

2.11 PROTECTIVE SHIELDING GUARDS

- A. The Contractor shall provide the product indicated on the Drawings or an Engineer-approved comparable product by one of the following:
 - 1. Plumberex Specialty Products Inc.
 - 2. TRUEBRO, Inc.
 - 3. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
- B. Description: Manufactured plastic covers for hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.12 FIXTURE SUPPORTS

- A. The Contractor shall provide the product indicated on the Drawings or an Engineer-approved comparable product by one of the following:
 - 1. Josam Company.
 - 2. MIFAB Manufacturing Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Watts.
- B. Lavatory Supports:
 - 1. Description: Type II, lavatory carrier with concealed arms and tie rod for a wall-mounting, lavatory-type fixture. Include steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The Contractor shall examine the roughing-in of the water supply and sanitary drainage and vent piping systems to verify the actual locations of piping connections before installing plumbing fixture.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

To ensure proper installation, the Contractor shall do the following:

- A. Assemble plumbing fixtures, trim, fittings, and other components according to the manufacturers' written instructions.
- B. Install off-floor supports, affixed to the building substrate, for wall-mounting fixtures:
 - 1. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 2. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install wall-mounting fixtures with tubular waste piping attached to supports.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install fixtures level and plumb according to roughing-in drawings.
- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation:
- G. Install trap and tubular waste piping on the drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on the drain outlet of each fixture to be indirectly connected to drainage system.
- I. Install accessible water closet with the flush handle mounted on the wide side of the compartment.
- J. Install toilet seats on water closets.
- K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

- M. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- O. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal the protruding fittings. Escutcheons are specified in Section 15053, Basic Mechanical Materials and Methods.
- Q. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Section 07900, Joint Fillers, Sealants, and Caulking.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according with Division 16 Sections.
- D. Connect wiring according with Division 16 Sections.

3.04 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms at final completion.

3.05 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.06 CLEANING

- A. The Contractor shall clean fixtures, faucets, and other fittings with the manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After installing exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow the use of plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION

SECTION 15815
METAL DUCTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.

1.02 RELATED WORK

- A. Section 15820, Duct Accessories, for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
- B. Section 15950, Testing, Adjusting, and Balancing, for testing, adjusting, and balancing requirements for metal ducts.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Factory- and shop-fabricated ducts and fittings.
 - 2. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 3. Fittings.
 - 4. Reinforcement and spacing.
 - 5. Seam and joint construction.

6. Equipment installation based on equipment being used on the Project.
 7. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
- D. Welding certificates.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing of Materials (ASTM)
1. ASTM A36/A36M—Standard Specification for Carbon Structural Steel.
 2. ASTM A653/A653M—Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 3. ASTM A1008/A1008M—Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 4. ASTM C916—Standard Specification for Adhesives for Duct Thermal Insulation.
 5. ASTM C920—Standard Specification for Elastomeric Joint Sealants.
 6. ASTM C1071—Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

- B. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - 1. ASHRAE 62.1—Ventilation for Acceptable Indoor Air Quality.
 - 2. ASHRAE/IESNA 90.1—Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. Environmental Protection Agency (EPA)
 - 1. 40 CFR 59 Subpart D—National Volatile Organic Compound Emission Standards for Architectural Coatings.
- D. National Air Duct Cleaners Association (NADCA)
 - 1. NADCA 1992—Assessment, Cleaning, and Restoration of HVAC Systems.
- E. National Fire Protection Agency (NFPA)
 - 1. NFPA 90A—Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 90B—Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- F. North American Insulation Manufacturers Association (NAIMA)
 - 1. NAIMA AH124—Fibrous Glass Duct Liner Standard.
- G. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - 1. SMACNA—Duct Cleanliness for New Construction Guidelines.
 - 2. SMACNA—HVAC Duct Construction Standards – Metal and Flexible.
- H. Underwriters Laboratories (UL)
 - 1. UL 723—Tests for Surface Burning Characteristics of Building Materials.

1.06 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.07 WARRANTIES

- A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

1.09 QUALIFICATIONS (NOT USED)

1.10 TESTING REQUIREMENTS (NOT USED)

1.11 MAINTENANCE (NOT USED)

1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS (NOT USED)

1.13 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and performance requirements and design criteria indicated in Article 3.08.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

PART 2 PRODUCTS

2.01 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723, certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65%.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (PVC coated or bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.04 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws compatible with duct materials.
- D. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with the fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of not less than 1 inch, plus allowance for insulation thickness.
- H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal all metal ducts to Seal Class A according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGERS AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
 - D. Hangers Exposed to View: Threaded rod and angle or channel supports.
 - E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
 - F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors comply with Section 15820, Duct Accessories.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for outlet connections.

3.06 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 1. Ducts connected to variable-air-volume air handling units:
 - a. Pressure class: Positive 5-inch wg.
 - b. Minimum SMACNA seal class: A.
 2. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct

liner manufacturer. Comply with Section 15820, Duct Accessories, for access panels and doors.

3. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
4. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.07 START UP

- A. Air Balance: Comply with requirements in Section 15950, Testing, Adjusting, and Balancing.

3.08 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.

C. Return Ducts:

1. Ducts Connection to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A.

E. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick. Install in duct within 15 feet of air handling units.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick. Install in duct within 10 feet of exterior discharge.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

- c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

G. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45° entry.
 - b. Rectangular Main to Round Branch: Spin in.

END OF SECTION

SECTION 15820
DUCT ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.02 RELATED WORK (NOT USED)

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and maintenance data.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. Air Movement and Control Association International (AMCA)
 - 1. AMCA 500-D—Laboratory Methods of Testing Dampers for Rating
- B. American Society for Testing of Materials (ASTM)
 - 1. ASTM A653/A653M—Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - 1. ASHRAE 62.1—Ventilation for Acceptable Indoor Air Quality.
 - 2. ASHRAE/IESNA 90.1—Energy Efficiency Standard.
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 90A—Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - 2. NFPA 90B—Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - 3. NFPA 96—Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- E. North American Insulation Manufacturers Association (NAIMA)
 - 1. NAIMA AH116—Fibrous Glass Duct Construction Standards Low Velocity Systems 2-inch w.g. (500 Pa) Maximum Static Pressure.
- F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - 1. SMACNA - HVAC Duct Construction Standards – Metal and Flexible.

G. Underwriters Laboratories (UL)

1. UL 1978—Grease Ducts.
2. UL 181—Standard for Safety Factory-Made Air Ducts and Connectors.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.07 WARRANTIES

- A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

1.09 QUALIFICATIONS (NOT USED)

1.10 TESTING REQUIREMENTS (NOT USED)

1.11 MAINTENANCE (NOT USED)

1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for length 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
 - 5. SEMCO Incorporated.
 - 6. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 1-inch wg.
- E. Frame: 0.063-inch-thick extruded aluminum, with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Felt.
- I. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.250 inch.

- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. 90° stops.

2.03 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. METALAIRE, Inc.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - e. Vent Products Company, Inc.
- 2. Standard leakage rating, with linkage outside airstream.
- 3. Suitable for horizontal or vertical applications.
- 4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.

- c. Stiffened damper blades for stability.
 - d. Galvanized-steel, 0.064-inch thick.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch WG or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Galvanized steel.

2.04 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.05 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel, support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.

2.06 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 degrees F.

2.07 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: Minus 20 to plus 175°F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

- C. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.08 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install backdraft dampers at inlets of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of the same depth as liner, and terminate liner with nosing at hat channel.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install flexible connectors to connect ducts to equipment.

- G. Connect flexible ducts to metal ducts with draw bands.
- H. Install duct test holes where required for testing and balancing.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that access doors can perform as intended.
 - 3. Operate fire and smoke dampers to verify the full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 15838
POWER VENTILATORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required for High Volume Low Speed (HVLS) Fans including mounting hardware, motor, gearbox, motor control panel, and appurtenances required to install the HVLS fans in accordance with the manufacturer's recommendations.

1.02 RELATED WORK

- A. Section 13120, Pre-Engineered Metal Building.
- B. Section 13125, Pre-Engineered Fabric Cover Building.

1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: 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. Wiring Diagrams: For power, signal, and control wiring.
- D. Operation and maintenance data.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS (NOT USED)

1.06 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. AMCA Compliance: Fans shall have AMCA-certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

1.07 WARRANTIES

- A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds and the requirements listed in this Section.
 - 1. The warranty shall not be voided for the environmental conditions including high winds, presence of moisture, and presence of ammonia.
 - 2. The manufacturer shall warranty the HVLS and components against defects in materials and workmanship pursuant to the following schedule:
 - a. Airfoils: Lifetime (Parts)
 - b. Hub: Lifetime (Parts)
 - c. Mounting System: Lifetime (Parts)
 - d. Motor: 12 years (Parts)
 - e. Gearbox and Controller Components: 12 years (Parts)
 - f. Labor: 1 year

PART 2 PRODUCTS

2.01 HVLS FANS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Macro-Air
 - 2. Rite Hite
- B. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- C. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch.

D. Fan Drive:

1. Statically and dynamically balanced.
2. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
3. Extend grease fitting to accessible location.
4. Service Factor Based on Fan Motor Size: 1.15.
5. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
6. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

F. Capacities and Characteristics:

1. Airflow at maximum fan speed: 96,000 cfm (min).
2. Fan Diameter: 12 feet.
3. Fan rpm: 121.
4. Motor Size: 1.0 hp.
5. Minimum number of blades: 6.
6. Preferred number of blades: 6.
7. Electrical Characteristics:
 - a. Volts: 208/240.
 - b. Phase: Single.
 - c. Hertz: 60.
 - d. Maximum Amp: 11.6 @ 240 V.

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, and enclosure type for motors specified below:
 - 1. Motor Sizes: Minimum size as indicated on drawing.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 16401.
 - 3. NEMA Type 4X enclosure
 - 4. Temperature Rating: 14°F to 104°F ambient continuous
 - 5. Thermal protection to 300°F
- B. Enclosure Type: Totally enclosed, fan cooled.

2.03 FAN CONTROLLER

- A. Fan controller shall be Underwriters Laboratory (UL) approved. Enclosed Industrial Control Panels and built pursuant to construction guidelines set forth by UL article 508A and the National Electrical Code.
- B. Fan controller shall have on/off switch, variable speed control with soft-start, and safety disconnect.
- C. Fan control shall be housed in a NEMA 4X enclosure. Each fan controller will include a factory programmed Variable Frequency Drive (VFD) to provide a soft-start for the fan as well as infinite speed control capability for the fan(s). The VFD will be sized per the motors maximum current requirements under locked rotor torque demands. When more than one fan motor is controlled by a VFD, the size of the VFD will be based on the maximum current requirements of the total peak currents of all motor loads under the worst operating conditions.
- D. Provide one fan controller for each fan. The controller shall be factory programmed to minimize the starting torque of the fan to approximately 15 foot pounds. This will extend the operating life of the fan by minimizing the stress on all components. Additionally, the controller will allow the speed of the fan to be altered easily to optimize the fan's use in any conditions.

2.04 MOUNT

- A. The fan mount shall be designed for quick and secure mounting of the fan from a structure's support beams. The mounting system shall not penetrate the structures's support beams. The mounting system of the fan shall allow easy removal and relocation, if required. The fan mount shall be lightweight and constructed of ¼-inch (0.7 cm) powder coated steel.
- B. Mounting shall stabilize fan. Other support such as guy wires may be necessary to limit fan base movement.
- C. Mounting shall meet windload requirements of the structure which the fan is attached to.

2.05 SAFETY WIRE ROPE

- A. The safety wire rope shall consist of a 7 x 19 class stranded galvanized steel of ¼-inch (0.7 cm) diameter with four clamps to secure the motor frame to the structural member from which the fan is attached. The safety wire rope shall have a breaking strength of not less than 7,000 pounds.

2.06 SOURCE QUALITY CONTROL

- A. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Support suspended units from structure using fan manufacturer brackets. Coordinate with metal building manufacturer.

3.02 CONNECTIONS

- A. Ground equipment according to Division 16.
- B. Connect wiring according to Division 16.

3.03 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. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
5. Verify lubrication for bearings and other moving parts.
6. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 15855
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes:
1. Louver face diffusers.
 2. Fixed face registers and grilles.

1.02 RELATED WORK

- A. Section 15820, Duct Accessories, for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data, including throw and drop, static-pressure drop, and noise ratings.
 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 70—Method of Testing for Rating the Performance of Air Outlets and Inlets.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 WARRANTIES

A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

1.09 QUALIFICATIONS (NOT USED)

1.10 TESTING REQUIREMENTS (NOT USED)

1.11 MAINTENANCE (NOT USED)

1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS (NOT USED)

PART 2 PRODUCTS

2.01 CEILING DIFFUSERS

A. Louver Face Diffuser:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:

- a. Anemostat Products; a Mestek company.
- b. Carnes.
- c. METALAIRE, Inc.
- d. Nailor Industries Inc.
- e. Price Industries.
- f. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, white.
5. Face Size: 24 inches x 24 inches.
6. Mounting: Lay-in.
7. Pattern: One, two, and four-way.
8. Dampers: Oposed blade.
9. Accessories:
 - a. Square to round neck adaptor.

