to serve the housing needs of Maryland's residents. DHCD both recognizes and anticipates that facts on the ground, however, can change more quickly than DHCD can respond through revisions to this QAP and Guide and there can be unintended consequences of any scoring system that could lead to undesirable outcomes. To provide dexterity and an opportunity to course-correct based on changes in the State's needs, DHCD

may award State Bonus Points to ensure that the award of competitive resources is balanced and in the State's best interest. Bonus points may be awarded to projects to ensure that the overall award of competitive LIHTC and RHFP:

- Represents a balance between the priorities outlined in this Guide, ensuring that unanticipated aspects of scoring do not systemically and practically prevent a given project type from receiving appropriate LIHTC and RHFP resources;
- Represents an equitable regional or geographic distribution of resources, ensuring that unintended consequences of scoring do not systemically and practically prevent a given region from receiving appropriate LIHTC and RHFP resources;
- Takes advantage of time sensitive opportunities to leverage substantial resources from the federal government or from other non-DHCD funding sources that may become available;
- Responds to urgent and recent changes in housing needs resulting from natural disasters, economic crises, market dislocations, acts of war or terrorism, environmental contamination, or other events;
- Responds to substantial economic development opportunities that have the opportunity to create new jobs in the State, such as investing in workforce housing that supports a major new employer creating new Maryland jobs;
- Responds to dislocations in the equity or debt markets related to LIHTC and the permanent financing sources used to provide mortgage debt to such projects;
- Promotes the development of projects that promote intergenerational housing opportunities or housing for the homeless;
- Responds to other critical policy directives, goals, or priorities identified and articulated by DHCD; or
- Affirmatively furthers fair housing or contributes to a concerted fair housing strategy.

DHCD may award State Bonus Points as follows:

- Only applications submitted in the round that were scored are eligible to receive State Bonus Points. Additionally, to receive State Bonus Points, a proposal must have scored at least one hundred and twenty (120) points prior to the award of State Bonus Points.
- No more than ten (10) State Bonus Points may be awarded to any project.
- No more than 20% of the State's competitive LIHTCs and RHFP funds may be awarded to projects receiving State Bonus Points.
- DHCD shall provide a written explanation of the factors leading to the award of State Bonus Points and this explanation will be published along with results of the funding round.

State Bonus Points are optional; they need not be fully awarded in any given funding round. DHCD may choose not to award any State Bonus Points within a round, choose to award fewer than the maximum State Bonus Points available, or choose to award all available State Bonus Points.

5 Waivers

5.1 Waivers – General

In general and unless specified elsewhere in this section, the Director of Multifamily Housing may grant waivers of the criteria and procedures in this Guide based on the factors for considering waivers. In addition, the Code of Maryland Regulations (COMAR) allows the Secretary of DHCD to waive or vary particular program regulations to the extent that the waiver is consistent with the governing statute if, in the determination of the Secretary of DHCD, the application of a regulation would be inequitable or contrary to the purposes of the governing statute. The standards for each program vary slightly, so applicants should consult COMAR 05.05.01 for the Rental Housing Program; 05.12.01 for the HOME Program; and 05.05.02 for MBP and RHW.

DHCD requires applicants seeking a waiver of the Threshold or Competitive Scoring Criteria in this Guide to submit such requests in writing to the Director, Multifamily Housing Development Programs, at least thirty (30) calendar days in advance of the round deadline. DHCD will provide a decision within fifteen (15) calendar days of receipt of the waiver request. This provision for waivers applies only to State-funded programs and State-imposed Threshold and Competitive Scoring Criteria. Federal regulations affecting LIHTC, HOME, and MBP may not be waived by the State, and applicants should consult their attorney or tax advisor on the possibility of waivers of federal requirements.

5.2 Waivers of Threshold or Competitive Criteria

5.2.1 Previous Project Performance (see Section 3.1.1)

For defaults involving loans, waivers of the restriction on participation in funding rounds may be granted for Primary Development Team members that were not involved in the defaulted loan for at least one (1) year prior to the default. In the case of other defaulted loans, waivers may be granted based on the circumstances surrounding the particular default. A waiver under this section must be approved by the Secretary of DHCD. Among the factors considered in granting a waiver are:

- Reasons for the default;
- The applicant's role in the defaulted property and responsibility for guaranties or operations of the defaulted property; and
- Performance of other properties in the applicant's portfolio.

5.2.2 Previous Participation (see Section 3.1.1)

DHCD may grant waivers for Primary Development Team members unable to meet DHCD processing requirements based on the circumstances surrounding the particular delays or failures, including the reasons for the delays, the applicant's role in the processing delays, and the performance of the applicant in meeting processing timeframes for other projects. A waiver under this section must be approved by the Secretary of DHCD.

5.2.3 Construction or Rehabilitation Costs (see Section 4.5.3 and Section 3.14)

DHCD may grant waivers of the per square foot maximum new construction or rehabilitation costs based on staff evaluation of the project's conformance with other application criteria, extenuating circumstance of the adaptive reuse of existing structures, the need to meet the Secretary of the Interior's Standards for Historic Rehabilitation (if applicable), the amount of equity and other financial resources leveraged, unusual site conditions, public infrastructure requirements, and the experience of the design professionals and the general contractor for the proposed project.

Requests for waivers of the $15,000 per unit cost minimum for rehabilitation projects may be submitted to DHCD for projects that can demonstrate:

- A strong need for preservation of affordable housing in the market area;
- Affordable housing units will be lost if the project is not financed using DHCD resources; and
- Adequate reserves based on a capital needs assessment performed by an engineer or other qualified professional will be available to the project.

5.2.4 Acquisition of Schools or School Sites (see Section 3.9.8.1)

Waivers of this policy may be granted only if the following conditions exist:

- All other potential sources of funds have been sought and are clearly unavailable, and it is not feasible to undertake the project without benefit of DHCD funds for acquisition; and
- The project has particularly high public purpose such as serving an unusually high percentage of disabled or special needs persons, serving an unusually high percentage of very low income persons, or location in a market area not otherwise served by DHCD programs.

5.2.5 Builder's Fees (see Section 3.9.8.3)

Waivers may be requested for small projects and/or projects with specialized services or consultants with proposed builder's fees in excess of the defined cap. Applicants must include a detailed explanation of the reasons for the increased builder's fee with the request for a waiver. DHCD will evaluate waiver requests for reasonableness on a case-by-case basis to

determine compliance with the threshold requirements. Increasing the fee to increase the LIHTC eligible basis is not a valid justification for a waiver.

5.2.6 Architects Fees (see Section 3.9.8.3)

Waivers may be requested for small projects and/or projects with specialized services or consultants with proposed architect fees in excess of the defined cap. Applicants must include a detailed explanation of the reasons for the increased architect's fee with the request for a waiver. DHCD will evaluate waiver requests for reasonableness on a case-by-case basis to determine compliance with the threshold requirements. Increasing the fee to increase the LIHTC eligible basis is not a valid justification for a waiver.

5.2.7 Civil Engineer Fees (see Section 3.9.8.3)

Waivers may be requested for small projects and/or projects with specialized services or consultants with proposed civil engineer fee in excess of the defined cap. Applicants must include a detailed explanation of the reasons for the increased civil engineer's fee with the request for a waiver. DHCD will evaluate waiver requests for reasonableness on a case-by-case basis to determine compliance with the threshold requirements. Increasing the fee to increase the LIHTC eligible basis is not a valid justification for a waiver.

5.2.8 Developer's Fees (see Section 3.9.8.3)

Applicants with proposed Developer's Fees in excess of the $2.5 million limit must include a detailed explanation of the reasons for the increased Developer's Fee with the request for a waiver. DHCD will evaluate waiver requests for reasonableness on a case-by-case basis to determine compliance with the threshold requirements, which may include factors such as large, complex projects involving relocation or substantial rehabilitation.

5.2.9 Project Phasing (see Section 3.9.9)

A request for a waiver of this restriction may be submitted provided that such requests include a Market Study meeting the criteria of this Guide and demonstrating that the subsequent phase(s) will not adversely affect the leasing and operations of the initial phase.

5.2.10 Underwriting Standards (see Section 3.9)

Applicants seeking waivers of other underwriting standards in Section 3.9 must provide a detailed written request including, if necessary, independent studies or analyses by qualified professionals (market analyses, capital needs assessments, etc.) that support their request. DHCD will evaluate waiver requests for reasonableness on a case-by-case basis to determine compliance with the evaluation requirements.