2.02 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
2. Material: Aluminum
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Fixed grid spaced less than 1-inch apart.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches side.
7. Mounting: Damper Type: Adjustable opposed blade.
8. Duct Inlet: Rectangular.

2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 15950
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes testing, adjusting, and balancing (TAB) to produce design objective for the following:
 - 1. Air systems.
 - 2. Verifying that automatic control devices are functioning properly.
 - 3. Reporting results of activities and procedures specified in this Section.
- B. The TAB contractor shall be under direct contract under the Owner. The Division 15 Contractor shall assist the TAB contractor by replacing pulleys, starter heaters, adjust settings, etc. as requested by the TAB contractor.

1.02 RELATED WORK (NOT USED)

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Certified TAB Reports: Submit six copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS (NOT USED)

1.06 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
 - 1. Acceptable Firms:
 - a. Test & Balance of Orlando
 - b. Southern Independent Testing Agency, Inc.
 - c. Test & Balance of Tampa.
 - d. Phoenix Agency

- e. Environmental Systems TAB.
 - f. Siemens Building Technologies, Inc.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
- 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." Or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

1.07 WARRANTIES (NOT USED)

1.08 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.09 QUALIFICATIONS (NOT USED)

1.10 TESTING REQUIREMENTS (NOT USED)

1.11 MAINTENANCE (NOT USED)

1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS (NOT USED)

1.13 DEFINITIONS (NOT USED)

1.14 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

- K. Examine strainers for clean screens and proper perforations.
- L. Examine control valves for proper installation for their intended function of diverting fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.

4. Balance dampers are open.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of system's "Record" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.

- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.05 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.06 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.07 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Steam Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.08 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.

- d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.

3.09 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

DIVISION 16
ELECTRICAL

SECTION 16080
ELECTRICAL TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification covers the requirements for testing the electrical equipment for the facility known as Lee/Hendry County Regional Solid Waste Disposal Facility Composting Facility.
- B. Personnel Definitions
 - 1. Owner: Lee County, Florida
 - 2. Engineer: Jones Edmunds & Associates, Inc.

1.02 RELATED WORK (NOT USED)

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. Field engineer's qualifications in accordance with Paragraph 3.01C.
- B. The DC Meggar field voltage test results recorded on data sheets in accordance with Paragraph 3.04E.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCE STANDARDS

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

- A. American Society for Testing and Materials (ASTM)

ASTM D1816—Standard Test Method for Dielectric Breakdown Voltage
of Insulating Oils of Petroleum Origin Using VDE Electrodes

B. Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE C37.20.1—Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

C. National Electrical Testing Association (NETA)

D. Motor and Equipment Manufacturers Association (MEMA)

E. National Electrical Manufacturers Association (NEMA)

F. National Fire Protection Association (NFPA)

G. Underwriters Laboratories (UL)

1.06 QUALITY ASSURANCE (NOT USED)

1.07 WARRANTIES

A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall adhere to the requirements specified in Section 01650, Delivery, Storage, and Handling, for storing and protecting the items specified in this Section.

1.09 QUALIFICATIONS (NOT USED)

1.10 MAINTENANCE (NOT USED)

1.11 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01830, Operations and Maintenance Manuals and Training.

1.12 CODES, INSPECTIONS, AND FEES (NOT USED)

1.13 PROJECT REQUIREMENTS (NOT USED)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The following standard tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of the standards.
- B. Field testing shall be extensive shall be completed as specified to provide positive assurance of correct installation and operation of equipment.
- C. The Contractor shall provide a qualified field engineer to perform all tests. A documented résumé of the field engineer's experience must be submitted to the Engineer before any testing will be allowed. The tests that will be performed are as follows:
 - 1. Test all wire, cable, electrical equipment and systems installed or connected by this contract to ensure proper installation, adjustment, setting, connection, and functioning in accordance with the manufacturer's recommendations.
- D. The Contractor must notify the Engineer before any testing begins, except for the megger test, so that the Engineer may witness these tests if desired. The Contractor will maintain a written record of all tests, showing dates, personnel making test, equipment of material tested, test performed, and results.
- E. The field engineer will conduct all tests recommended by the equipment manufacturer whether specified or not, unless specifically waived.
- F. The following equipment is to be tested.
 - 1. 240V motors.
 - 2. 600V and below cable.
 - 3. 120/240 volt lighting panels
 - 4. VFDs and ventilation fans

3.02 TEST FOR 460V AND LOWER VOLTAGE MOTORS

- A. Time-resistance tests on equipment rated at 480 volts shall be made at 1,000 volts DC, and step voltage tests in this class shall be made using 500 and 1,000 volts DC.
- B. Time-resistance tests on equipment rated less than 480 volts shall be made at 500 volts DC unless this voltage would exceed the manufacturer's stated limits

for such equipment. Step-voltage tests shall not be used for equipment in this class.

- C. Final tests for insulation resistance acceptance shall be based on the "time-resistance" method (absorption effect) unless otherwise specified. When the results of time-resistance tests are questionable, the circuit shall be further tested by the step-voltage method when appropriate.
- D. The test period for final acceptance tests using the time-resistance method shall be not less than 60 seconds, but the test shall continue as long as the insulation resistance continues to increase. In the case of heavy circuits (circuits rated 500 amperes or more) or large equipment (motors 500 HP and larger, 5KV), the test may require as long as 10 minutes or more. Resistance values shall be recorded at 30 seconds, 60 seconds, 5 minutes, 10 minutes, and the conclusion of the test. When the insulation resistance value remains essentially constant (not decreasing) for 30 seconds, the test shall be terminated. The test shall also be terminated if the insulation resistance starts to decrease. Hi-Pot testing shall not be done without approval or direction of the Engineer because of the possibility of damaging the cables or equipment.
- E. The test period for step-voltage tests shall be 60 seconds at the lower voltage followed immediately by 60 seconds at the higher voltage. The value of insulation resistance shall be recorded at the end of each 60 seconds.

Motor Voltage	Minimum Megohms
240V	10
115V	3

- F. Make an initial uncoupled test of the motor. The motor shaft rotation shall be noted and verified that it is turning in the proper direction. The motor bearing temperatures shall be monitored. NETA, NEMA, and IEEE testing standards shall be followed.
- G. Make coupled start-up tests. The starting time shall be measured and verified that it is less than the manufacturer's rated stall time. When the motor reaches full speed, verify that there is not excessive vibration or noise. The bearing temperatures shall be monitored to verify proper cooling. In addition, the Contractor shall verify that the cooling and lubrication systems are operating properly.

3.03 TEST EVALUATION

- A. All insulation resistance test results will be reviewed by the Engineer and if any test value is not acceptable, the circuits involved shall be re-tested, repaired, or otherwise corrected to the Engineer's satisfaction at the Contractor's expense.
- B. Copies of all approved tests shall be furnished to the Engineer and Owner for permanent record. Reports shall include the date of the test plus the wet bulb and dry bulb temperatures at the time of testing, insulation-resistance value at the time intervals outlined above, Dielectric Absorption Ratio and Polarization Index values, and final description of each circuit tested.
- C. All time-resistance tests requiring 10 minutes or longer shall be evaluated on the basis of "Polarization Index" (the ratio of the insulation resistance at 10 minutes to the value of 1 minute). A ratio of 3.0 or greater is acceptable without further testing.
- D. All time-resistance tests requiring less than 10 minutes shall be evaluated on the basis of "Dielectric Absorption Ratio." (The ratio of the insulation resistance at 60 seconds to the value at 30 seconds). A ratio of 1.4 or greater shall be acceptable without further testing if the insulation resistance has held essentially constant (not decreasing) for at least 30 seconds after the value at 1 minute is obtained.
- E. In some instances involving small equipment and wiring, the insulation resistance may rise to a constant high value in a short period and Dielectric Absorption Ratio of 1.4 cannot be obtained. In such cases, a ratio less than 1.4 shall be acceptable if the insulation resistance has reached a constant high value (not decreasing) of at least 30 seconds after the value at 1 minute has been obtained.
- F. In no case shall a value of insulation resistance that is decreasing or exhibits any tendency to decrease at the end of a test period be acceptable. In such cases, the weakness or defect shall be located, repaired, and the circuit retested.

3.04 600 VOLT AND BELOW CABLE CHECKS AND TESTS

- A. Visually inspect all cable, preferably when received but before installation. This inspection shall include investigating for concealed damage to the cable on the reels that are damaged or broken and in boxes that have been punctured by sharp objects or severely crushed and dented from improper handling. Any cable showing signs of damage shall not be installed. When installing cable, be alert for concealed damage or defective insulation and reject any cables that exhibit any abnormalities.

- B. After installation but before termination, megger all wire and cable phase-to-phase and phase-to-ground with a 1,000-volt megger for possible damage to the insulation during installation. Insulation resistance during this test shall be at least on megohms. The results of such tests need not be recorded since the completed installation including splices and terminations shall be subjected to final insulation resistance tests and any weakness or defects in the installation shall be corrected.
- C. Insulation-resistance tests for final acceptance shall be made with all equipment connected and terminated but with circuit-protective devices open and all lamps removed from their sockets. (Lamps shall be replaced after test is complete).
- D. Phase-to-ground tests are required for each phase. Phase-to-phase tests are also required except that they shall be omitted on motor circuits, transformer circuits, other similar circuits, and equipment where the phases cannot be readily isolated. On grounded neutral circuits, only the neutral shall be disconnected during the tests and shall be reconnected after the tests are completed.
- E. The wet bulb and dry bulb temperatures at the time of testing shall be included with the test reports.
- F. All insulation-resistance tests shall be made using a calibrated (within the past 12 months by a certified NETA-approved instrumentation testing lab) motor-driven, constant potential, DC Megger unless otherwise approved by the Engineer.
- G. Tests on very small or special equipment that cannot be tested at the voltage stated above shall be made using a 3-volt ohm meter with a high range (Simpson Model 260 or equal approved by the Engineer). Acceptance tests for equipment in this class shall be based on the manufacturer's recommendations, wiring diagrams, and schematics.
- H. Minimum megger readings at ambient temperature shall be 45 megohms for 480-volt conductors.
- I. A 1,000-volt DC motor-driven megger shall be used on all 480-volt service conductors.

3.05 120/208 VOLT CABLE TEST

- A. Lighting circuits and other 120/240 volt services shall be tested during construction for continuity and identification and shall pass operational tests to confirm that the circuits perform all functions for which they are designed.

3.06 GROUND RESISTANCE TESTING

- A. If the existing ground rods for the service ground systems require replacing, the replacement driven ground rods or similar ground connections required to protect personnel and electrical equipment shall be tested when installed and periodical thereafter. The maximum acceptable resistance for plant and facilities grounding systems shall be 20 ohms or less. A three-point ground tester shall be used. This type of tester shows resistance directly without making calculations. Tests shall be made no less than 24 hours after rainfall.

END OF SECTION

SECTION 16401
LOW-VOLTAGE ELECTRICAL WORK—GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary for a complete corrosion-resistant and operable electrical installation, including all fees, charges, and permits necessary. Work of this Section includes electrical installation requirements for equipment of other sections. This Section is general and may include specifications for materials and equipment not contained within the scope of this project.
- B. The Contractor shall provide temporary and permanent electrical services of proper voltage and phase as required for the Project. All single-phase temporary receptacle outlets shall be provided with ground fault protection in accordance with NEC Article 590.6 and installed in accordance with NEC 406.8.
- C. The Contractor shall coordinate the work of this Section with others involved in the construction of the project.
- D. The Contractor shall demolish equipment as indicated on the Plans. All electrical equipment removed from service shall be carefully removed to avoid damage and returned to the Owner in good condition. The Contractor shall document the transfer of all equipment to the Owner in the form of a returned equipment spreadsheet which, at a minimum, describes the equipment, the model number, the serial number, the condition of the equipment when it was removed from service, the date of equipment transfer, and a signature indicating the Owner's receipt of the equipment.

1.02 RELATED WORK

- A. The provisions of all other technical sections of the Specifications are fully applicable to this Section as if incorporated in this Section.
- B. Parts A through G and Division 1 of these Specifications are a part of this Section as if incorporated in this Section.

1.03 SUBMITTALS

The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:

- A. The Contractor shall submit a complete list of materials and equipment to be incorporated in the work to the Owner for review within 30 days after the Award of Contract.
- B. The list shall include catalog numbers, cut sheets, diagrams, and other descriptive data required to demonstrate conformance with the Specifications. Partial lists will not be acceptable.
- C. The basis of acceptance shall be the manufacturer's published ratings for the equipment. The manufacturer shall be regularly engaged in the manufacture of products specified.
- D. Shop drawings shall be submitted for the following items of equipment:
 - 1. Wiring Devices.
 - 2. Panelboards.
 - 3. Safety Switches.
 - 4. Circuit Breakers.
 - 5. Motors.
 - 6. Motor Starters.
 - 7. Outdoor Electrical Equipment Housing.
 - 8. Control Devices.
 - 9. Lighting Fixtures.
 - 10. Concrete Posts/Poles.
 - 11. Transient Voltage Surge Suppressors.
 - 12. Arc Flash Study
 - 13. Lightning protection systems for maintenance building.
 - 14. Concrete Handholes and Pull Boxes.
- E. Contents of the shop drawings shall include the following:
 - 1. Details of construction, outline and assembly drawings.
 - 2. Dimensions.
 - 3. Materials.
 - 4. Finish.
 - 5. Ratings.
 - 6. Accessories.
 - 7. Trim.
 - 8. Engineering data.