5.2.11 Deductions for Team Experience (see Section 4.1.2)

Applicants seeking waivers of the provisions for negative points in Section 4.1.2 must provide a detailed written request consistent with the standards outlined in Section 5.2.1 above.

5.2.12 Definition of Elderly Housing (see Section 3.2.2)

Applicants seeking waivers of this definition must include: (a) a discussion demonstrating the public purpose of the waiver request and why the project is most feasible with the targeted elderly population; and (b) a Market Study meeting the criteria of this Guide.

6 Loan Processing Procedures

6.1 Processing LIHTC, RHFP, and RHW Reservations of Funding

If projects include RHFP or RHW loan financing, the following processes and requirements apply (see Appendix A flowchart). If projects also include LIHTC, additional procedures, described in the QAP, apply as well.

6.1.1 Loan Reservations

Following approval of recommended reservations, sponsors will receive RHFP funding reservation letters. These reservation letters include preliminary terms and conditions for the commitment of loan funds. They also specify requirements that must be met for projects to be approved for a commitment letter to be issued, including processing documentation and timeframes. The reservation is not a commitment to make a loan and DHCD is not obligated to make a loan until all conditions in the commitment letter are satisfied. DHCD reserves the right in making a reservation to substitute sources of funds, if, in DHCD's sole determination, this substitution provides for a more efficient use of DHCD resources.

A reservation may be canceled and an application withdrawn from processing if any of the following occur:

- The loan processing and submission kit requirements as described in this section are not met. This includes a failure to meet the timeframes established in each kit.
- The project changes substantially from the initial submission. A substantial change includes: (1) a change resulting in a score reduction of the lesser of 3% or an amount sufficient to lower the score below the cut-off score for the round in which the project was approved; (2) a significant change in the project's design, financing, or amenities; (3) a material reduction in the project's income targeting or unit count; (4) a change of the project's sponsor or other member of the Development Team without the prior written approval of the Director, of Multifamily Housing; or (5) a change of the project's site.
- The project is changed so that it no longer meets all Threshold Criteria.
- The project's Developer, sponsor, owner, or its general partner(s) or managing member(s) files for bankruptcy or is the subject of an involuntary bankruptcy.
- The project is, for any reason, no longer feasible.
- The project's Developer, sponsor, or owner submits false, misleading, or incomplete information to DHCD.

6.1.2 Post Reservation Scheduling

DHCD must approve any significant deviations from the project schedule set forth in the application. In these cases, sponsors must submit updated schedules, including an explanation for the change, to DHCD for review. Sponsors must promptly notify DHCD if for any reason projects that receive reservations become infeasible.

DHCD monitors the progress of projects to ensure timely completion. LIHTC, RHFP and RHW Reservations and LIHTC Carryover Allocations will be canceled if a project falls too far behind its schedule, in DHCD's determination, or if it is determined that DHCD resources are in jeopardy of being lost to the State due to nonperformance by the sponsor. Failure to meet DHCD processing schedules may also affect future scoring (see also Section 4.1 – Capacity of Development Team).

For projects requesting RHFP and RHW, the applicant's processing schedule must be consistent with DHCD's loan submission kit process. For projects requesting allocations of current year LIHTC, sponsors must demonstrate that projects will meet the requirements for allocation of current year LIHTC. Please refer to the QAP for more information on processing LIHTC reservations and allocations.

6.1.3 Kick-off Meeting

Following its issuance of reservation letters, DHCD schedules "kick-off" meetings with sponsors. The multifamily lending team assigned to each project, which includes underwriting, construction, LIHTC, and finance staff, will be present at the meetings. Sponsors should require representatives of their contractor, architect, and management agent to attend. If any project financing requires mortgage insurance, a representative of the insurer also should be present at this meeting. Other DHCD staff members that may need to attend the kick-off meeting include the Director or Deputy Director of Multifamily Housing, DHCD's Equal Opportunity Officer, DHCD's attorney, and compliance and asset management staff.

The purpose of these meetings is to review reservation letters to gain a common understanding of their requirements, terms, and provisions for further processing of applications. At the kick-off meetings, assigned team members review the requirements and timeframes of the loan processing schedule and submission kit processing in detail. At this time, the assigned team members may elect to schedule subsequent meetings with sponsors to conduct detailed site visits.

6.1.4 Underwriting and Construction Review

After reservation letters are issued, loan applications are underwritten and detailed construction plans and documents are reviewed before the issuance of commitment letters. The review process is generally divided into two phases, viability and commitment reviews. In

its discretion, DHCD may permit the submission of a combined viability and commitment package (fast track). Specific milestone dates for completing these reviews and issuing commitment letters are discussed at kick-off meetings and set in conformance with DHCD's submission kit loan process.

Detailed guidance is provided to sponsors throughout this process to assist the Development Team in the preparation of construction plans and underwriting documentation. The architectural requirements for each stage of this review are those defined in the American Institute of Architect's (AIA) publication The Architect's Handbook of Professional Practice.

Additionally, other underwriting requirements will be detailed and made clear to all parties early in the process. Projects in the advanced stages of pre-development will be able to proceed at much quicker paces. In any event, DHCD and sponsors should make every attempt to complete all review requirements within the timeframes outlined in reservation letters and during kick-off meetings.

6.1.5 Viability Review

During this phase of the review process, sponsors submit updated application forms along with more detailed construction and underwriting documentation, all as specified in the viability submission kit supplied at kick-off meetings. DHCD staff reviews the material and issues viability reports to sponsors. Viability reports include DHCD's underwriting pro-forma and a term sheet showing any changes in anticipated loan terms and conditions based on findings during the viability review.

6.1.6 Commitment Review

At this stage of review, sponsors submit final application forms and complete construction and underwriting documentation. After DHCD staff has reviewed the materials, a commitment report, including a final underwriting pro-forma and updated term sheet, are prepared. The commitment report is sent to sponsors and the term sheet to DHCD's attorney. Based on the findings in the commitment report, a draft commitment letter is prepared and sent to the sponsor. DHCD's goal is to complete any adjustments to the draft commitment letter within fifteen (15) calendar days of issuing the commitment report and to issue the commitment letter not later than seventy (70) calendar days after the sponsor submits the commitment review package. Once all adjustments are made, DHCD's attorney finalizes the commitment letter and begins preparing loan documents.

6.1.7 Initial Closing; First Draw Requisition

Along with the commitment letter, sponsors receive a loan closing checklist. Initial closing will occur once all closing conditions set forth in the commitment letter and closing checklist have been satisfied.

DHCD's standard loan conditions are detailed in the commitment letter. Sponsors should also review and understand DHCD's draw and requisition requirements, particularly those affecting the initial draw. Staff is available to meet and review the draw procedures. Copies of the draw procedures also are available on DHCD's website at:

http://dhcd.maryland.gov/HousingDevelopment/Pages/MFLibrary.aspx

Initial draw requests must be submitted to DHCD at least fifteen (15) business days prior to initial closing. Accepting DHCD's form closing documents without modification expedites the closing process.

6.1.8 Construction or Rehabilitation Period

Construction or rehabilitation of projects normally commences once initial closing is complete. Prior to the start of construction or rehabilitation, sponsors and their general contractor must participate in a pre-construction conference with the Multifamily Housing construction staff and Finance Manager responsible for the project. The purpose of the meeting is to fully review all construction period procedures such as inspections by DHCD staff, draw requisition and disbursement procedures, and change order procedures and requirements. All other project lenders should be present at this meeting to ensure a smooth inspection and draw process.

At a sponsor's request, DHCD may permit work on projects to begin prior to closing of DHCD's financing. An "Early Start" of the construction or rehabilitation may be authorized only after issuance of the commitment letter. Approval for an Early Start is evidenced by a written approval issued by DHCD. Work may begin when the conditions of the Early Start letter are met and the pre-construction conference has been held. DHCD will not fund any costs incurred for work performed under an Early Start unless the loan is eventually closed.

6.1.9 Developer's Fee Disbursement

For transactions involving RHFP, DHCD may allow up to 25% of the projected non-deferred portion of the budgeted Developer's Fee to be disbursed at initial closing or through substantial completion, as evidenced by the issuance of an acceptable certification of substantial completion by the project architect. At substantial completion, DHCD may allow an additional 25% of the projected non-deferred portion of the budgeted Developer's Fee to be disbursed. The remaining non-deferred Developer's Fee is disbursed only after the project is 100% complete, a cost certification is accepted by DHCD, and DHCD's final closing requirements have been completed.

Developer's Fees may be paid only from equity, cash flow, or other non-DHCD sources of funds if DHCD loans are not in default and the Developer continues to perform satisfactorily.

Deferred Developer's Fees are disbursed only after all must-pay debt and cash flow payments are made from net operating income.

6.1.10 Final Closing

After the completion of construction or rehabilitation, sponsors must complete a cost certification prepared by an independent certified public accountant. The cost certifications will be reviewed within ninety (90) calendar days of receipt provided all construction close-out documents and change order requests have been submitted before or at the same time that the cost certification is received. A final determination of mortgage proceeds letter will be prepared and sent to the sponsor for signature.

6.2 Processing Multifamily Bond Program Applications

For projects that request MBP financing, the following requirements apply:

Processing Multifamily Bond Program Applications

Applicants requesting MBP financing and non-competitive LIHTC (not allocated from the State's LIHTC ceiling) should apply using the Application Submission Package available on the DHCD website. All requests for MBP financing are subject to DHCD underwriting and construction reviews. Projects requesting MBP financing, with or without non-competitive LIHTC, may be submit an application at any time.

For taxable/tax exempt MBP Financing, all bonds must be outstanding for at least twenty-four (24) months.

Requirements

Applications for the MBP are subject to an initial review against the Threshold Criteria, as described in Chapter 3 of this Guide, and must score at least 92 points on the Competitive Scoring Criteria as described in Chapter 4 of this Guide. Processing is subject to certain fees that are subject to change. The current fees are described in Appendix C of this Guide. Updates to fees will be provided on DHCD's website.

Projects financed with Multifamily Bonds are eligible for non-competitive LIHTC. DHCD issues letters pursuant to §42(m) of the Internal Revenue Code reserving LIHTC to qualified projects prior to initial loan closing. Applicants may elect to lock in the Tax Credit applicable percentage for the month the bonds are issued by completing the DHCD certification form any time during the month the bonds are issued through the fifth day of the following month; otherwise, the LIHTC applicable percentage defaults to the month the building is placed in service (see the Internal Revenue Code §42(b)(2)(A)(ii)). Projects receiving either mortgage insurance or subsidies from HUD may also be subject to subsidy layering review under §911 of the Federal Housing and Community Development Act of 1992.

Projects financed with MBP must meet federal income targeting requirements. Minimum income elections for the MBP are identical to the requirements of the LIHTC program: 20% of all units must be rented to households with incomes of 50% or less of area median; or 40% of all units must be rented to households with incomes of 60% or less of area median.

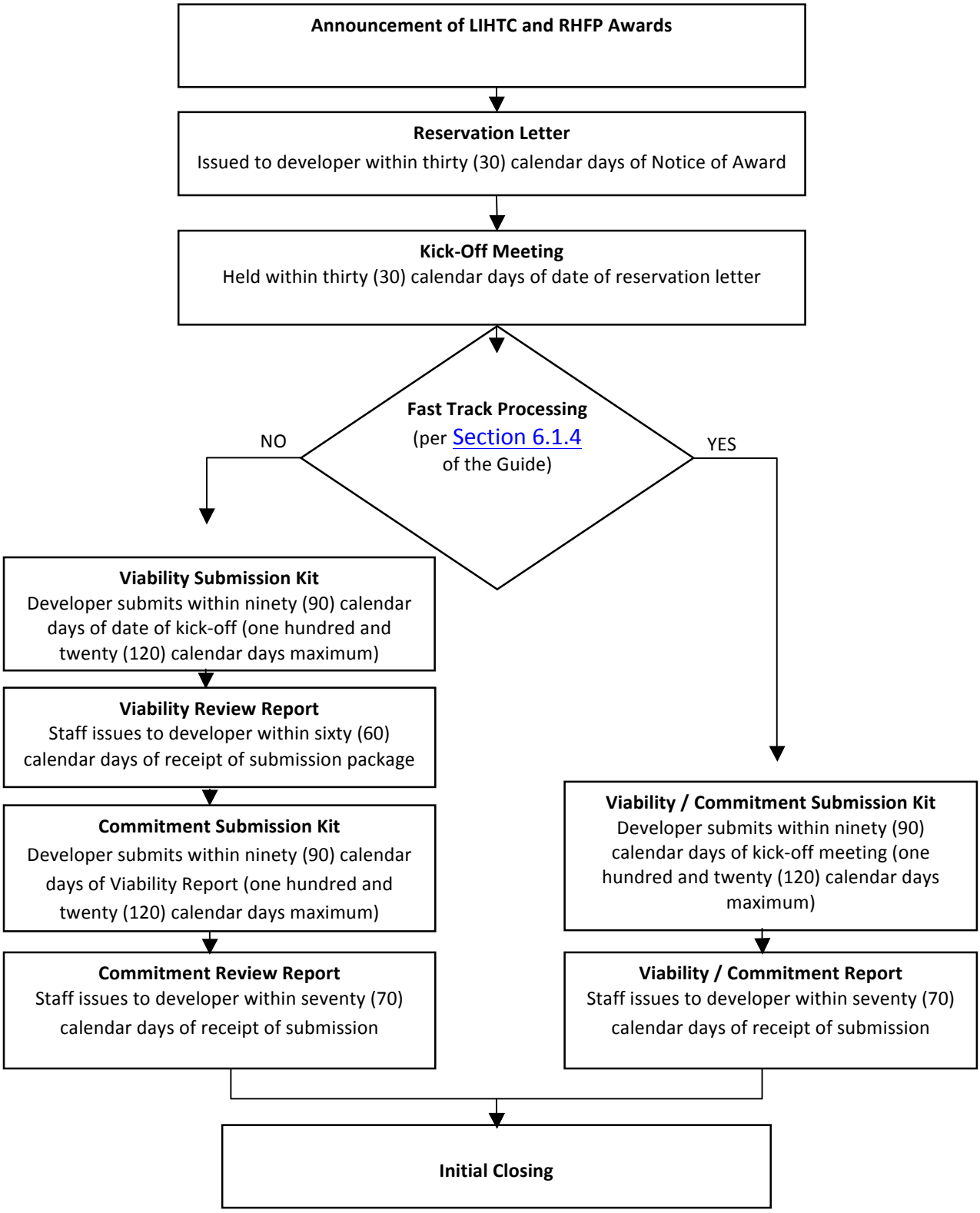
DHCD reserves the right to impose additional State income targeting requirements for MBP financed projects. DHCD continues to modify the MBP to meet customer needs with updates posted to DHCD's website on a regular basis.

Expedited Processing

Eligible projects requesting MBP financing may be processed under an expedited system. To be eligible, applications must request tax exempt financing without other DHCD financing or assistance, meet all Threshold Criteria or receive a waiver in accordance with Section 5.1 of this Guide, score at least ninety-two (92) total points and meet the additional scoring criteria outlined for FHA Risk Sharing Insurance noted in the call out box at the beginning of Chapter 4. If these requirements are met and subject to conditional HFRC recommendation, projects can expect to receive inducement approvals within ninety (90) calendar days of application submission.

To ensure timely processing, construction and underwriting reviews are limited to an analysis of a project's overall conformity to construction and underwriting standards established by DHCD and conformity to Federal requirements. The primary underwriting responsibilities are delegated to the credit enhancers and their appropriate Delegated Underwriters and Servicers (DUS Lenders) and to full insurance FHA lenders.

Appendix A: Underwriting and Closing Process



Appendix B: Application and Processing Fees

Fee Type	LIHTC	Rental Housing Financing Programs and Rental Housing Works*	When Due
Application Fee	$2,500 per application regardless of the number of funding resources requested.		Submission of application for funding.
Reservation Fee	$5,000 per reservation.	N/A	Remit to CDAs Trustee as invoiced.
LIHTC Allocation Fee	5% of the annual LIHTC amount allocated.	N/A	Varies depending on financing and sponsor type; see QAP for details.
Commitment Fee	N/A	1.5% of the loan amount.	Earlier of initial loan closing or bond closing; may be financed.
10% Expenditure Test Deadline Extension Fee	$1,000 for each month the deadline is extended.	N/A	Submission of application for extension.
IRS Form 8609 Amendment Fee	$4,000 per project; waived if amendment results from an administrative error by CDA.	N/A	Submission of a request for an amended IRS Form 8609.
Closing Attorney's Fees	N/A	$25,000 for the first loan $5,000 for each additional loan	Initial loan closing.
LIHTC Compliance Monitoring Fee	$30 per unit per year.	N/A	Annually as invoiced.
IRS Form 8823 Compliance Review Fee	$25 per unit per occurrence.	N/A	Submission of a request for issuance of an 8823 by CDA to correct a previously uncorrected 8823.
Assumption Closing Fee	N/A	$5,000	With request.
Subsidy Layering	$1,000		Initial Closing