9. Test Equipment datasheets and proposed test procedures for testing the grounding system.
- F. The Contractor shall submit the manufacturer's literature for the equipment listed in Paragraph 1.03D above to the Owner for review, including the following:
1. Written description of equipment function, normal operating characteristics and limiting conditions.
 2. Recommended assembly, installation, alignment, adjustment, and calibration instructions.
 3. Operating instructions.
 4. Guide to troubleshooting.
 5. Maintenance instructions and timetables.
 6. Parts List and an assembly drawing with the parts identified.
- G. Transient voltage surge suppressor submittals shall include the following:
1. UL 1449 peak let-through voltage documentation.
 2. Category C3 peak let-through voltage test results.

1.04 WORK SEQUENCE (NOT USED)

1.05 REFERENCES

Reference standards and recommended practices referred to in this Specification Section shall be the latest revision of any such document in effect at the bid time. The following documents are a part of this Section. Where this Section differs from these documents, the requirements of this Section shall apply.

A. American National Standards Institute (ANSI)

1. ANSI C2—National Electrical Safety Code (NESC).
2. ANSI C12.20—Electricity Meters 0.2 and 0.5 Accuracy Class.
3. ANSI C62.41—Guide on Surge Voltages in AC Power Circuits Rated up to 600V.
4. ANSI C62.45—Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
5. ANSI C80.1—Electrical Rigid Steel Conduit (ERSC).

6. ANSI C82.9—High-Intensity Discharge and Low-Pressure Sodium Lamps, Ballasts, and Transformers - Definitions.

B. American Society for Testing and Materials (ASTM)

1. ASTM A36—Standard Specification for Carbon Structural Steel.
2. ASTM A48—Standard Specification for Gray Iron Castings.
3. ASTM A153—Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
4. ASTM B8—Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. Anti-Friction Bearing Manufacturers Association (AFBMA)

1. AFBMA Std 20—Radial Bearings of Ball, Cylindrical Roller, and Spherical Roller Types, Metric Design.

D. Federal Specifications and Standards (FSS)

1. FSS A-A-50552—Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible.
2. FSS A-A-50553A—Fittings for Conduit, Metal (Thick-Wall (Rigid) and Thin-Wall (EMT) Type).
3. FSS A-A-50563A—Conduit Outlet Boxes, Bodies and Entrance Caps, Electrical: Cast Metal.
4. FSS A-A-55809A—Insulation Tape, Electrical, 600V, Polyvinyl Chloride, Pressure-Sensitive Adhesive.
5. FSS A-A-55810—Conduit, Metal, Flexible.
6. FSS A-A-59213—Splice Connectors.
7. FSS A-A-59544—Cable and Wire, Electrical (Power, Fixed Installation).
8. FSS W-C-375C—Circuit Breakers, Molded Case: Branch Circuit and Service.
9. FSS W-C-375D—Circuit Breakers, Molded Case; Branch Circuit and Service.
10. FSS W-C-596G(2)—Connector, Electrical Power (General Specification).
11. FSS W-P-115C—Panel, Power Distribution.
12. FSS W-S-896F(1)—Switches, Toggle (Toggle and Lock), Flush-Mounted (General Specification).

E. National Electrical Manufacturers Association (NEMA)

1. NEMA ICS 1—Industrial Control and Systems: General Requirements.
2. NEMA ICS 6—Industrial Controls and Systems: Enclosures.
3. NEMA MG 1—Motors and Generators.

4. NEMA PB 1—Panelboards.
5. NEMA ST 20—Dry-Type Transformers for General Applications.
6. NEMA TC 2—Electric Polyvinyl Chloride (PVC) Conduit.
7. NEMA TC 3—Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
8. NEMA WD 1—General Color Requirements for Wiring Devices.

F. National Fire Protection Association (NFPA)

1. NFPA 70—National Electrical Code (NEC).
2. NFPA 101—Life Safety Code.

G. Underwriters Laboratories, Inc. (UL)

1. UL 6—Electrical Rigid Metal Conduit – Steel.
2. UL 50—Enclosures for Electrical Equipment.
3. UL 67—Panelboards.
4. UL 83—Thermoplastic-Insulated Wires and Cables.
5. UL 360—Liquid-Tight Flexible Steel Conduit.
6. UL 467—Grounding and Bonding Equipment.
7. UL 489—Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
8. UL 498—Attachment Plugs and Receptacles.
9. UL 508—Industrial Control Equipment.
10. UL 510—Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
11. UL 514A—Metallic Outlet Boxes.
12. UL 514B—Conduit, Tubing, and Cable Fittings.
13. UL 514C—Nonmetallic Outlet Boxes, Flush-Devices Boxes, and Covers.
14. UL 651—Schedule 40 and 80 Rigid PVC Conduit and Fittings.
15. UL 797—Electrical Metallic Tubing - Steel.
16. UL 1029—High-Intensity-Discharge Lamp Ballasts.
17. UL 1449—Surge Protective Devices.
18. UL 1660—Liquid-Tight Flexible Nonmetallic Conduit.

H. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 112—Standard Test Procedure for Polyphase Induction Motors and Generators.
2. IEEE 117—Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery.
3. IEEE 519—Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 WARRANTIES

- A. Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01780, Warranties and Bonds.
- B. All equipment and materials supplied shall be warranted against defective design, materials, and workmanship for a minimum of 1 year, or as specified in this Section, against normal use. The warranty period shall begin once the total project is accepted by the Owner and shall cover replacement of equipment and/or repair, including labor, travel time, and miscellaneous expenses at no cost to the Owner for the full warranty period.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall adhere to the requirements specified in Section 01650 for storage and protection of the items specified in this Section.
- B. The Contractor shall deliver materials with manufacturer's tags and labels and UL labels intact. Packaged material shall be delivered in the manufacturer's original, unopened containers bearing the manufacturer's name, brand, and UL label. Materials and equipment shall be stored in a dry, clean location. Handle and store so as to avoid damage. Items delivered in broken, damaged, rusted, or unlabeled condition shall be removed from the project site immediately and replaced with acceptable items. The Contractor shall provide suitable protection of materials and equipment from dust and moisture. The Contractor shall be responsible for the condition of materials and equipment until they are accepted by the Owner.

1.09 QUALIFICATIONS (NOT USED)

1.10 TESTING REQUIREMENTS (NOT USED)

1.11 MAINTENANCE (NOT USED)

1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. Operations and Maintenance Manuals shall be in accordance with General Conditions, Supplementary Conditions, and Specification Section 01830, Operations and Maintenance Manuals.
- B. Before final acceptance of this project, an operation and maintenance manual shall be submitted to the Owner. The manual shall include manufacturer's literature as outlined in Paragraph 1.03F above, drawings corrected in accordance

with shop drawing review comments and including all modifications, and lists of suppliers and/or service shops that can provide parts and accessories and equipment repair for the items of equipment listed in Paragraph 1.03D above. The lists shall include a contact name, telephone number, and address.

- C. A test report detailing the results of the grounding system test shall be provided with the O&M Manual.

1.13 CODES, INSPECTIONS, AND FEES

- A. The Contractor shall obtain all necessary permits and inspections required for the work of this Section and pay all charges incidental to this work. The Contractor shall deliver to the Owner all certificates of inspection issued by authorities having jurisdiction.

1.14 PROJECT REQUIREMENTS (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All material and equipment shall be new and listed or labeled for use within the United States by a Nationally Recognized Testing Laboratory (NRTL). Equipment shall be provided with a specific listing, such as UL, when indicated in this Section or in other portions of the Contract Documents. Only products by manufacturers regularly engaged in the production of specified units will be acceptable.
- B. Where two or more units which perform the same function or are of the same class of equipment or materials are required, provide all units from a single manufacturer.
- C. Provide materials and equipment of suitable composition to perform satisfactorily when exposed to corrosive conditions of the project site.
 - 1. Provide breather and drain fittings in all raceways and enclosures where necessary to prevent condensation or trapping of moisture.
 - 2. Provide heaters in all control panels to prevent condensation.

2.02 CONDUIT

- A. Rigid Metal Conduit: Rigid metal conduit shall be zinc-coated steel and shall conform to UL 6. Fittings shall be cast or malleable iron, zinc-coated, and shall conform to FSS A-A-50563A and UL 514B.
 - 1. PVC-coated rigid steel conduit, elbows, and fittings shall be coated with a bonded polyvinylchloride which is permanently fused on at the factory.
 - a. Aboveground conduit system PVC coating shall have a minimum thickness of 80 mils. Couplings and condulets shall have overlapping pressure sealing sleeves.
 - b. Below-ground conduit system PVC coating shall have a minimum thickness of 80 mils.
 - c. Below-ground conduit system PVC coating for extreme corrosive conditions shall have a minimum thickness of 80 mils and shall have external and internal bonded coatings.
- B. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be polyvinyl chloride compound and shall conform to NEMA TC-2 and UL 651. Conduit shall be sunlight resistant, rated for use with 90 °C conductors. Fittings shall be of the same polyvinyl chloride compound and from the same manufacture as the conduit and shall conform to NEMA TC-3 and UL 514B. Conduit and fittings shall be joined by a solvent cement. The type of cement and the procedure for application shall be as recommended by the conduit manufacturer. The conduit shall be CarlonPlus 80, or equal. PVC Conduits shall be used within the Composting structures and shall be properly fastened with two-hole PVC conduit straps.
- C. Flexible Metal Conduit: Flexible metal conduit shall be zinc-coated steel and shall conform to FSS A-A-55810. Fittings shall conform to FSS A-A-50552.
- D. Liquidtight Flexible Metal Conduit: Liquidtight flexible metal conduit shall be made with galvanized steel flexible conduit covered with an extruded PVC jacket. Fittings shall be compression type specifically designed for use with flexible conduit and shall form watertight connections. Box connectors shall have an "O" ring between the fitting body and the enclosure.
- E. Liquidtight Flexible Nonmetallic Conduit: Liquidtight flexible nonmetallic conduit shall be an assembly of a hard PVC spiral completely surrounded by flexible PVC. Conduit shall conform to UL 1660 for use as indicated in Article 351 of the NEC and shall be sunlight resistant.

1. Fittings shall be compression type designed for use with the flexible conduit. Box connectors shall have "O" ring between the fitting body and the enclosure.
2. Conduit shall be "Carflex" manufactured by Carlon, or equal.

2.03 BOXES

- A. General: Boxes shall be sized as recommended by the NEC or as shown on the Drawings.
 1. Boxes shall be nonmetallic or code-gauge galvanized steel, stainless steel, or cast metal, as specified or shown on the Drawings.
 2. Cast metal boxes shall be cast iron and shall be gasketed of the type indicated on the Drawings.
- B. Outlet Boxes: Outlet boxes shall be sheet steel, cast metal, or nonmetallic.
 1. Sheet steel boxes shall be cadmium-coated or zinc-coated.
 2. Cast metal boxes shall conform to FSS A-A-50563A.
 3. Non-metallic boxes shall conform to UL 514C.
 4. Fixture outlet boxes and junction boxes shall be 4-inch, octagonal.
 5. Switch and receptacle outlet boxes shall be 2 inches wide by 4 inches high by 2 inches deep.
 6. Junction box extensions and covers shall conform to UL 514A.
 7. Boxes installed in wet locations or on exterior surfaces shall be gasketed.

2.04 WIRING DEVICES

- A. Toggle Switches: Toggle switches shall be specification grade and shall conform to FSS W-S-896F(1) and shall be totally enclosed with bodies of molded compound and a mounting strap.
 1. Handles shall be brown.
 2. Wiring terminals shall be screw type, back- or side-wired.

3. Switches shall be rated, quiet type, 20 amperes, 277 volts.
 4. Switches shall be suitable for control of tungsten filament lamp loads with "T" marking of UL.
 5. No more than one switch is allowed in a single gang position of a switch box.
- B. Receptacles: Receptacles shall be specification grade and shall conform to FSS W-C-596G(2), NEMA WD-1 and UL 498.
1. Single and duplex receptacles for general purpose use shall be heavy-duty specification grade, 20 amperes, 125 volts, three-wire grounding, NEMA configuration 5-20R.
 2. Special purpose single receptacles shall be heavy-duty specification grade, 20 amperes, 250 volts, three-wire grounding, NEMA configuration 6-20R, unless indicated otherwise on the Drawings.
 3. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, three-wire grounding, NEMA configuration 5-20R.
 - a. Receptacles shall have a nominal sensitivity to ground leakage current of 4 to 6 milliamps and shall interrupt the current supply for any value of ground leakage current exceeding the trip level of 4 to 6 milliamps on the load side of the receptacle with a maximum tripping time of 1/30th of a second.
 - b. Receptacles shall provide protection for any device connected to the circuit beyond the receptacle.
 - c. Receptacles shall have test and reset buttons accessible on the face of the receptacle.
 4. Receptacles shall be suitable for mounting in a standard outlet box and shall have a high-impact nylon face.
 5. Wiring terminals shall be screw type, back- or side-wired.
 6. Receptacles shall be Leviton, Hubbell, or approved equal. All 120 volt receptacles within composting and maintenance buildings shall be GFCI as shown on the drawings.