*The RHFP and RHW application and processing fees apply to any funds awarded under this Guide. For fees applicable to DHCD's other programs, including the Partnership Rental Housing Program,

the Shelter and Transitional Housing Facilities Grant Program, and energy lending programs, please see DHCD's website at www.dhcd.maryland.gov

Appendix C: Bond Application and Processing Fees

Fee Type	LIHTC	Multifamily Bond Program (Traditional)*	Multifamily Bond Program (Refinance)	When Due
Application Fee	$2,500 per application.		Fees range from $1,000 to $5,000 or 0.015% of the loan option selected; consult program staff for more information.	Submission of application for funding.
LIHTC Allocation Fee	5% of estimated annual tax credit amount allocated.		None if no new allocation of LIHTC requested.	Issuance of §42(m) letter. Issuance of IRS Form(s) 8609 for any additional fee for actual tax credit allocated over initial estimate.
Commitment or Origination Fee	N/A	1.5% of the first $10 million of loan principal plus 1% of loan principal over $10 million. Fee increased to 3% for Taxable/Tax Exempt financings	Generally 1.5% of outstanding loan principal.	Earlier of initial loan closing or bond closing; may be financed for new loan.
Assumption Fee	N/A	None.	1.5% of the loan principal assumed.	Loan closing.
Costs of Issuance	N/A	Actual costs of issuance.	$100,000 plus 1% of the new loan principal.	Initial closing for new loans and closing for refinance.

Fee Type	LIHTC	Multifamily Bond Program (Traditional)*	Multifamily Bond Program (Refinance)	When Due
Negative Arbitrage[1]	N/A	Amount determined for each loan after each draw.		After each draw as invoiced.
Non Usage Fee	N/A	2% of estimated loan principal as a deposit against costs of issuance.	None.	Before POS issued and bonds priced (generally sixty (60) to ninety (90) calendar days prior to scheduled initial closing); amount credited to costs of issuance at initial closing.
Closing Attorney's Fees	N/A	$25,000 for the first loan. $5,000 for each additional loan.	$5,000	Initial loan closing.
MBP CLC/PLC Extensions Fee[2]	N/A	Actual costs incurred in connection with extensions of maturity and/or delivery dates of GNMA securities.		As invoiced.

*For fees applicable to the taxable/tax-exempt financing product, see the DHCD website at: http://dhcd.maryland.gov/HousingDevelopment/Documents/mbp/Taxable_GNMA_Loans.pdf

[1] Negative arbitrage is the difference between the bond yield and the investment yield on undrawn proceeds. A letter-of-credit may be required to be posted prior to closing for an amount sufficient to cover the maximum amount of negative arbitrage on the loan. Consult program staff for more information.

[2] These costs may include administrative charges, reasonable costs or expenses incurred by CDA, and reasonable reimbursement or fees of all professionals working on the transaction in connection with any requested extension, including costs, fees, reasonable hourly reimbursement, and expenses of bond counsel, other in-house or outside counsel, any rating agency, and any financial advisor to CDA.

Fee Type	LIHTC	Multifamily Bond Program (Traditional)*	Multifamily Bond Program (Refinance)	When Due
LIHTC Allocation Amendment Fee	$4,000 per project; waived if amendment results from an administrative error by CDA.	N/A		Submission of a request for an amended IRS Form 8609.
LIHTC Compliance Monitoring Fee	$30 per unit per year.	N/A		Annually as invoiced.
MBP Loan Pre-payment[3]	N/A	$5,000 initial review and $5,000 Payoff		Receipt at payoff review and at the time of repayment.
IRS Form 8823 Compliance Re- Review Fee	$25 per unit per occurrence.	N/A		Submission of a request for issuance of an 8823 by CDA to correct a previously uncorrected 8823.
Equity Redefinition Fee	N/A	1.5% of outstanding loan principal.		Upon agreement of redefinition.
Servicing Fee	N/A	0.25% added to bond loan interest rate		Each payment of debt service
IRS Form 8609 Amendment Fee	$4,000 per project; waived if amendment results from an administrative error by CDA.	N/A		Submission of a request for an amended IRS Form 8609.

[3] These are costs incurred in connection with redeeming bonds as permitted by the deed of trust note and may include negative arbitrage for forty-five (45) calendar days; unamortized costs of issuance and premiums, if any; bond counsel fees; and administrative charges. Consult DHCD Finance staff for more information.

Appendix D: Qualified Census Tracts Standards

http://www.huduser.org/portal/datasets/qct.html

Appendix E: Rental Housing Financing Programs and Rental Housing Works Surplus Cash Split Examples

(0% Interest Rate Option with "Contingent Interest")

	State Soft Debt	Local Soft Debt	DHCD %	Local Gov. %	Developer %	Comments	% Splits w/ Deferred Dev Fees	
Ex. 1	$2,000,000	$0	75.00%	0.00%	25.00%	DHCD will only take 50% of Surplus Cash until all Developer Deferred Fees are Paid.	DHCD	50.00%
	100.00% of Total	0.00% of Total					LG	0.00%
							Dev	50.00%
							Total	100.00%
Ex. 2	$2,000,000	$225,000	75.00%	0.00%	25.00%	DHCD will only take 50% of Surplus Cash until all Developer Deferred Fees are Paid. The Local Government cannot negotiate a higher share of the Surplus Cash with DHCD and/or Developer.	DHCD	50.00%
	89.89% of Total	10.11% of Total					LG	0.00%
							Dev	50.00%
							Total	100.00%
Ex. 3	$2,000,000	$500,000	60.00%	15.00 %	25.00%	DHCD will only take 50% of Surplus Cash until all Developer Deferred Fees are Paid. The Local Government is receiving a Prorated Share of the non-Developer portion (75.00%) of the Surplus Cash.	DHCD	50.00%
	80.00% of Total	20.00% of Total					LG	15.00%
							Dev	35.00%
							Total	100.00%
Ex. 4	$2,000,000	$750,000	54.55%	20.45 %	25.00%	DHCD will only take 50% of Surplus Cash until all Developer Deferred Fees are Paid. The Local Government is receiving a Prorated Share of the non-Developer portion (75.00%) of the Surplus Cash.	DHCD	50.00%
	72.73% of Total	27.27% of Total					LG	20.45%
							Dev	29.55%
							Total	100.00%
Ex. 5	$2,000,000	$1,000,000	50.00%	25.00 %	25.00%	The Local Government is receiving a Prorated Share of the non-Developer portion (75.00%) of the Surplus Cash.	DHCD	50.00%
	66.67% of Total	33.33% of Total					LG	25.00%
							Dev	25.00%
							Total	100.00%
Ex. 6	$2,000,000	$1,500,000	50.00%	25.00 %	25.00%	The Local Government Share of the Surplus Cash is being capped at 25.00% (or 33.33% of the 75.00% non-Developer portion). The Local Government cannot negotiate a higher share of the Surplus Cash with DHCD and/or Developer.	DHCD	50.00%
	57.14% of Total	42.86% of Total					LG	25.00%
							Dev	25.00%
							Total	100.00%
Ex. 7	$2,000,000	$2,000,000	50.00%	25.00 %	25.00%	The Local Government Share of the Surplus Cash is being capped at 25.00% (or 33.33% of the 75.00% non-Developer portion). The Local Government cannot negotiate a higher share of the Surplus Cash with DHCD and/or Developer.	DHCD	50.00%
	50.00% of Total	50.00% of Total					LG	25.00%
							Dev	25.00%
							Total	100.00%
Ex. 8	$2,000,000	$3,050,000	37.50%	37.50 %	25.00%	The Local Government Share of the Surplus Cash is being capped at 37.50% (or 50.00% of the 75.00% non-Developer portion). The Local Government cannot negotiate a	DHCD	37.50%
	39.60% of	60.40% of					LG	37.50%
							Dev	25.00%

	Total	Total				higher share of the Surplus Cash with DHCD and/or Developer.	Total

EXHIBIT E.1:
DEVOPMENT QUALITY THRESHOLD NARRATIVE

ELIZABETH HOUSE III
1315 APPLE AVENUE
SILVER SPRING, MD 20910

3.13.1 – CRITERIA APPLICABLE TO ALL PROJECTS

1. BUILDING CODE COMPLIANCE
   The project will comply with all applicable State and local building codes as noted on the Code analysis sheet.
2. UFAS
   Portions of the project applicable to the Maryland Department of Housing and Community Development requirements will comply with UFAS and other applicable laws as noted on the Code analysis sheet.
3. RESNET/BPI Rater
   The Owner will retain the services of a qualified RESNET/BPI Rater to perform the requisite performance testing and evaluation.
4. INTEGRATED PEST MANAGEMENT
   The Owner, through the property management entity, will develop and implement an Integrated Pest Management program equivalent to the HUD Healthy Homes Initiative.
5. HIGH PERFORMANCE ROOFING
   The main roof assembly will consist of hot fluid-applied rubberized asphalt, insulation, roof pavers, and continuous vegetated roof. Green roof systems help support storm water management for the project. Roof pavers will have a solar reflectance index of not less than 78 in order to comply with LEED requirements. The roof membrane will provide a minimum 20-year warranty per the specifications.
6. DURABLE/QUALITY DOORS, FRAMES AND HARDWARE
   Building entrance doors will be aluminum storefront. Other exterior doors will be hollow metal. Dwelling unit entry doors are rated hollow metal. Doors in amenity spaces will be solid core wood doors. Refer to Specifications for more information.
7. LAUNDRY FACILITIES
   A washer and dryer will be provided in each of the residential units. Standard units will receive a stackable washer-dryer unit, and accessible units will receive an all-in-one washer-dryer unit.

8. INTERNET ACCESS
   The Owner will provide internet access, including necessary software and hardware, in the plaza level amenity spaces.
9. INSTALLATION OF PRODUCTS AND MATERIALS
   All products and materials will be installed in accordance with manufacturer's installation instructions as noted in the drawings and specifications.

3.13.2 – BASE LEVEL GREEN STANDARDS FOR ALL PROJECTS

1. DEMOLITION PLAN
   Demolition drawings have been provided by the Design Team for adjacent structures and site work. The General Contractor and Owner will coordinate required demolition permits and access to existing occupied structures. The General Contractor will execute a construction waste management plan per the project LEED requirements.
2. SITE WORK
   The General Contractor will employ MDE 2011 standards for soil erosion control during construction. The limit of disturbance area is noted in the drawings. The geotechnical report has been included as part of the Specifications and recommendations have been implemented into the design documents, and will be followed during construction. Site access will be monitored by the General Contractor during construction.
3. LANDSCAPING
   New plantings in the project scope will utilize 50% native plants. Tree preservation has been reviewed and coordinated with Montgomery County Park and Planning as part of the Site Plan submission process approvals. The General Contractor will coordinate protection of any existing trees during construction as required.
4. CONSTRUCTION WASTE RECYCLING/DECONSTRUCTION
   The General Contractor will execute a construction waste management plan per the project LEED requirements.
5. AIR QUALITY
   The project will comply with LEED Indoor Environment Air Quality requirements as noted in the Specifications. Unsealed engineered or composite wood products will be free of added urea formaldehyde as specified. Submittals will be reviewed by the Architect during construction to make sure they comply with green requirements.

6. CHLOROFLUOROCARBONS
   HVAC equipment will not use CFC refrigerant as noted in the Specifications
7. MOISTURE AND MILDEW
   Mold, mildew and moisture will be treated in observed areas of the building as required during construction. Specifications will indicate treatment procedures.
8. RADON GAS
   Owner will confirm if legitimate hazard exists and will provide passive radon gas reduction pipe system if required.
9. RECYCLE PLAN
   Project will utilize a recycling plan to comply with Montgomery County Multifamily Recycle program. A recycle chute is provided for the residents of the building on each floor of the trash room, and recycle bins are provided in the trash room at the B1 level of the building. Property management will enforce recycling plan with residents.
10. WATER CONSERVATION
    Project water fixtures and faucets have been specified to comply with LEED requirements. Refer to specifications for more information.
11. SMOKING AREAS
    A designated smoking area will be provided no closer than 25 feet from each building entrance and air intake at grade. Residential windows are located starting at the 4th level of the building and will not be affected. The building will follow a no-smoking policy for interior common areas.
12. SITE LOCATION
    The site is not located within a FEMA flood zone.
13. HABITAT PROTECTION
    There are no existing habitats for protected or endangered species.

3.13.2 – ADDITIONAL CRITERIA APPLICABLE ONLY TO NEW CONSTRUCTION AND GUT REHABILITATION

1. ENERGY STAR RATING
   Project will comply with Energy Star Multifamily High-Rise rating system.

2. HVAC SYSTEMS

   An efficient and comfortable HVAC system will be provided that complies with Energy Star requirements in all residential units and common areas.

3. APPLIANCES

   All appliances will be Energy Star rated. Refer to specifications for more information.

4. WINDOWS

   The project is designated as a high rise building per Building code. Therefore, windows do not have to comply with energy star requirements. Refer to code analysis sheet for more information.

5. ROADWAY ASSEMBLY

   Standard duty residential roadway or better will be provided for all paved surfaces around site perimeter. Refer to civil drawings for more information.

6. DOORS

   No bi-fold doors have been specified on the project.

EXHIBIT E.2:
DEVOPMENT QUALITY SELF-SCORING AND NARRATIVE

ELIZABETH HOUSE III
1315 APPLE AVENUE
SILVER SPRING, MD 20910

4.6.1 – GREEN FEATURES (MAXIMUM 12 POINTS)

The project is designed to achieve a minimum LEED 2009 Silver rating for New Construction as defined by the U.S. Green Building Council (USGBC).

4.6.2 – ENERGY AND WATER CONSERVATION AND SUSTAINABILITY (MAXIMUM 6 POINTS)

We are not pursuing points under this category due to the project type and specifications.

4.6.3 – PROJECT DURABILITY AND ENHANCEMENTS (MAXIMUM 13 POINTS)

1. ACCESSIBILITY
   The building, parking and site elements are laid out for convenient access by the residents, including those with disabilities. Site improvements will include renovations to some existing sidewalks to make them more accessible.
2. BUILDING ENTRANCES & EXTERIOR SPACES
   Building entrances will be treated with security hardware and protected from weather with canopies. Green space is provided at the central plaza to the overall project. A portion of the plaza will be built during this phase of the overall Elizabeth Square project, with the ultimate green space provided once the second phase is complete.
3. BUILDING ARCHITECTURE
   The building architecture, structure and massing complement the adjacent buildings in scale and material. The building massing steps in multiple locations in order to break up the elevations, respond to the existing structures, and allow light into the plaza courtyard. Fiber cement panels, glazing, and stone are used on the residential portion of the building. Natural material tones were chosen to ground the building.
4. ARCHITECTURAL ACCESSORIES
   Special features are implemented throughout the building. The residential entrance is highlighted with glazing, stone and metal panels. A lower canopy was created to

respond to the pedestrian scale and identify the residential entrance on Apple Avenue. Multiple window sizes are used along the main building facades to emphasize movement and break up the massing.

5. PAVING

   Paving is used at the building entrance and courtyard, as well as at the connection to the Capital Crescent Commuter trail on both Fenwick Lane and Apple Avenue. Resident parking is provided in the garage below grade.

6. UNITS AND COMMON AREAS

   Units and common areas have been designed to allow ease of movement for the residents, taking into mind UFAS and Universal Design principles to encourage healthy and accessible living.

7. BUILDING EXTERIOR

   Exterior building materials consist of fiber cement panels, natural stone, glazing and metal panel.

8. INTERIOR DOORS

   Interior door panels and hardware will be of grade two (2) or better with levered handles as noted in the specifications.

9. NON-SMOKING POLICY

   The Owner and Property Management group will enforce a non-smoking policy applicable to all interior common spaces and units. A designated smoking area will be provided to comply with LEED requirements.

10. BATHROOM FLOORS

    Porcelain tile will be used on all resident bathroom floors. A 10-year minimum warranty is indicated in the specifications.

11. TUB/SHOWER SURROUNDS

    Tub and shower surrounds are comprised of porcelain tile with cementitious backer board in compliance with the Tile Council of North America (TCNA).

4.6 DEVELOPMENT QUALITY STANDARDS

		Max. Pts.	Pts By Self Score
4.6.1	Green Features	12	12
4.6.2	Energy and Water Conservation and Sustainability	6	0
4.6.3	Project Durability and Enhancements	13	11
	Development Quality Self Scoring		**23**

APPENDIX C

ENERGY STAR REQUIREMENTS

ENERGY STAR Multifamily High Rise National Performance Path Requirements, Version 1.0

ENERGY STAR MFHR Performance Path Requirements:

To earn the ENERGY STAR using this performance approach, a building must meet the requirements specified below, the Performance Target, and be verified and field-tested in accordance with the *ENERGY STAR MFHR Testing and Verification Protocols*. Note that compliance with these guidelines is not intended to imply compliance with all local code requirements that may be applicable to the building to be built.[1]

To meet the certification guidelines, the developer of a project participating in the program must provide EPA or its designated agent with program specific submittals. These submittals, which must be validated by a licensed professional (registered architect or professional engineer), are used to demonstrate that the program's performance target has been met, that all prerequisites are included, and that each energy conservation measure chosen by the design team is installed to specification.