7. Welding receptacles in the maintenance building areas shall be 50 ampere 240 volts, 2 pole, 3 wire (2 hots and ground) NEMA Type 6-50A

2.05 DEVICE PLATES

Cover Plates: Cover plates shall conform to UL 514A.

- A. Furnish one-piece type to suit devices installed, with round or beveled edges.
- B. Weatherproof switch cover plates shall be spring-loaded gasketed type with individual cover for each switch. Receptacle covers shall be weatherproof with or without the attachment plug cap inserted.
- C. Waterproof cover plates shall have screw cap for each outlet. The plug shall have a matching screw attachment to maintain the rating when the plug is attached. The screw cap shall be permanently attached to the cover plate by a chain. A matching plug shall be provided for each cover plate.
- D. Zinc-coated steel or cast-metal plates shall be used on unfinished walls.
- E. Satin-finish stainless steel plates shall be used on finished walls.
- F. The Contractor shall provide metal screws with countersunk heads and finish to match the finish of the plate.

2.06 WIRE AND CABLE

- A. Conductors: All conductors shall be annealed soft drawn copper, conforming to ASTM B8, FSS A-A-59544, UL 83, and the latest requirements of the NEC. All conductors shall have THW or THWN type insulation, rated at 600 volts, unless specifically noted otherwise.
 1. Other types of insulation may be used as permitted by the NEC. The Contractor shall be responsible for change in conduit size and conductor size to maintain the ampacity of the circuit.
 2. Wire #8 AWG and larger shall be stranded concentric lay. Wire sizes #14, #12, and #10 AWG shall be stranded for control and motor power and solid for light and receptacle circuits.
 3. Conductors shall be as manufactured by Senator Wire & Cable Company, Larabee Wire Manufacturing Company, Inc., Southwire Company, or equal.

4. Conductors installed between Adjustable Speed Drives (ASD) and motors shall be shielded ASD cables for conductor sizes AWG 4/0 and below. ASD cables shall be rated for up to 1000V and have cross-linked polyethylene (XLPE) Type XHHW-2 insulation on current-carrying conductors. ASD cables with current-carrying conductors of size No 2 and smaller shall have an insulated grounding conductor. Larger cables may have insulated or bare grounding conductors. ASD cables shall have a braided or tape shield. The outer jacket shall be black sunlight and oil-resistant PVC. ASD cables shall be rated for 90°C in wet or dry locations and shall be suitable for direct burial. ASD cables shall be designed specifically for use in ASD applications. The Contractor shall install the ASD cables in accordance with the cable manufacturer's and the ASD manufacturer's recommendations. ASD cables shall be manufactured by Belden, or approved equal.

B. Conductor splices shall conform to FSS A-A-59213. Acceptable: Scotchcast Splicing Kit, 3M Company. Plastic tape shall conform to FSS A-A-55809A.

2.07 PANELBOARDS

A. Panelboards shall be Type 1, Class 1 circuit-breaker type, conforming to FSS W-P-115C, as indicated on the panelboard schedules and where shown on the Drawings. Panelboards shall be of a dead-front safety type, equipped with thermal-magnetic molded case, bolted-in circuit breakers. Bus structure and main lugs or the main breaker shall have current and voltage ratings as shown on the panelboard schedules. Such ratings shall be established by heat rise tests, with the maximum hot spot on any bus bar or connections not to exceed a 50°C rise above ambient. All current-carrying parts of the bus assembly shall be tin plated copper.

B. The panelboard bus assembly shall be enclosed in a steel cabinet for surface mounting or mounting within a motor control center. The size of the wiring gutters and gauge of steel shall be in accordance with NEMA PB1 and UL 67 for electric panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel. Fronts shall include doors and shall have flush, brushed stainless steel, cylinder tumbler-type locks with catches and spring-loaded door pulls. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim clamps. Doors shall be mounted by concealed steel hinges. Fronts shall not be removable with the door in the locked position. Complete panelboard enclosure shall be of Code gauge, full-finished steel with rust-inhibiting primer and baked enamel finish.

- C. A directory card shall provide a space for each circuit and shall designate the type of load (lights, receptacle, or equipment name). Entries on the directory card shall be typewritten.
- D. Circuit breakers shall be arranged and numbered as shown on the panelboard schedule. Circuit numbering shall be such that, starting at the top, odd numbers shall be used in sequence down the left-hand side and even numbers shall be used in sequence down the right-hand side. Multi-pole circuit breakers shall have only one circuit number. Connect adjacent breaker poles to Line 1 and Line 2, respectively, and maintain the same relationship of sequence.
- E. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for the type of conductor specified. Terminals for branch circuit wiring, breaker, neutral, and ground shall be UL listed as suitable for the type of conductor specified.
- F. All panelboards shall be equipped with a copper neutral bus bar and separate equipment copper grounding bar. All lugs shall be tin plated copper, AL/CU rated lugs are not acceptable.
- G. Panelboard circuit breakers shall comply with FSS W-C-375C.
 - 1. All molded-case circuit breakers shall be quick-make, quick-break, thermal-magnetic with trip indication and have common trip on all multi-pole breakers. Trip indication shall be clearly shown by the breaker handle taking a position between ON and OFF when the breaker is tripped.
 - 2. All breakers shall be calibrated for operation in an ambient temperature of 40°C.
 - 3. The circuit breakers shall be labeled or imprinted on the case with frame size, trip size, voltage rating, UL approval, and shall be sealed at the factory.
- H. The panelboards shall have a single integrated equipment fault current interrupting the rating as shown on the panelboard schedules. The rating shall be indicated on the equipment nameplate.
- I. The panelboard assembly shall be designed such that any individual breaker can be removed without disturbing an adjacent unit, loosening or removing supplemental insulation supplied as a means of obtaining clearances, or affecting other requirements of UL.

- J. Panelboards shall be listed by Underwriters Laboratories and bear the UL label and shall be rated for service entrance use where required. Panelboards shall be as manufactured by Square D or approved equal.

2.08 SAFETY SWITCHES

- A. Safety switches shall be NEMA heavy-duty type and UL listed. Switches shall be rated as indicated on the Drawings.
 - 1. All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall have permanently attached arc suppressors, hinged or otherwise attached to permit easy access to line-side lugs without removal of the arc suppressor. Lugs shall be UL listed tinned copper and front removable. All current-carrying parts shall be plated by electrolytic processes.
 - 2. Switches shall have a quick-make and quick-break operating handle and mechanism which shall be an integral part of the box, not the cover. Padlocking provisions shall be provided for padlocking in the OFF position only, with at least three padlocks. Switches shall have a dual-cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open.
- B. Enclosures: Switches installed indoors shall be furnished in NEMA 12 general-purpose enclosure, unless otherwise specified. Switches located outdoors shall be furnished in NEMA 4X stainless steel enclosures as indicated on the Drawings.
 - 1. Covers on NEMA 12 enclosures shall be attached with butt-type pin hinges.
 - 2. NEMA 4X switches shall be furnished in stainless steel enclosures without knockouts. The means of sealing the cover shall be positive, with 30-through 200-ampere switches having quick release latches with pin type hinges and gaskets. Enclosures shall be of Code-gauge stainless steel.
- C. The switch jaws shall be multi-spring type for positive grip of the switch blades. The fuse clips shall be spring-reinforced, positive-pressure type, or electrolytic copper.
- D. Switches shall be as manufactured by Square D or approved equal. All switches shall be by the same manufacturer.

2.09 CIRCUIT BREAKERS

- A. The Contractor shall provide molded-case thermal magnetic circuit breakers of the type, size, and electrical characteristics specified or indicated on the Drawings. Circuit breakers used as service entrance disconnects shall be suitable and rated as service entrance equipment.
- B. Circuit breakers shall be of single-unit construction, and multi-pole circuit breakers shall have trip elements in each pole with common trip bar. Frame size 225 amperes or larger shall have adjustable magnetic instantaneous trip and shall have interchangeable thermal magnetic trip units.
- C. Shunt trip shall be installed in circuit breakers where required by the Drawings or Specifications.
- D. Circuit breaker interrupting ratings shall be equal to the available short circuit current at the point of installation with the minimum ratings as follows:

<u>Frame Size</u>	<u>240 V</u>
100 A	18,000
225 A	25,000
400 A	42,000
800 A	42,000
1200 A	42,000

- E. Provide NEMA Type 12 enclosures for general duty indoor use (in maintenance building). Enclosures shall be NEMA 4X stainless steel for exterior locations including applications in composting buildings unless indicated otherwise.
- F. Circuit breakers shall be as manufactured by Square D, or approved equal.

2.10 MOTORS

- A. Motors shall be provided with the equipment driven by the motor, unless otherwise indicated or specified, and shall conform to the latest requirements of NEMA, IEEE, ANSI, NEC, and Anti-Friction Bearing Manufacturer's Association (AFBMA) standards, where applicable.
 - 1. Motors shall be of sufficient capacity to operate the driven equipment, under all load and operating conditions, without exceeding 100% of the motor's nameplate horsepower rating, excluding the service factor, and without exceeding the motor's rated temperature limits.

2. Motors shall be furnished with permanent, highly visible stainless steel nameplates. Nameplates shall include all motor ratings, accessories, and special features.
- B. Motors may be single speed or variable speed as required for the application.
1. Motors for variable-speed applications shall be designed for operation at the rated maximum speed and at reduced speed throughout the variable-speed range without overloading. Motors for variable-speed operation shall be inverter duty rated and compatible with the associated variable-speed control equipment and operating conditions, including the effects of harmonic current and voltage distortion. Motors for variable-speed operation shall be equipped with a normally closed automatic reset winding thermostat in addition to all accessory equipment recommended by the variable-speed equipment manufacturer. Thermostat leads shall be brought to the motor connection box.
- C. Motors shall be NEMA Design B, unless otherwise indicated or specified, and shall be suitable for continuous duty operation. Motor currents and torque shall be in accordance with NEMA MG1-12.34 and MG1-12.37.
1. Single-phase general-purpose induction motors shall be split-phase or capacitor start rated 115/230-208 volt, single-phase, 60 Hz. Motors 1-1/2 HP and larger shall be NEMA Design M. Motors smaller than 1-1/2 HP shall be NEMA Design L or N. Motor currents and torque shall be in accordance with NEMA MG1-12.31, MG1-12.32, and MG1-12.33.
- D. Motors shall be provided with Class F non-hygroscopic insulation system using materials and an insulation system evaluated in accordance with IEEE 117 classification tests. Temperature rise shall be limited to a maximum of 80° C, by resistance, at a service factor of 1.0 in an ambient temperature of 40° C. Motors shall have multiple dips and bakes of varnish treatment for additional protection.
- E. Motors larger than 5 HP shall be provided with locked-rotor current not exceeding NEMA Code letter "G."
- F. Motors shall be furnished with a minimum service factor of 1.15.
- G. Motors shall be suitable for full voltage across-the-line-type starting, unless otherwise specified or indicated on the Drawings.
- H. Motors shall be equipped with ball, open, single-row, deep-groove Conrad-type bearings conforming to the AFBMA Standard 20. Drive end bearings may be cylindrical roller type for belted drives.

1. Bearing life shall be 17,500 hours minimum for belted applications and 100,000 hours minimum for flexible direct-coupled applications.
 2. The bearing identification number shall be stamped on the motor nameplate.
 3. The lubrication system shall consist of a capped grease fitting inlet, a relief plug 180 degrees from inlet, and a grease reservoir in bracket and cast inner cap.
 4. Bearings shall be greased by the manufacturer with a premium moisture-resistant polyuria-thickened grease containing rust inhibitors and suitable for operation over a temperature range of -25°C to 120°C.
- I. The motor enclosure, including frame with integrally-cast feet and/or vertical P-base mounting, end brackets, bearing inner caps, fan guards, and conduit box and cover shall be ASTM Type A48, Class 25 cast iron or better.
1. Conduit boxes shall be provided with the number and size of conduit connections, as shown on the Drawings. The conduit box shall allow rotation to accommodate conduit connection Provision for grounding shall be made using a mounted clamp-type lug in the conduit box.
 2. Motors shall be equipped with lifting lugs. Motor enclosures shall be equipped with stainless-steel screens for all openings in accordance with NEMA MG 1 for guarded machines.
 3. Vertical hollow-shaft motors shall be equipped with non-reverse ratchets to prevent backspin.
 4. Motors shall be NEMA MG 1 open drip-proof, weather-protected Type I, totally enclosed fan-cooled, or explosion-proof as specified in other sections of the Specifications or indicated on the Drawings.
- J. Submersible motors shall be explosion-proof and NRTL listed for Class 1, Division 1, Group C & D hazardous locations as defined by the NEC.
1. All electrical components shall be housed in an air-filled or oil-filled cast-iron, watertight enclosure which is sealed by the use of O-rings. Joints shall be rabbeted with extra-large overlaps.
 2. Automatic reset, normally closed, thermal overloads shall be imbedded in the motor winding to provide overheating protection.