Performance Target:

The Performance Target is 15% energy cost savings over the ASHRAE 90.1 Standard (2007 or 2010) equivalent to the state energy code under which the building is permitted, using the Appendix G protocols and the *ENERGY STAR MFHR Simulation Guidelines*. Energy cost savings associated with on-site power generation, including cogeneration, photovoltaics, and wind turbines, may not be used to meet the Performance Target of 15%.

ENERGY STAR MFHR Simulation Guidelines (Simulation Guidelines):

The *Simulation Guidelines* is a companion document to ASHRAE 90.1-2007/2010 and ASHRAE 90.1 - Appendix G and contains program guidance to assist energy modelers in developing the Baseline Building, Proposed Design, and As-Built models for each project. The intent of these guidelines is to:

- Facilitate consistent modeling among different modelers;
- Facilitate consistent modeling of baseline components not mentioned in Appendix G;
- Establish modeling protocols for measures that ASHRAE 90.1 leaves to the rating authority to determine; and
- Ensure that modeling results are used to drive the energy-efficient design process.

If an energy conservation measure is included in the model that is not addressed in the *Simulation Guidelines* or ASHRAE 90.1-2007/2010 - Appendix G, the energy modeler is required to clearly document their assumptions and calculations. Each measure not included in the guidelines is subject to approval by EPA or its designated agent.

ENERGY STAR MFHR Testing and Verification Protocols (T&V Protocols):

The *T&V Protocols* are mandatory requirements for the inspection, testing, and verification of components related to the building's energy performance. All inspections and diagnostic tests described within these protocols are required for each of the energy-related components and systems that exist in the participating building. Results of inspections must be documented and kept on record with the building file by a licensed professional and submitted to EPA, or its designated agent, at the completion of construction. These inspections shall be conducted throughout the project construction phase at a time that is best suited to determine whether the energy efficiency element is installed to specification.

ENERGY STAR MFHR Submittal Requirements:

To meet the certification guidelines, EPA or its designated agent must approve a complete Proposed Design Submittal and a complete As-Built Submittal. EPA or its designated agent will not approve incomplete submittals, but will communicate with Developer Partners and licensed professionals on which requirements must be met to bring the submittal into compliance with program requirements.

Proposed Design Submittal (Submitted prior to construction)

The Proposed Design Submittal is used to ensure that the project design meets the Performance Target and that the mandatory requirements of the program have been included in the construction documents. The licensed professional is responsible for submitting a Proposed Design Submittal, with an *ENERGY STAR MFHR Submittal Validation Form* to EPA, or its designated agent for approval, prior to beginning construction. The Proposed Design Submittal includes the following:

- Proposed Design Performance Path Calculator[2]
  The *Proposed Design Performance Path Calculator* summarizes the modeling results of the proposed building design, and is used to demonstrate achievement of the Performance Target.

- Testing and Verification Worksheets
  A full review of all construction documents must be conducted prior to construction and documented using the *T&V Worksheets.* The *Prerequisites Checklist* is used at this stage to demonstrate that prerequisites and energy conservation measures chosen by the design team have been properly specified within the construction documents. The checklist is included as part of the *T&V Worksheets* and is automatically completed if the other *T&V Worksheets* are used to document the review process.

Developer partners may not promote the units within their project as ENERGY STAR until all program requirements are met and confirmed by EPA or their designated agent. Eligible projects may use the Designed to Earn the ENERGY STAR mark after the design phase of the project if they have an approved Proposed Design Submittal and the design receives a score of 75 or higher, using EPA's Portfolio Manager. More information is available in the *Designed to Earn the ENERGY STAR for MFHR* document available on the Guidance Documents page.

As-Built Submittal (Submitted post construction)

The As-Built Submittal is used to ensure that the energy conservation measures chosen by the design team are installed to specification. After the final inspection, the licensed professional is responsible for submitting an As-Built Submittal, with an *ENERGY STAR MFHR Submittal Validation Form* to EPA, or its designated agent for approval. Once EPA has determined that the project has fulfilled all of the program requirements, the Developer Partner will be notified that the building has earned the ENERGY STAR and that it can be marketed and promoted per the *ENERGY STAR Logo Identity Guidelines*. The As-Built Submittal includes the following:

- As-Built Performance Path Calculator
  The *As-Built Performance Path Calculator* summarizes the modeling results of the completed building, and is used to demonstrate achievement of the Performance Target. Any modifications to the project's energy conservation measures during construction must be reflected in the *As-Built Performance Path Calculator*.

- Testing and Verification Worksheets and Photo Template
  The *T&V Worksheets* and *Photo Template* are used to demonstrate that prerequisites and energy conservation measures chosen by the design team are included in the completed building and meet all requirements of the *ENERGY STAR MFHR Testing and Verification Protocols*. (Note, once a licensed professional or Developer Partner has successfully certified 3 buildings, submission of a Photo Template as a component of the Testing and Verification Protocols is no longer required.)

ENERGY STAR MFHR Prerequisites[3]:

Appliances	When provided in common areas and/or apartments, refrigerators, dishwashers, clothes washers, ceiling fans and vending machines must be ENERGY STAR certified.
Heating and Cooling Equipment	▪ The heating and cooling systems must comply with ASHRAE 90.1-2007, Section 6.4. ▪ Load sizing calculations must reflect the design[4]. The installed capacity cannot exceed design by more than 20%, except when smaller sizes are not available. ▪ Atmospherically vented gas furnaces and boilers shall not be specified.

Heating and Cooling Distribution[5,6,7,8,9,10,11,12]	▪ Total duct leakage for in-unit systems shall be ≤8 CFM25 per 100 ft^2 of conditioned floor area[6]. Sampling procedures and tolerances are described in the *T&V Protocols*. ▪ Heating and cooling supply and return ductwork shall be insulated to a minimum R-6 in unconditioned space.
Envelope[13,14,15]	▪ The envelope components must comply with ASHRAE 90.1-2007, Section 5.4. Assembly U-value determinations must follow ASHRAE 90.1-2007, Appendix A[16]. ▪ The building plans shall demonstrate a continuous, unbroken air barrier separating the conditioned space of the building from the following spaces: - the exterior, - unconditioned spaces within the building, - commercial spaces, - mechanical rooms vented with unconditioned air, - mechanical chases opening to unconditioned spaces, - elevator shafts, and - garages or other vehicle/equipment storage facilities. ▪ All roof, wall, floor, and slab insulation shall achieve RESNET-defined Grade I installation or, alternatively, Grade II for surfaces that contain a layer of continuous, air impermeable insulation (≥R-3 in CZ 1-4 and ≥R-5 in CZ 5-8). ▪ For steel-framed and metal building walls, continuous exterior insulation (≥R-3) is required on above grade walls[17]. For mass or masonry walls with metal framing, continuous interior or exterior insulation (≥R-3) is required on above grade walls. ▪ Specified windows must be double or triple-pane, with low-emissivity glass or coatings.
Garages and Sidewalks[18,19]	Attached garages shall be fully compartmentalized from the rest of the building through air sealing. All pipe and conduit penetrations shall be sealed with material compatible with the surface and resilient to temperature fluctuations.
Ventilation and Infiltration[20]	▪ Apartments shall be sealed to reduce air exchange between the apartment and outside as well as the apartment and other adjacent spaces. A maximum air leakage rate of 0.30 CFM50 per square feet of enclosure is allowed. Sampling procedures and tolerances are described in the *T&V Protocols*. Specific apartment air leakage paths to be sealed are listed in the *T&V Worksheets*. ▪ Common area ventilation systems shall be designed and tested to satisfy minimum requirements of ASHRAE 62.1-2007. Apartment ventilation and local exhaust systems shall be designed and tested to satisfy minimum requirements of ASHRAE 62.2-2007, without reliance on natural ventilation[21]. Apartment in-line and ceiling exhaust fans must be ENERGY STAR certified.
Domestic Water Heating[22,23]	▪ Domestic water heating systems must comply with ASHRAE 90.1-2007, Section 7.4. ▪ Atmospherically vented gas water heaters, tankless coils and side-arm water heaters shall not be specified. Indirect water heaters, with or without storage, are acceptable. If storage is provided, the maximum storage tank capacity shall be specified based on occupancy. ▪ The average flow rate for all faucets must be ≤ 2.0 gallons per minute (as rated at 80 psi) [24]. ▪ All showerheads must be WaterSense® labeled ▪ All tank-type toilets must be WaterSense® labeled.