3. Moisture-detection probes shall be incorporated to detect moisture in either the seal or stator cavity by measuring resistivity between the probes. Float-type devices or single probe-to-ground moisture detectors are not acceptable.
 4. Submersible motors shall have power and control conductors housed in multi-conductor cables of sufficient length to reach the control panel or junction box as indicated on the Drawings. Cable leads shall allow cable-to-motor connections to be accomplished in the field without soldering. Cable entrance to the motor shall be sealed.
 5. Submersible motors shall be designed to allow either fully submerged or completely dry operation.
- K. Polyphase motors shall be of an energy-efficient design having a minimum efficiency rating as listed in NEMA MG 1-12.55, Table 12-6C.
1. Motor efficiency shall be determined in accordance with NEMA MG 1-12.54.1 and IEEE 112, Method B.
 2. Efficiency rating shall be labeled on the motor nameplate in compliance with NEMA MG 1-12.54.2.
- L. Motors shall be capable of the following starts per hour, unless otherwise specified, without overheating or causing damage to the motor.
1. 60 HP and below, six starts per hour.
 2. Above 60 HP, four starts per hour.
 3. Submersible motors, 10 starts per hour.
- M. Motors 5 HP and above, except submersible motors, shall be provided with a 120-volt single-phase space heater. Leads shall be brought to the motor terminal box.

2.11 MOTOR STARTERS

- A. Manual Motor Starters: Manual motor starters shall be toggle, key, or pushbutton type and shall be equipped with melting alloy overload protection on each pole.
1. Fractional horsepower manual motor starters shall be Square D Class 2510 Type F (or equal) single-unit with handle guard/lock-off feature. The handle shall be toggle type unless otherwise specified or indicated on the Drawings.

2. Integral horsepower manual motor starters shall be Square D Class 2510 Type M or T (or equal) rated 600 VAC/250 VDC, with lock-off feature and auxiliary contact. Auxiliary contact shall be normally open unless otherwise indicated. Control shall be pushbutton or toggle as indicated on the Drawings.
 3. Manual motor starters shall be provided in surface-mounted enclosures unless otherwise indicated.
 - a. Type F units mounted outdoors shall be in NEMA 4 cast-metal enclosures.
 - b. Type M or T units mounted outdoors shall be in NEMA 4 stainless-steel or cast-metal enclosures.
 - c. Manual motor starters in hazardous locations shall be Class 2510 NEMA 7 and 9, by Square D or equal.
- B. Magnetic Motor Starters: Magnetic motor starters shall be rated in accordance with NEMA standards, sizes, and horsepower ratings. Starters shall be sized for the horsepower ratings as indicated on the Drawings or required by the driven equipment. Minimum sizes and type of starter shall be as indicated on the Drawings and shall have the following features:
1. Magnetic starters shall be equipped with double-break silver-alloy contacts. All contacts shall be replaceable without removing power wiring or removing the starter from the panel or enclosure.
 2. Coils shall be of molded construction. All coils shall be replaceable from the front without removing the starter from the panel or enclosure.
 3. Overload relays shall be the melting-alloy type with a replaceable control module. Thermal units shall be of one-piece construction and interchangeable. The starter shall be inoperative if the thermal unit is removed.
 4. A phase-failure relay shall be provided for all motor starters and shall have solid-state sensing circuitry monitoring all three phases. The relay shall have isolated DPDT contacts and shall protect the motor against the loss of one of the three phases: voltage unbalance in excess of 10% rated voltage, phase reversal, and undervoltage. Undervoltage shall be adjustable to 75% of rated voltage. The relay shall be Square D Company Class 8430 or approved equal.

5. All motor starters shall have their own control power transformer for individual starter control voltage, except where installed in control panels in which a common control power transformer may be incorporated. Control voltage shall be 120 VAC. Control power transformers shall be sized to include motor space heater load, starter or contactor coil, timers, relays, and other devices as indicated or specified. Primary inputs and the ungrounded secondary output of the control power transformer shall be fused.
 6. Starters shall be suitable for adding at least four external electrical interlocks of any arrangement, normally open or normally closed. Starters shall be supplied with a minimum of two interlock contacts.
 7. All magnetic starters shall be provided with terminal blocks for wiring devices external to the starter enclosure. The starter shall be supplied in a NEMA 1 enclosure unless otherwise indicated or specified.
 8. The starter shall be capable of starting the motor the number of times per hour stated for motors or as required by the pumping sequence, without causing damage to the starter.
 9. Panel-mounted elapsed-time meters shall have six register wheels indicating up to 99,999.9 hours, without a reset knob, and be rated at 115 VAC, 60 Hz. The panel manufacturer shall provide one meter for each motor installed and connect the meter so that the meter will record the time that the motor is energized.
 10. Equip all magnetic controllers and/or starters, unless otherwise noted, with a three-position selector switch labeled "Hand-Off-Automatic" or as indicated. Switch in Hand position shall start motor.
 11. Equip all magnetic controllers and/or starters with indicating lights as follows: green-power on, red-running.
 12. A list of overload relay heater elements installed in each starter shall be included in the Operation and Maintenance Manual. The list shall identify the starter by name of equipment and show the type, size, and model number of the heater element.
- C. Full-Voltage Non-reversing Starters (FVNR): Full-voltage non-reversing motor starters shall be designed for across-the-line full-voltage starting and stopping of squirrel-cage motors and shall be the combination type with motor circuit protector unless otherwise indicated.

1. The starters shall be rated 600 VAC, 60 Hz.
- D. Full-Voltage Reversing Starters (FVR): Full-voltage reversing motor starters shall be designed for across-the-line full-voltage starting and stopping of squirrel-cage motors and shall be the combination type with motor circuit protector unless otherwise indicated.
1. The starters shall be rated 600 VAC, 60 Hz.
- E. Combination Starters:
1. All motor starters shall be combination type unless noted otherwise.
 2. Combination starters shall be manufactured in accordance with the latest published NEMA Standards. Combination starters shall consist of circuit breaker, a fused disconnect, or a motor circuit protector, as indicated on the Drawings, and a magnetic motor starter as specified above. Combination starters shall have an interrupting rating sufficient for the short circuit current available at the line terminals. All combination starters shall be mounted in a NEMA 4X enclosure, unless otherwise indicated on the Contract Drawings.
 3. The operator and operator arm shall be permanently attached to the handle of the breaker with positive indication of switch position with door either open or closed. The door and switch shall be interlocked to prevent closing the switch when the door is open.
 4. The door latch shall be tamper proof with a coin-proof slot in the door handle latch. The door handle shall have double safety interlocking of the operator and door handle to prevent opening of the door when the breaker is in the "ON" position. An interlock bypass shall be provided to allow access to authorized personnel. All exposed parts shall be dead when the switch is in the "OFF" position.
 5. Padlocking facilities shall be provided to positively lock the disconnect in either the "ON" or "OFF" position with from one to three padlocks with the door open or closed.
 6. Combination starters shall be Square D, or approved equal.
- F. Control Devices:
1. Pushbutton control, when indicated on the Drawings, shall be non-illuminated, momentary contact (unless otherwise indicated), oil-tight,

pushbutton with no guard. Pushbutton controls shall be Square D Type “K” or approved equal.

2. Selector switch operators, when indicated on the Drawings, shall be two- or three-position, non-illuminated, oil-tight switches with normal return to all positions. Selector switch operators shall be Square D Type “K” or approved equal.
3. Pilot lights shall be 120-volt LED push-to-test type.
4. Control relays shall be double pole, double throw sealed, plug-in type relays with din rail or panel mount base, rated for 10A current at 120Vac, with internal LED pilot light to indicate relay coil is energized.

2.12 ADJUSTABLE SPEED DRIVES (ASD) FOR MOTORS SMALLER THAN 100 HP (NOT USED)

2.13 MOTOR CONTROL CENTERS (NOT USED)

2.14 SWITCHBOARDS (NOT USED)

2.15 OUTDOOR ELECTRICAL EQUIPMENT HOUSING (NOT USED)

2.16 DRY-TYPE TRANSFORMERS (NOT USED)

2.17 LIGHTING

A. Lighting fixtures similar and equal to the types indicated on the Drawings shall be furnished and installed complete with all ballasts, lamps, starters, lenses, accessory hardware, and associated equipment to provide a complete and working lighting system. Each fixture furnished shall be designed for the wattage and lamp type indicated on the Drawings and/or specified in this Section. Lighting fixture manufacturers shall be per Contract Drawings lighting schedule. Any deviations shall be approved by the engineer and a complete photo-metric study shall be submitted to the engineer for approval.

1. Lamps of the proper type, wattage, and voltage rating shall be furnished and installed in each fixture. Lamps shall be delivered to the project site in their original cartons. Unless otherwise indicated, lamps shall comply with the following:

- a. Incandescent lamps shall be inside-frosted, medium-screw-shell base, extended-service type, rated at 125 VAC.

- b. Fluorescent lamps shall be standard cool white, with 3150 initial lamp lumens, 40-watt power usage, and 20,000-hour lamp life.
- c. High-pressure sodium lamps shall be diffused and shall be rated for 24,000-hour lamps life with initial lumens as follows:

<u>Watts</u>	<u>Initial Lamp Lumens</u>
70	5,950
100	8,800
150	15,000
250	26,000
400	47,500

- d. Metal halide lamps shall be pulse-start and be rated for 15,000 life hours, and have a CRI (Color Rendering Index) of 65 or above, with initial lumens as follows:

EISA 2007 Act Compliant "Pulse-Start" Metal Halide "Enclosed-Rated Bulbs"	
Watts	Initial Lumens (Minimum)
50	3,200
70	4,800
100	8,200
150	13,000
175	16,500
250	23,500
400	42,000

EISA 2007 Act Compliant "Pulse-Start" Metal Halide "Open-Rated Bulbs"	
Watts	Initial Lumens (Minimum)
100	8,100
150	12,000
175	15,000
250	21,000
400	38,000

2.18 TRANSIENT-VOLTAGE SURGE SUPPRESSORS

- A. Primary transient-voltage surge suppressor shall be installed at the main service on the load side of the main breaker or automatic transfer switch as indicated on the Drawings.

1. Primary service transient-voltage surge suppressors shall be listed in accordance with UL 1449 and shall be tested to Category C3 (20 kV, 10 kA, 8/20 μ sec. Waveform) in accordance with ANSI/IEEE C62.41 and C62.45. Suppressors shall meet or exceed the following criteria:

- a. Single impulse current rating of 160,000 amperes per phase (8/20 μ sec. waveform).
- b. Pulse life rating of 1,000 occurrences with no clamping drift for Category C (8/20 μ sec. waveform).
- c. UL 1449 peak let-through voltage shall not exceed the following:

<u>Voltage</u>	<u>L-N</u>	<u>N-G</u>
120/208 or 120/240	500	500
277/480	800	800

- d. The test for Category C3 peak let-through voltage ANSI/IEEE C.62.41 (20 kV-1.2/50 μ s) shall be conducted by an independent testing laboratory. Documentation of the test shall be submitted with the shop drawings.
- e. Peak let-through voltage measured in UL and ANSI/IEEE testing shall include the effect of 6-inch leads connected to the complete unit.
- f. Turn-on and turn-off times shall be less than 1.0 nanosecond.

- B. Secondary transient-voltage surge suppressors shall be installed on the secondary side of step-down transformers or at the associated panelboards, at control panels, and at motor disconnects or junction boxes as indicated on the Drawings. Suppressors at panelboards shall be connected to a 30-amp multi-pole breaker. All other suppressors shall be fused.

1. Secondary transient-voltage surge suppressors shall be listed in accordance with UL 1449. Suppressors shall meet or exceed the following criteria:

- a. Single impulse current rating of 80,000 amperes per phase (8/20 μ sec. waveform).
- b. Pulse life rating of 1,000 occurrences with no clamping drift for Category C (8/20 μ sec. waveform).
- c. UL 1449 peak let-through voltage shall not exceed the following:

<u>Voltage</u>	<u>L-N</u>	<u>N-G</u>
120/240	500	500

- d. The test for Category C3 peak let-through voltage ANSI/IEEE C.62.41 (20 kV-1.2/50 μ s) shall be conducted by an independent testing laboratory. Documentation of the test shall be submitted with the shop drawings.
- e. Peak let-through voltage measured in UL and ANSI/IEEE testing shall include the effect of 6-inch leads connected to the complete unit.
- f. Turn-on and turn-off times shall be less than 1.0 nanosecond.

C. Minimum requirements for surge suppressors:

- 1. Provide suppression elements between each phase or leg and the system neutral and between the neutral conductor and ground.
- 2. Each module of modular type suppressors shall be externally fused. The status of each module shall be monitored on the front of the enclosure and on each module.
- 3. The suppressor failure mode shall be of a "fail-short" design.
- 4. Visible indication of proper connection and operation shall be provided.
- 5. Modular-type suppressors shall have an internal disconnect and current limiting fuses. Encapsulated suppressors shall have external fuse or circuit breaker protection.
- 6. Terminals shall be provided for all necessary power and ground connections and shall accommodate #10 to #1 AWG wire sizes.

7. Suppressors shall be of solid-state componentry and shall operate bidirectionally.
 8. Suppressors shall have a warranty guarantee period of at least 5 years.
- D. All transient-voltage surge suppressors shall be of the same manufacture and shall be installed in accordance with the manufacturer's installation instructions. The mounting position shall be selected to provide the shortest lead possible between the suppressor and the point of connection.
- E. Transient-voltage surge suppressors shall be as manufactured by Advanced Protection Technologies, Inc., or approved equal.

2.19 ARC FLASH STUDY

A. Approved Computer Software Developers

Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include but are not limited to the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.
6. Or Equal.

B. Computer Software Program Requirements

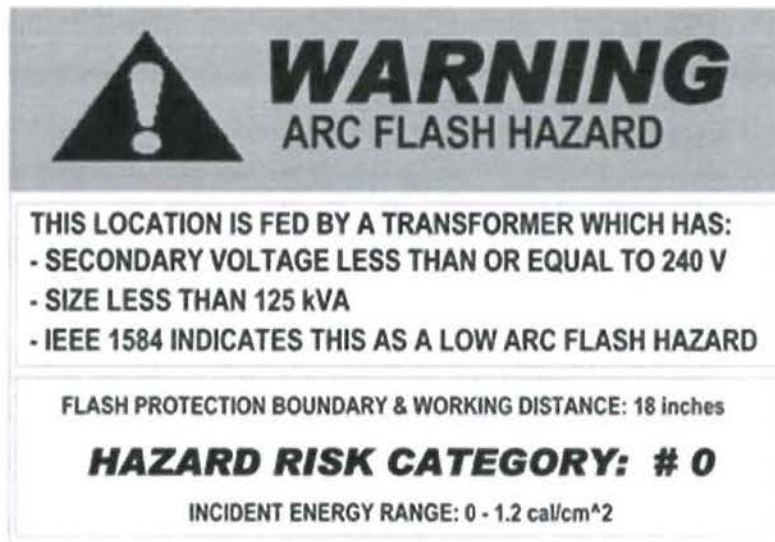
1. Comply with IEEE 399.
2. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
3. The computer software program shall be able to plot and diagram time-current-characteristic curves as part of its output. The 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:

a. Optional Features:

- (1) Arcing faults.
- (2) Simultaneous faults.
- (3) Explicit negative sequence.
- (4) Mutual coupling in zero sequence.

C. Arc Flash Warning Labels:

1. Electrical Contractor shall perform System Arc Flash study and provide and install the proper labeling of all electrical power distribution equipment. Study results shall be submitted to the electrical engineer.
2. Provide arc flash warning labels for all electrical distribution equipment and control panels in accordance with NFPA 70E.
3. Arc flash warning labels shall indicate the available fault current available at the equipment.
4. Arc flash warning labels shall indicate the minimum personal protective equipment (PPE) level required to service the equipment.
5. Arc flash warning labels shall be fabricated and installed in accordance with Section 16075, Electrical Identification.



 WARNING	
 Arc Flash and Shock Hazards 	
33 inches - Arc Flash Protection Boundary	Category 1
3.2 cal/cm ² - Incident Energy Flash Hazard at 18 inches	
Appropriate PPE Required for both Arc Flash and Shock Hazards:	
Clothing: Arc-rated FR Shirt & Pants Foot Protection: Leather work shoes Safety glasses, electrically rated hard hat with hood and face shield. Leather Gloves	
480 VAC- Shock Hazard with covers/doors open	Shock Hazard
42 inches - Limited Approach Boundary	
12 inches - Restricted Approach Boundary	
1 inches - Prohibited Approach Boundary	
Bus: BUS-0006 Prot: PD-0003	
06/17/2012 0001	

 WARNING	
Arc Flash and Shock Hazard	
Appropriate PPE Required	
FLASH PROTECTION	SHOCK PROTECTION
Flash Hazard Category: 1	Shock Hazard when cover is removed: 480 VAC
Min. Arc Rating: 3.2 cal/cm²	Limited Approach: 42 inches
Flash Protection Boundary: 33 inches	Restricted Approach: 12 inches
PPE:	Prohibited Approach: 1 inches
<input type="checkbox"/> Cotton Underwear <input checked="" type="checkbox"/> FR Shirt and Pants (or Coverall) <input checked="" type="checkbox"/> Full Flash Suit and Hard Hat Liner <input checked="" type="checkbox"/> Hard Hat / Hood / Face Shield <input checked="" type="checkbox"/> Safety Glasses or Goggles <input checked="" type="checkbox"/> Hearing Protection <input checked="" type="checkbox"/> Leather Gloves and Shoes <input type="checkbox"/> Non-Melting Shirt and Pants	
Bus: BUS-0006 Prot: PD-0003	Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

2.20 GROUNDING

- A. Ground rods shall be copper-clad steel, 3/4-inch-x-10-foot sectional type, with couplings and driving studs for installation.
- B. The conductor shall be bare, stranded copper, complying with ASTM B8, for main power ground and instrument ground, unless otherwise indicated. Grounding conductors run in conduit shall have green insulation.
- C. Connection to the ground rod shall be made with exothermic welding kits by Cadweld or approved equal. "Acorn" type clamps are not acceptable. Ground connections to equipment frames, building steel, etc., shall be made with equipment grounding lugs or clamps intended or by exothermic weld for grounding purposes.

2.21 PLASTIC CAUTION TAPE

- A. The Contractor shall provide a continuous non-metallic caution tape, 12 inches below finished grade, above each duct or conduit run. The tape shall be 6 inches wide, imprinted to indicate underground electric utilities, as manufactured by Griffolyn, Terra-Tape, or equal.

2.22 PRECAST PRODUCTS

- A. Concrete Handholes: Concrete handholes shall conform to the dimensions shown on the Drawings, shall be designed to AASHTO H-20 loading, and shall be constructed of 4,000 psi (minimum) reinforced concrete.
 - 1. Handholes shall have full-size aluminum (T6061-T6) diamond plate pedestrian covers with reinforcing angles, rated for 300 pounds per square foot unless otherwise indicated. Covers shall be removable and shall be provided with lifting holes (four per cover). Covers larger than 4-foot-x-4-foot nominal shall be of sectional construction. Aluminum angles with flat bars shall be set into the inside of walls flush with the top to match covers.
 - 2. Handholes shall be open bottom unless otherwise indicated or specified.
 - 3. Handholes shall have pulling eyes cast in the wall opposite duct entry. The conduit shall be terminated in a handhole with end bells grouted in entrance windows with non-shrink grout.
 - 4. Power and/or signal cables shall be supported on heavy-duty non-metallic cable racks with adjustable arms and be held in place with non-metallic tie wraps. Racks shall be maximum 3 feet apart with a minimum of one per wall of handhole. Racks shall be attached to handhole walls in accordance with the rack manufacturer's recommendation with a minimum of three anchors per rack. An anchor shall be located in holes immediately above each adjustable arm.
 - 5. Handholes shall be installed on a 6-inch-thick bed of gravel. The gravel shall be compacted before casting or setting handholes. Handholes shall protrude 2 inches minimum above surrounding grade.
- B. Concrete Pull Box: The pull box shall be constructed of reinforced concrete or polymer concrete and shall be Brooks Products, Inc., Quazite, or equal. Covers shall be provided with lifting slot, bolts, and "ELECTRIC" logo.

PART 3 EXECUTION

3.01 LAYOUT OF CONDUIT AND WIRING SYSTEMS

- A. The Contractor shall lay out the work and shall be responsible for all necessary lines, levels, elevations, and measurements. The Drawings indicate the extent and general arrangement of the components. The Contractor shall become familiar with the work of other trades engaged in the construction. The exact routing of raceways and locations of equipment may be governed by structural conditions and obstructions. The Contractor shall coordinate with the details of equipment shop drawings for power and control connections to equipment furnished by others. This is not to be construed as permitting redesigning systems.
- B. Submit all requests for changes in the proposed layout due to structural features, equipment locations, and similar conditions to the Owner, with the following provisions:
 - 1. Detail the reasons for the changes.
 - 2. Submit requests within 30 days after award of Contract.
 - 3. Make no changes without written approval of the Owner.
- C. Examine areas scheduled to receive electrical equipment and material for conditions which will adversely affect the execution, permanence, or quality of the work. Determine field conditions by actual measurement. Do not proceed with installation until defects have been corrected.

3.02 INSTALLATION

- A. General: Comply with NEC, NESC, local codes, and rules and regulations of local agencies having jurisdiction. Coordinate electrical installation of systems and packaged equipment items specified in other sections of these Specifications.
 - 1. Conductors, circuit breakers, motor controllers, and protective devices indicated or specified shall be sized to serve the electrical equipment furnished and shall meet all requirements of the NEC. Voltage drop shall be limited to 3%, including main service, feeder, and branch circuit.
 - 2. Coordinate protective, control, and signaling devices.
- B. Maintenance Building: Grounding and Bonding: The Contractor shall establish a grounding and bonding system that electrically connects metal structural materials, equipment enclosures, conduits, outlet boxes, cabinets, motor frames, fixtures, devices, transformer cases, switchgear enclosures, incoming service neutral conductor, and the earth. The common point of attachment for the

grounding and bonding system shall be at the main service disconnect unless otherwise indicate in this Section or in the Drawings. The grounding and bonding system shall be properly bonded and sized in accordance with NEC. Solidly bond all non-current-conducting metal parts to the electrical installation grounding bus. A green insulated grounding conductor shall be carried with each circuit.

1. Provide common grounds throughout the system.
 2. Provide a ground grid consisting of driven copper-clad steel ground rods connected by bare copper conductor at the service entrance and/or as shown on the Drawings. Resistance to remote earth shall be 10 ohms or less before connection to the system.
 3. Minimum burial depth of ground rods and ground ring (halo) conductors shall be 24 inches BFG. Plastic warning marking tape shall be installed above buried ground conductors 12 inches BFG for the entire length of buried conductors.
 4. All ground connections BFG shall be by exothermic weld process (including connection of lightning protection system downleads) with the exception of connections in the ground test well which shall be done using UL listed mechanical brass clamps.
- C. Identification: Equipment such as but not limited to disconnect switches, motor starters, control panels, etc., shall be clearly marked.
1. Identify all devices operating at more than 250 VAC phase-to-phase or 125 VAC phase-to-ground with red enamel letters or numerals of appropriate height applied with a stencil.
 2. Except as otherwise noted, all equipment shall be marked with engraved nameplates of laminated two-color phenolic plastic having white letters. Attach each nameplate with stainless steel screws. Align nameplates on equipment being marked in the center near the top.
 3. Panelboards and control panels shall have designation in 1/2-inch-high letters and voltage in 1/4-inch-high letters centered above the door on exterior trim.
 4. Mark equipment mounted remotely from the source of power (such as pumps and fans) with equipment number, source of power, and starter location. Where starters are remotely mounted, marking shall include equipment name, number, and location.

5. Conductors shall be identified at each termination, pull box, junction box, handhole, point of entry to or exit from wireways, panelboards, control panels, and other points of access. Tags or labels shall be securely affixed to the conductor in visible locations. Tags shall be durable plastic with the designation stamped on one side with suitable dies. Labels shall be permanent with legible black characters on white heat-shrink tubing or equivalent identification acceptable to the Owner.
 - a. Power conductors shall be color-coded to identify phases, neutral and switch legs, using plastic, self-sealing tape. Tags or labels shall identify the switchboard, MCC, panel, etc., it is served from and the circuit number.
 - b. The control conductor (including monitor and instrumentation conductors) shall be identified by color coding and tag or label as to wire number (corresponding to the manufacturer's wiring diagram) and equipment name.
 - c. Power wiring and control wiring shall be identified in all handholes with a waterproof permanent tag attached to the cable with plastic cable ties.
- D. Equipment Connections: Provide complete system with all power and control connections required for proper operation.
- E. Conduit:
 1. Aluminum conduit may be used as follows:
 - a. Exposed in buildings (only in Maintenance Building).
 - b. Exposed with PVC coating where indicated on the Drawings.
 - c. Concealed in poured concrete.
 - d. Below grade with PVC coating where indicated on the Drawings.
 2. Rigid non-metallic (PVC) conduit may be used as follows:
 - a. Concealed in walls and floors, Schedule 80.
 - b. Below-grade direct burial, Schedule 80.
 - c. Schedule 80 PVC conduits shall be used throughout composting buildings and attached to metallic structural member with two hole PVC straps listed for that purpose.

- d. Exposed below 6 feet above the finished floor or grade and where subject to damage, Schedule 80.
3. Burial depth of conduit shall be measured from the top of the conduit to the top surface of finished grade, pavement, concrete, or similar cover as follows:
 - a. 24 inches (minimum) below unpaved areas.
 - b. 30 inches (minimum) below stabilized subbase in paved areas.
4. For concrete slabs on grade and foundations, conduit burial depth shall be measured from the bottom of the concrete slab or foundation as follows:
 - a. 12 inches (minimum) below concrete slabs on grade or foundations.
5. It shall be the responsibility of the Electrical Contractor to coordinate the location and depths of all electrical conduits to be installed under this Contract with other trades. Particular attention shall be given to all locations where conduits enter a structure or building from underground. Proper clearances from the top of the conduits to the bottom of slabs and foundations shall be maintained.
6. Where conduits rise through slabs on grade, curved portion of bends shall not be visible above the finished slab.
7. Conduit stub-up to above grade and conduit stub-up out of or from below floor slab shall be Schedule 80 PVC90° bends below grade shall be PVC coated galvanized steel.
8. Stub-ups through concrete slabs for connection of future equipment or conduits runs shall be provided with couplings threaded inside for plugs and shall be set flush with the finished floor or slab. Install screwdriver-operated threaded flush plugs in couplings. Provide pull wire in all empty conduit runs.
9. Avoid bends and offsets, where possible. Make bends and offsets with an approved hickey or conduit bending machine. Install plastic (PVC) coated conduit and fittings in accordance with the manufacturer's installation manual using tools designed for installing plastic (PVC) coated conduit and fittings. Touch up any and all damaged areas with manufacturer-recommended coating compound. Do not install crushed or deformed conduit. Use expansion fittings or other approved devices where conduit or tubing crosses expansion joints. Prevent dirt or trash from lodging in

conduits, boxes, and fittings. Free clogged conduit of all obstructions or replace conduit.