Lighting[25,26]	Occupancy Controls All non-apartment spaces, except those intended for 24-hour operation or where automatic shutoff would endanger the safety of occupants, must have occupancy sensors or automatic bi-level lighting controls.
	Common Space Lighting 80% of installed light fixtures in common spaces must be ENERGY STAR certified or have ENERGY STAR certified lamps installed. Alternatively, 100% of installed light fixtures in common spaces must have high-efficacy lamps installed, as defined in Appendix B. Total specified lighting power for the combined common spaces must not exceed ASHRAE 90.1-2007 allowances for those combined spaces by more than 20%.
	In-Unit Lighting 80% of installed light fixtures within apartments must be ENERGY STAR certified or have ENERGY STAR certified lamps installed. Alternatively, 100% of installed light fixtures within apartments must have high-efficacy lamps installed, as defined in Appendix B.
	Exterior Lighting ▪ 80% of outdoor lighting fixtures shall be ENERGY STAR certified or have ENERGY STAR certified lamps installed. Alternatively, 100% of outdoor lighting fixtures must have high-efficacy lamps installed, as defined in Appendix B. ▪ Fixtures must include automatic switching on timers or photocell controls except fixtures intended for 24-hour operation, required for security, or located on apartment balconies.
	Exit Signs All exit signs shall be specified as LED (not to exceed 5W per face) or photo-luminescent and shall conform to local building code; fixtures located above stairwell doors and other forms of egress shall contain a battery back-up feature.
Pump Motor Efficiency[27]	All three-phase pump motors 1 horse-power or larger shall meet or exceed efficiency standards for NEMA Premium™ motors, where available.

ENERGY STAR MFHR Benchmarking:

Although eligible units in a multifamily high rise building may earn the ENERGY STAR based on the mandatory requirements listed above at completion of construction, building performance is as much a function of proper building management as the energy conservation measure incorporated into the structure. Therefore, after earning the ENERGY STAR, the developer/owner must commit to benchmarking their building in Portfolio Manager for a period of at least two years.

Portfolio Manager is a free, online, interactive energy management tool that allows developer/owner to measure and track their building's energy and water consumption, identify investment priorities, and verify improvements over time. Developers/owners can use Portfolio Manager to track weather-normalized energy use intensity (EUI), energy costs, greenhouse gas emissions, and water consumption. For more information on how to use Portfolio Manager, see the Portfolio Manager - Multifamily Housing Quick Reference Guide document.

To accomplish this goal, the developer/owner or an entity working on their behalf, must be capable of evaluating the utility consumption of the residential-associated spaces independent of any commercial/retail space. These nonresidential associated parts of the building shall be separately metered (or sub-metered) for electricity, gas, fuel oil, water, steam, and hot water for domestic and/or space heating purposes. Also, they should work with tenants to secure consumption information. If the building is direct-metered for utilities to the apartments, the building owner may need signed releases from individual apartment occupants to allow for benchmarking or find alternative methods to assessing whole building energy consumption such as a whole-building meter or asking the utility for aggregated data.

All data uploaded to Portfolio Manager is strictly confidential and only used to estimate the energy performance of the building as a whole, not of individual apartments.

ENERGY STAR MFHR Website:

More information on program requirements, submittals, processes, and benchmarking can be found at www.energystar.gov/mfhr, including our Current Policy Record, which contains policy issues that were received and have been resolved since the last revision of the program documents. Questions? Please email us at mfhr@energystar.gov.

ENERGY STAR Multifamily High Rise National Performance Path Notes

1. Where requirements of the local codes, manufacturers' installation instructions, engineering documents, or regional ENERGY STAR programs overlap with the requirements of these guidelines, EPA offers the following guidance:

    a. In cases where the overlapping requirements exceed the ENERGY STAR guidelines, these overlapping requirements shall be met;

    b. In cases where overlapping requirements conflict with a requirement of these ENERGY STAR guidelines (e.g., slab insulation is prohibited to allow visual access for termite inspections), then the conflicting requirement within these guidelines shall not be met. Qualification shall only be allowed if the licensed professional has determined that no equivalent option is available that could meet the intent of the conflicting requirement of these ENERGY STAR guidelines (e.g., switching from exterior to interior slab edge insulation).

2. The *Performance Path Calculator* is a set of worksheets in an Excel file designed to provide consistency among energy modelers by providing the exact calculations described in the Simulation Guidelines. It also provides a consistent format for reporting the results of the Performance Rating. Many of these worksheets are optional, however, submission of the Excel file, with Basic Info and Reporting Summary worksheets completed, is mandatory.

3. Each building that participates in the program, regardless if it chooses the Performance Path or the Prescriptive Path, must meet certain mandatory program requirements. These requirements are listed within this document and outlined in the *Prerequisites Checklist*, a worksheet within the *ENERGY STAR MFHR Testing and Verification Worksheets*. These prerequisites establish the minimum program requirements within which the design team may make performance trade-offs in the design of an ENERGY STAR certified building. While these prerequisites can contribute to the achievement of the Performance Target, these requirements alone are not sufficient to earn the ENERGY STAR. As used in this document, the word 'shall' means that the action specified is mandatory and must be accomplished.

<u>Heating and Cooling Equipment</u>

4. Heating and cooling loads shall be calculated, equipment capacity shall be selected, and duct systems shall be sized according to the latest editions of ACCA Manual J, S, & D, respectively, ASHRAE 2009 Handbook of Fundamentals, or a substantively equivalent procedure. Indoor temperatures shall be 70°F for heating and 75°F for cooling. Outdoor temperatures shall be the 1.0% and 99.0% design temperatures, respectively, as published by the ASHRAE Handbook of Fundamentals.

<u>Heating and Cooling Distribution</u>

5. Terminal heating and cooling distribution equipment serving an apartment shall be controlled by a thermostat(s) within the same apartment.

6. Heating and cooling ductwork shall be sealed at all transverse joints and connections, including ductwork connections through drywall or other finish materials, using UL-181 compliant methods and materials. Construction documents shall specify that ductwork must be inspected before access is covered up. As an alternative to meeting total duct leakage requirements post-construction, total duct leakage measured at rough-in, ≤4 CFM25 per 100ft^2, with air handler and all ductwork installed, is accepted.

7. Heating and cooling ductwork that is specified as flex duct shall follow the Sheet Metal and Air Conditioning Contractors' (SMACNA) installation standards for flex ducts (see *Appendix A*).

8. For hydronic distribution systems, all terminal heating and cooling distribution equipment must be separated from the riser or distribution loop by a control valve or terminal distribution pump, so that heated or cooled fluid is not delivered to the apartment distribution equipment when there is no call from the apartment thermostats.

9. Piping carrying fluid or steam with temperatures greater than 105°F must have a minimum of 1" of insulation; pipes 1.5" in diameter and greater must have a minimum of 1.5" of insulation. Piping carrying fluid (chilled water or refrigerant) with

temperatures less than 60°F must have a minimum of 0.5" of insulation; pipes 1.5" in diameter and greater must have a minimum of 1.0" of insulation. Construction documents must account for piping total thickness including required insulation when passing through planks or any other penetrations. For PTACs or any other heating/cooling systems that require branch pipe insulation, the insulation thickness must be considered when designing room dimensions and access chases. Construction documents shall specify that the piping must be inspected before access is covered up. Extent and location to be determined by ASHRAE 90.1-2007 Section 6.4.4.1.3 or local code.

10. For systems designed with outdoor-air supplied to the heating, cooling, or ventilation distribution system, provide motorized dampers that will automatically shut when systems or spaces are not in use.

11. For hydronic distribution systems without automatic balancing valves, all supply/return headers must be designed in a "reverse return" configuration (i.e. first riser supplied is the last returned, etc.) and/or sized based on a water velocity of less than 4 ft/s. Total pressure drop of terminal unit branch piping and fittings between a supply and return riser must be significantly greater than the total pressure drop from the top to the bottom of these risers. Calculations and assumptions for sizing circulating pumps must meet Chapter 43 of the ASHRAE Handbook, HVAC Systems and Equipment or equivalent industry accepted standard.

12. For in-unit forced air distribution systems, perform design calculations (using ACCA Manuals J and D, the ASHRAE Handbook of Fundamentals, or an equivalent procedure) and install ducts accordingly. Bedrooms must be pressure-balanced using any combination of transfer grills, jump ducts, dedicated return ducts, and/or undercut doors.