10. Supports:

- a. Pipe straps, wall brackets, hangers, or ceiling trapeze.
- b. Use wood screws or screw-type nails for fastening to wood. Use toggle bolts for fastening to hollow masonry units. Use concrete inserts or expansion anchors for fastening to concrete. Use machine screws, welded threaded studs, or spring-tension clamps for fastening to steel work.
- c. Power-driven threaded studs may be used in lieu of expansion bolts or machine or wood screws where acceptable to the Owner.
- d. Do not weld conduit or pipe straps to steel structures.
- e. Non-metallic conduit through 1-inch size shall use two-hole snap-strap clamps and 1-1/4-inch through 2-inch shall use two-hole snap-strap clamps, with maximum spacing between supports as outlined in the NEC based on 50°C conductor temperature. Clamps shall be manufactured from a nylon compound.

11. Expansion couplings shall be used in all straight lengths of non-metallic conduit in exposed applications. Maximum spacing between expansion couplings shall be 100 feet.

12. Connections: All conduits, where they enter sheet metal enclosures such as panelboards, pull boxes or outlet boxes, shall be secured in place by galvanized locknuts and bushings, one locknut inside of box with bushing on conduit end and one locknut outside of box for rigid conduit. The locknuts shall be tightened against the box without deforming the box.

- a. Conduit connections shall use fittings to maintain NEMA rating of enclosures.
- b. All bushings and conduit box connectors shall have the insulating material permanently fastened to the fittings.
- c. Grounding bushings shall be used in switchgear and motor control centers.

- d. Conduit connections exposed in wet locations shall be by watertight threaded hub. Metallic conduit box connections may use a two-piece hub with built-in recessed neoprene gasket such as Appleton Uni-Seal. Non-metallic conduit box connectors may use a neoprene flat washer or "O" ring placed over threads of the fitting between the shoulder of the fitting and the box.

F. Duct Banks:

- 1. Conduit: Conduit shall be Schedule 80 PVC of the number and size as indicated on the Drawings.
 - a. Conduits shall maintain a continuous slope between handholes and shall be sloped toward handholes with a minimum grade of 3 inches per 100 feet, where practical.
 - b. Conduits shall terminate in handholes with end bells.
 - c. Thoroughly clean each conduit after installation. Pass a mandrel not less than 12 inches long with a diameter 1/4-inch less than the inside dimension through each conduit.
 - d. Conduit shall follow straight lines, as far as possible, with spacing both horizontally and vertically maintained by spacers manufactured by the conduit manufacturer. Securely anchor conduit to prevent movement during placement of backfill or concrete encasement. Conduit couplings shall be staggered by rows. Long radius bends shall be used where deviation from straight lines is necessary.
 - e. Concrete encasement, where indicated on the Drawings, shall be constructed to the dimensions shown. Trench bottoms shall be tamped firm and even. Suitably braced side forms shall be employed. Concrete shall be installed in a continuous pour to eliminate joints.
 - f. The high point of conduits between handholes shall have a minimum of 18 inches cover below the finished grade.
 - g. The entire underground conduit/duct system shall be watertight. Seal conduits to exclude moisture at each building or structure.
 - h. Provide plastic caution tape above the duct run 12 inches below finished grade.

G. Cast-in-Place Concrete Handholes: Cast-in-place concrete handholes shall conform to the dimensions shown on the Drawings, shall be designed to AASHTO H-20 loading, and shall be constructed of 4,000 psi reinforced concrete. The construction shall conform to the methods, form, mixture, placement, and curing as specified in Section 03300, Cast-in-Place Concrete.

1. Handholes shall have full-size aluminum (T6061-T6) diamond plate pedestrian covers with reinforcing angles, rated for 300 pounds per square foot unless otherwise indicated. Covers shall be removable and shall be provided with lifting holes (four per cover). Covers larger than 4-foot-x-4-foot nominal shall be of sectional construction. Aluminum angles with flat bars shall be set into inside of walls flush with the top to match covers.
2. Handholes shall be open bottom unless otherwise indicated or specified.
3. Handholes shall have pulling eyes cast in the wall opposite duct entry. Conduit shall be terminated in handhole with end bells.
4. Power and/or signal cables shall be supported on heavy-duty non-metallic cable racks with adjustable arms and be held in place with non-metallic tie wraps. Racks shall be maximum 3 feet apart with a minimum of one per wall of handhole. Racks shall be attached to handhole walls in accordance with the rack manufacturer's recommendation with a minimum of three anchors per rack. An anchor shall be located in holes immediately above each adjustable arm.
5. Cast-in-place handholes shall have 6-inch-thick walls reinforced with 4-inch-x-4-inch W2.9 x W2.9 WWF.
6. Handholes shall be installed on a 6-inch-thick bed of gravel. The gravel shall be compacted before casting or setting handholes. Handholes shall protrude 2 inches minimum above surrounding grade.

H. Boxes:

1. The Contractor shall provide outlet, pull, junction, or terminal boxes in wiring or conduit systems wherever required for pulling wires, making connections, and mounting devices or fixtures.
 - a. Indicated locations are approximate only. Coordinate actual location with all work to be performed in the space or area and for the equipment to be served.

- b. Locate outlets so that fixtures and other items will be symmetrically located according to the space or area layout.
 - c. Outdoor switch and receptacle outlets shall use non-metallic boxes and covers.
 - 2. Outlet boxes in exposed work or wet locations shall be cast metal. Sheet metal boxes shall be concealed in walls or ceiling. Non-metallic boxes shall be used with non-metallic conduit.
 - 3. Supports:
 - a. In open overhead spaces, cast boxes threaded to rigid metallic conduit need not be separately supported unless used for fixture support.
 - b. Use wood screws or screw-type nails for fastening to wood. Use toggle bolts for fastening to hollow masonry units. Use concrete inserts or expansion anchors for fastening to concrete. Use machine screws or welded, threaded studs for fastening to steel work.
 - c. Power-driven threaded studs may be used in lieu of expansion bolts or machine or wood screws where acceptable to the Engineer and the Owner.
- I. Wiring Devices: Receptacles installed outdoors shall be the ground-fault circuit-interrupter type.
- J. Wiring:
 - 1. The Contractor shall provide a complete system of conductors as indicated.
 - 2. Size shall be as required by the NEC and shall be #12 AWG minimum for power and lighting circuits and #14 AWG minimum for control and alarm circuits.
 - 3. Crimp-on insulated wire terminals shall be used on stranded wire for terminations.
 - 4. Splices shall be in accessible locations only and shall be insulated-pressure type for #10 AWG and smaller wires. For #8 AWG and larger, use

solderless connectors covered with an insulation material equivalent to the conductor insulation.

- K. Lighting Fixtures: All fixtures and supports shall be carefully laid out and equipped with suitable swivel hangers, canopies, and/or other auxiliaries as required to ensure that fixtures are plumb without bending or offsetting stems, rods, or supports and properly aligned both lengthwise and crosswise except that where obstructions or conflicts are encountered the fixtures shall be relocated as directed by the Engineer or the Owner and installed in such a manner as to provide a finished, neat, and workmanlike installation.
- L. Appearance: All items shall be cleaned or touched up as necessary to ensure first-class condition.

3.03 FIELD TESTS AND OBSERVATION

- A. General: Do not enclose or cover any work until it has been observed, tested, and accepted.
 - 1. Provide all personnel, equipment, and instruments required for observation and testing.
 - 2. Demonstrate that all circuits and devices are in operating condition. Tests shall include the following:
 - a. Megger all motor windings before operation for insulation resistance and, if found low, dry out windings to secure acceptable insulation resistance.
 - b. Check control center components, buses, starters, breakers, relays, alarms, interlocks, etc., and place in service in accordance with the manufacturer's instructions. Inspect and adjust electrical equipment before energization.
 - c. Megger all power cables and wiring for insulation resistance and record.
 - d. Check all motors for correct lubrication and lubricate, if required, in accordance with the manufacturer's instructions.
 - e. Check direction of rotation of all motors and reverse, if necessary.

3. Assemble in binders and turn over to the Owner all instruction bulletins, lubrication schedules, operating instructions, pamphlets, parts lists, prints, etc. accompanying or attached to apparatus and equipment.
 4. Notify the Engineer and the Owner 1 week before test date.
- B. Ground Rod Test: Before any wire is connected to ground rods, test each rod for resistance to ground.
1. The testing instrument shall be a direct reading, single test, portable ground testing megger.
 2. The test procedure shall be as recommended by the manufacturer of the test instrument used.
 3. The make and model of the test instrument and a copy of the test procedure shall be submitted to the Owner before the test is conducted.
 4. Do not conduct tests within 48 hours after rainfall or during foggy weather.
 5. If ground resistance exceeds 10 ohms, additional grounds shall be driven.
 6. The grounding test shall be witnessed by the Engineer or other representative of the Owner. A copy of the test results and method shall be included in the maintenance manual. Deliver one copy of the test results to the Engineer and the Owner within 1 week after the test.

3.04 ADJUST AND CLEAN

- A. The Contractor shall remove excess and waste materials from the project site.
- B. Remove defective work and replace with material that meets Specification requirements or repair to the satisfaction of the Owner.
- C. Touch up scratches, abrasions, voids and other defects in factory- or shop-finished surfaces.

END OF SECTION

SECTION 16520
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes requirements for the following:
 - 1. Exterior luminaires with lamps and ballasts.
- B. See this Section, for exterior luminaires normally mounted on exterior surfaces of buildings.

1.02 RELATED WORK (NOT USED)

1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with Section 01330, Submittals and Acceptance:
 - 1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
 - 2. Shop Drawings: Include anchor-bolt templates keyed to specific poles and certified by the manufacturer.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- B. Comply with IEEE C2, National Electrical Safety Code.
- C. Comply with NFPA 70.

1.05 REFERENCE STANDARDS (NOT USED)

1.06 QUALITY ASSURANCE (NOT USED)

- 1.07 WARRANTIES (NOT USED)
- 1.08 DELIVERY, STORAGE, AND HANDLING (NOT USED)
- 1.09 QUALIFICATIONS (NOT USED)
- 1.10 TESTING REQUIREMENTS (NOT USED)
- 1.11 MAINTENANCE (NOT USED)
- 1.12 OPERATIONS AND MAINTENANCE (O&M) MANUALS (NOT USED)
- 1.13 CODES, INSPECTIONS, AND FEES (NOT USED)
- 1.14 PROJECT REQUIREMENTS (NOT USED)
- 1.15 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION
 - A. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied as stated in AASHTO LTS-4.
 - B. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
 - C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4:
 - 1. Wind speed for calculating wind load for poles 50 feet or less in height is 150 mph, Risk Category II, Exposure B.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In Exterior Lighting Device Schedule, where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. If listed lighting is substituted, the Contractor shall submit a computer-generated point-by-point lighting calculation based on the IES Report for the listed fixture for approval.

2.02 LUMINAIRES: GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Luminaires shall be fluorescent, HID (sodium or metal halide), or LED.
- D. Approved manufactures shall be Lithonia, Hubbell, or approved equal.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- H. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- I. Exposed Hardware Material: Stainless steel.
- J. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- K. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- L. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85%.
 - 2. Specular Surfaces: 83%.
 - 3. Diffusing Specular Surfaces: 75%.

- M. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- N. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel luminaires: Dark bronze. Comply with NAAMM's *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- P. Factory-Applied Finish for Aluminum luminaires: Color shall be dark bronze. Comply with NAAMM's *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.

2.03 BALLASTS FOR HID LAMPS

- A. Shall comply with ANSI C82.4 and UL 1029 and be capable of open-circuit operation without reduction average life. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22°F.
 - 3. Normal Ambient Operating Temperature: 104°F.
 - 4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
- B. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90°C.
 - 1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W:
 - a. Restrike Range: 105- to 130-V ac.
 - b. Maximum Voltage: 250-V peak or 150-V ac RMS.
 - 2. Minimum Starting Temperature: Minus 40°F.

2.04 HID LAMPS

- A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

PART 3 EXECUTION

3.01 LUMINAIRE INSTALLATION

- A. To ensure proper installation, the Contractor shall do the following:
 - 1. Install lamps in each luminaire.
 - 2. Fasten luminaire to indicated structural supports:
 - a. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by the manufacturer.
 - 3. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

END OF SECTION

EXHIBIT C
PUBLIC CONSTRUCTION PERFORMANCE AND PAYMENT BOND

By this bond, we [Name of Contractor], as **Principal**, and [Name of Surety], as **Surety**, are bound to **Lee County Board of County Commissioners**, a political subdivision of the State of Florida, herein called **Owner**, in the sum of **[Total Contract Price]**, for payment of which we bind ourselves, our heirs, personal representatives, successors, and assigns, jointly and severally.