Envelope

13. When required by local building code, entranceways shall be designed with vestibules with weather-stripping hard-fastened to the door or frame.

14. If installing sleeves for through-wall AC units, insulated covers must be provided by the building for use during heating season and when AC units are not installed.

15. Ductwork penetrating the building envelope shall be sealed to prevent air leakage through the duct system and/or the building envelope. This includes, but is not limited to, roof curbs and exterior wall exhaust/intake vents.

16. An area weighted average of the U-factors of the wall and floor perimeter assemblies is acceptable in the energy model. When calculating the wall U-factor, the full R-value for any exterior wall insulation can only be used for portions of the assembly where shelf angles or other continuous metal fastened to the wall are not used. For portions of this assembly where shelf angles or other continuous metal fastened to the wall are used, the exterior insulation cannot contribute to the assembly R-value and an overall U-value shall be calculated based on an area weighted ratio.

17. Where specific details cannot meet this continuous insulation requirement, the Licensed Professional shall provide the detail to EPA to request an exemption prior to the building's certification. Projected balconies are currently exempt, however EPA recommends that they be thermally broken.

Garages and Sidewalks

18. Garages, including plenums and dropped ceilings within the garage, shall not be heated for comfort or to prevent pipes from freezing. Piping design and layout shall locate piping within conditioned spaces or grouped and properly insulated to prevent freezing. If heat tracing is used for freeze protection, it must be activated based on pipe wall temperature, rather than air temperature, and the energy consumption must be modeled in the As-Built (but excluded in the Baseline). The heat tracing thermostat set point must be no higher than 40°F and the set point must be confirmed by a field inspection.

19. Radiant heating (i.e. infrared), either wall or ceiling-mounted, or heating within the garage floor (or sidewalks) may be used to prevent ice formation on the ground as a safety feature only and temperature-based controls must comply with

ASHRAE 90.1-2007 Section 6.4.3.8. Energy consumption associated with these systems must be modeled in the As-Built (but excluded in the Baseline).

Ventilation and Infiltration

20. Ventilation system ductwork shall be sealed at all transverse joints and connections including boot to wall/ceiling connections through drywall using UL-181 compliant materials and methods. Central exhaust systems that serve one or more apartments must be tested for duct leakage, where the maximum leakage allowance is calculated as 5 CFM per register per shaft plus 5 CFM per floor per shaft. See *T&V Protocols* for details.

21. Compliance with ASHRAE 62.2-2007 Sections 4.3 and 5.3.1 is recommended, but not required. Providing outdoor air to each unit directly from the outdoors is recommended, but not required. For kitchen exhaust fans, prescriptive duct sizing requirements described at www.energystar.gov/newhomesresources may be used in lieu of measuring the actual air flow rate.

Domestic Water Heating

22. The temperature setting of in-unit storage water heaters must not exceed 140°F. For both in-unit and central DHW systems, temperatures measured at faucets and showerheads must not exceed 125°F. Domestic hot water piping carrying liquid with temperatures greater than 105°F must have a minimum of 1" insulation. Pipes over 1.5" in diameter must have a minimum of 1.5" of insulation. Extent and location to be determined by ASHRAE 90.1-2007 Section 7.4.3 or local code.

23. Self-contained or electronic mixing valves shall be used to control hot water temperature for central domestic water heating systems serving apartments.

24. If flow ratings at 80 psi are not available, WaterSense® labeled faucets or aerators may be used to meet this prerequisite.

Lighting

25. ASHRAE 90.1-2007, Section 9.1.4a, requires that light fixtures be modeled with the maximum labeled wattage of the fixture. EPA will allow light fixtures to be modeled based on the installed wattage of the lamps. Ex: A fixture with a 13 W screw-in CFL can be modeled as 13 W, plus any associated ballast power. See Appendix B to determine input power.

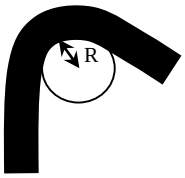
26. Lighting must comply with ASHRAE 90.1-2007, Section 9.4. At a minimum, interior lighting must be designed or measured to meet light levels (footcandles) by space type as recommended by the Illumination Engineering Society (IESNA) Lighting Handbook, 9th edition. Values for commonly used spaces are listed below. For senior housing, minimum illumination requirements may follow recommendations in IESNA's 2007 Lighting and the Visual Environment for Senior Living, and an increase in lighting power densities and allowances corresponding to the increase in footcandles, is permitted. See Appendix B to determine lamp lumens.

ASHRAE Space Type	Lighting Power Densities (W/ft^2)	Recommended Light Levels (Weighted Avg. Footcandles)	ASHRAE Space Type	Lighting Power Densities (W/ft^2)	Recommended Light Levels (Weighted Avg. Footcandles)
Apartments	1.1	10	Stairs - Active	0.6	15
Storage, active	0.8	20	Restroom	0.9	12
Storage, inactive	0.3	8	Office	1.1	35
Food Preparation	1.2	40	Conference/meeting/ multipurpose	1.3	30
Dining Area - For Family Dining	2.1	23	Electrical/Mechanical	1.5	30
Lobby/Elevator	1.3	16	Workshop	1.9	50
Corridor/Transition	0.5	10	Parking garage	0.2	7

Motors

27. Many motors are NEMA labeled and this label alone, does not ensure that a motor is energy-efficient. This requirement refers specifically to the **NEMA Premium** energy efficient motors program. Participating companies may be found at http://www.nema.org/Policy/Energy/Efficiency/Documents/NEMA_Premium_Partners.pdf. Motors for fire pumps and booster pumps are exempt from this requirement.

Appendix A: Specifications for Flexible Duct Installation

Component/Location	Standard
Duct length	Limit duct length to no more than 25' per run for flex duct, not to exceed the manufacturer's recommended limit
Excess ductwork	Runs should be as direct as possible. Excess ductwork should be no more than 5% for any given section of flexible duct.
Supports	Suspended horizontal ducts should be supported at least every 5'.
Hangers	Hanger material should be at least 1-1/2" in width and hangers should not crimp the ductwork, causing the interior dimension of the duct to be less than specified
Sag	Suspended ductwork should be allowed to sag no more than ½" for every 1' of run
Trunk and boot connections	Flexible duct should be allowed to run straight out of any connection at least 12" before taking a turn
Bends	The radius at the centerline of a bend must be a minimum of one duct diameter as shown in the diagram (R = 1 duct diameter): 
Connections	Connections to boots, collars, and trunks must be substantially airtight
Sealants	Sealants and tapes used to make ductwork airtight must be compliant with UL=181 standards and installed according to the manufacturer's specifications

Reference: Sheet Metal and Air Conditioning Contractor's National Association

Appendix B: Typical lamp lumens and input power for installed lighting

Efficacy: Lumens per Watt = Measured Lamp Lumens [Lumens]/Measured Input Power [Watts]

High Efficacy Lamps: Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps or lamps with a minimum efficacy of 60 lumens/W for lamps over 40W; 50 lumens/W for lamps over 15W to 40W; and 40 lumens/W for lamps 15W or less

Footcandle: one lumen per square foot.

Lamp Lumens: Lamp lumens must be measured using the lamp and ballast that are shipped with the fixture, using the tables on the ENERGY STAR website, or by using the charts below.

Input Power: Input power must be measured with the lamp and ballast that are shipped with the fixture, by using Tables 9-E through 9-H in the User's Manual for ASHRAE 90.1-2007, or the charts below.

Standard Metal Halide			
Lamp Watts	Lumens	Input Power	Efficacy
150	13,500	186	73
175	15,000	205	73
250	23,000	295	78
360	36,000	388	93
400	40,000	461	87

Typical T-8 (Electronic Ballast)			
Lamp Watts	Lumens	Input Power	Efficacy
17	1400	22	64
25	2225	27	82
32	3100	32	97
40	3725	46	81
86	8200	88	93

Compact Fluorescent					
Lamp Watts	Lumens	Input Power	Ballast	Efficacy	Minimum Lumens Needed
9	280-680	13	Electro-magnetic	22*-52	650
9	280-680	10	Electronic	28*-68	500
13	600-950	17	Electro-magnetic	35*-56	850
13	600-950	14	Electronic	43*-68	700
26	1200-1900	37	Electro-magnetic	32*-51	1850
26	1200-1900	28	Electronic	43*-68	1400

*may not meet current ENERGY STAR specifications, check lamp lumens on ENERGY STAR website.