THE CONDITION OF THIS BOND IS that is that if Principal:

1. Performs this contract dated _____, 20____, between Principal and Owner for construction of improvements known as **[Name of Project]** located at **[Street Address or Legal Description]**, under Lee County Solicitation No. [Solicitation number], the contract being made a part of this bond by reference, at the times and in the manner prescribed in the contract; and
2. Promptly makes payments to all claimants, as defined in Section 255.05 (1), Florida Statutes, supplying Principal with labor, materials, or supplies, used directly or indirectly by Principal in the prosecution of the work provided for in the contract; and
3. Pays Owner all losses, damages, expenses, costs, and attorney's fees, including appellate proceedings, that Owner sustains because of a default by Principal under the contract; and
4. Performs the guarantee of all work and materials furnished under the contract for the time specified in the contract, then this bond is void; otherwise it remains in full force.

Any action instituted by a claimant under this bond for payment must be in accordance with the notice and time limitation provisions in Section 255.05(2), Florida Statutes.

Any changes in or under the contract documents and compliance or noncompliance with any formalities connected with the contract or the changes do not affect Surety's obligation under this bond.

	OWNER	PRINCIPAL	SURETY
NAME	Lee County Board of County Commissioners	[Name of Contractor]	[Name of Surety]
ADDRESS	2115 Second St. Fort Myers, FL 33901	[Principal Business Address of Contractor]	[Principal Business Address of Surety]
PHONE NUMBER	239-533-2221	[Principal Business Phone of Contractor]	[Principal Business Phone of Surety]

[The remainder of this page intentionally left blank.]

BOND NO. [Surety to enter bond #]

[Name of Contractor]

DATED THIS _____ DAY

OF _____, 2 _____

By: _____
[Printed Name and Title of Signer]

STATE OF _____
COUNTY OF _____

The foregoing instrument was acknowledged before me this _____ day of _____, 20____, by [name of person acknowledging].

(NOTARY SEAL)

Signature of Notary Public

[Name of Notary Typed, Printed, or Stamped]

Personally Known _____ OR Produced Identification _____
Type of Identification Produced:

[Name of Surety]

DATED THIS _____ DAY

OF _____, 2 _____

By: _____
[Printed Name] as Attorney in Fact

Address: _____

STATE OF _____
COUNTY OF _____

The foregoing instrument was acknowledged before me this _____ day of _____, 20____, by [name of person acknowledging].

(NOTARY SEAL)

Signature of Notary Public

[Name of Notary Typed, Printed, or Stamped]

Personally Known _____ OR Produced Identification _____
Type of Identification Produced:

EXHIBIT D
INSURANCE REQUIREMENTS
CERTIFICATES OF INSURANCE

(1) The Contractor shall obtain and maintain such insurance as will protect it from: (1) claims under workers' compensation laws, disability benefit laws, or other similar employee benefit laws; (2) claims for damages because of bodily injury, occupational sickness or disease or death of its employees including claims insured by usual personal injury liability coverage; (3) claims for damages because of bodily injury, sickness or disease, or death of any person other than its employees including claims insured by usual personal injury liability coverage; and (4) from claims for injury to or destruction of tangible property including loss of use resulting there from -- any or all of which claims may arise out of, or result from, the services, Work and operations carried out pursuant to and under the requirements of the Contract Documents, whether such services, Work and operations be by the Contractor, its employees, or by Subcontractor(s), or anyone employed by or under the supervision of any of them, or for whose acts any of them may be legally liable.

(2) This insurance shall be obtained and written for not less than the limits of liability specified hereinafter, or as required by law, whichever is greater.

(3) The Contractor shall require, and shall be responsible for ensuring throughout the time the Agreement is in effect, that any and all of its Subcontractors obtain and maintain until the completion of that Subcontractor's work, such of the insurance coverages described herein as are required by law to be provided on behalf of their employees and others.

(4) The Contractor shall obtain, have and maintain during the entire period of the Agreement insurance policies, which contain the following information and provisions:

- (A) The name and type of policy and coverages provided;
- (B) The amount or limit applicable to each coverage provided;
- (C) The date of expiration of coverage;
- (D) The designation of the County as an additional insured and a certificate holder (This requirement may be excepted for workers' compensation and professional liability Insurance);
- (E) The following clause must appear on the Certificate of Insurance:

Should any material change occur in any of the above described policies or should any of said policies be canceled before the expiration date thereof, the issuing company shall mail at least thirty (30) calendar days' written notice to the County.

(5) If the initial, or any subsequently issued Certificate of Insurance expires prior to the completion of the Work or termination of the Agreement, the Contractor shall furnish to the County, in triplicate, renewal or replacement Certificate(s) of Insurance not later than thirty (30) calendar days prior to the date of their expiration. Failure of the

Contractor to provide the County with such renewal certificate(s) shall be considered justification for the County to terminate the Agreement.

(6) Contractor shall include the County, the County's agents, officers and employees in the Contractor's General Liability and Automobile Liability policies as additional insureds.

(7) If the County has any objection to the coverage afforded by other provisions of the insurance required to be purchased and maintained by Contractor in accordance with the requirements of the Contract Documents on the basis of its not complying with the Contract Documents, the County shall notify Contractor in writing thereof within thirty (30) calendar days of the delivery of such certificates to the County. Contractor shall provide to the County such additional information with respect to its insurance as may be requested.

(8) The Contractor shall obtain and maintain the following insurance coverages as provided hereinbefore, and in the type, amounts and in conformance with the following minimum requirements:



LEE COUNTY
SOUTHWEST FLORIDA

Major Insurance Requirements

Minimum Insurance Requirements: *Risk Management in no way represents that the insurance required is sufficient or adequate to protect the Vendor's interest or liabilities. The following are the required minimums the Vendor must maintain throughout the duration of this Contract. The County reserves the right to request additional documentation regarding insurance provided.*

- a. **Commercial General Liability** - Coverage shall apply to premises and/or operations, products and completed operations, independent contractors, and contractual liability exposures with minimum limits of:

\$1,000,000 per occurrence
\$2,000,000 general aggregate
\$1,000,000 products and completed operations
\$1,000,000 personal and advertising injury

- b. **Business Auto Liability** - The following Automobile Liability will be required and coverage shall apply to all owned, hired and non-owned vehicles use with minimum limits of:

\$1,000,000 combined single limit (CSL)
\$500,000 bodily injury per person
\$1,000,000 bodily injury per accident
\$500,000 property damage per accident

- c. **Workers' Compensation** - Statutory benefits as defined by Chapter 440, Florida Statutes,

encompassing all operations contemplated by this Contract or Agreement to apply to all owners, officers, and employees regardless of the number of employees. Workers' Compensation exemptions may be accepted with written proof of the State of Florida's approval of such exemption. Employers' liability will have minimum limits of:

\$500,000 per accident
\$500,000 disease limit
\$500,000 disease – policy limit

*The required minimum limit of liability shown in a. and b. may be provided in the form of "Excess Insurance" or "Commercial Umbrella Policies," in which case, a "Following Form Endorsement" will be required on the "Excess Insurance Policy" or "Commercial Umbrella Policy."

Verification of Coverage:

1. Coverage shall be in place prior to the commencement of any work and throughout the duration of the Contract. A certificate of insurance will be provided to the Risk Manager for review and approval. The certificate shall provide for the following:

- a. The certificate holder shall read as follows:

Lee County Board of County Commissioners
P.O. Box 398
Fort Myers, Florida 33902

- b. *"Lee County, a political subdivision and Charter County of the State of Florida, its agents, employees, and public officials"* will be named as an "Additional Insured" on the General Liability policy, including Products and Completed Operations coverage.

Special Requirements:

1. An appropriate "Indemnification" clause shall be made a provision of the Contract.
2. If applicable, it is the responsibility of the general contractor to ensure that all subcontractors comply with all insurance requirements.
3. Place the project name and number in the Description of Operations box.
4. Insurance carriers providing coverage required herein shall be licensed to conduct business in the State of Florida and shall possess a current A.M. Best's Financial Strength Rating of B+ Class VII or better.



CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

10/23/2018

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER Associated Benefits & Risk Consulting 6000 Clearwater Drive Minnetonka MN 55343		CONTACT NAME: Peggy Lund PHONE (A/C, No, Ext): 952-947-9700 E-MAIL: Peggy.Lund@AssociatedBRC.com ADDRESS: Peggy.Lund@AssociatedBRC.com		FAX (A/C, No): 952-947-9793	
		INSURER(S) AFFORDING COVERAGE			NAIC #
		INSURER A: Zurich American Insurance Company			16535
		INSURER B: Ironshore Specialty Insurance Company			25445
		INSURER C:			
		INSURER D:			
		INSURER E:			
		INSURER F:			

INSURED
Legacy Building Solutions, Inc
Legacy Manufacturing LLC
19500 Cty Rd 142
South Haven MN 55382

LEGAC-4

COVERAGES**CERTIFICATE NUMBER:** 521072939**REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS
A	<input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS-MADE <input checked="" type="checkbox"/> OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: <input type="checkbox"/> POLICY <input checked="" type="checkbox"/> PROJECT <input checked="" type="checkbox"/> LOC <input type="checkbox"/> OTHER:	Y	Y	GLO0115423	6/1/2018	6/1/2019	EACH OCCURRENCE \$ 1,000,000 DAMAGE TO RENTED PREMISES (Ea occurrence) \$ 100,000 MED EXP (Any one person) \$ 5,000 PERSONAL & ADV INJURY \$ 1,000,000 GENERAL AGGREGATE \$ 2,000,000 PRODUCTS - COMP/OP AGG \$ 2,000,000 \$
A	<input checked="" type="checkbox"/> AUTOMOBILE LIABILITY <input type="checkbox"/> ANY AUTO <input type="checkbox"/> OWNED AUTOS ONLY <input checked="" type="checkbox"/> SCHEDULED AUTOS <input checked="" type="checkbox"/> HIRED AUTOS ONLY <input checked="" type="checkbox"/> NON-OWNED AUTOS ONLY <input checked="" type="checkbox"/> Uninsured <input checked="" type="checkbox"/> Underinsured	Y	Y	BAP0115422	6/1/2018	6/1/2019	COMBINED SINGLE LIMIT (Ea accident) \$ 1,000,000 BODILY INJURY (Per person) \$ BODILY INJURY (Per accident) \$ PROPERTY DAMAGE (Per accident) \$ UI/UM \$ 1,000,000
A	<input checked="" type="checkbox"/> UMBRELLA LIAB <input checked="" type="checkbox"/> OCCUR <input type="checkbox"/> EXCESS LIAB <input type="checkbox"/> CLAIMS-MADE <input type="checkbox"/> DED <input checked="" type="checkbox"/> RETENTION \$ 0			AUC0115497	6/1/2018	6/1/2019	EACH OCCURRENCE \$ 15,000,000 AGGREGATE \$ 15,000,000 \$
A	<input checked="" type="checkbox"/> WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	Y	N	WC0115424	6/1/2018	6/1/2019	<input checked="" type="checkbox"/> PER STATUTE <input type="checkbox"/> OTH-ER E.L. EACH ACCIDENT \$ 1,000,000 E.L. DISEASE - EA EMPLOYEE \$ 1,000,000 E.L. DISEASE - POLICY LIMIT \$ 1,000,000
B	Professional E&O			002796202	6/3/2018	6/3/2019	Prof E&O Agg 5,000,000
A	Leased/Rent Equip			CPP0115480	6/1/2018	6/1/2019	Prof E&O Retention 25,000 Leased/Rented 500,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

THE FOLLOWING ENDORSEMENT APPLY TO THE NAMES/PROJECTS LISTED BELOW, ONLY IF REQUIRED BY WRITTEN CONTRACT OR AGREEMENT: GENERAL LIABILITY: U-GL-1175-F CW 04/13 Additional Insured Automatic - Owners, Lessees, Contractors-Ongoing & Completed Operations-Primary & Non-Contributory, CG2015 04/13 Additional Insured - Vendors, CG2032 04/13 Additional Insured - Engineers, Architects of Surveyors Not Engaged by the Named Insured, U-GL-925-B 12/01 Waiver of Subrogation Blanket, CG2417 10/01 Contractual Liability - Railroads, CG2414 04/13 Waiver of Governmental Immunity // AUTO LIABILITY: CA2001 10/13 Lessor - Additional Insured & Loss Payee, U-CA-424-F CW 04/14 Additional Insured - Required by Contract-Primary & Non-Contributory & Waiver of Subrogation // WORKERS COMPENSATION: WC000313 04/84 Waiver of Subrogation / U-WC-198C 07/93 Foreign Voluntary Compensation
Lee County, a political subdivision and Charter County of the State of Florida, its agents, employees, and public officials will be named as additional insured on the General Liability policy, including Products and Completed Operations coverage.

CERTIFICATE HOLDER**CANCELLATION**

Lee County Board of County Commissioners
PO Box 398
Fort Myers FL 33902

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

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EXHIBIT E
RELEASE AND AFFIDAVIT

COUNTY OF _____

STATE OF FLORIDA

Before me, the undersigned authority, personally appeared

_____,
who after being duly sworn, deposes and says:

(1) In accordance with the Contract Documents and in consideration of
\$ _____ paid,
_____ ("Contractor") releases
and waives for itself and its subcontractors, materialmen, successors and assigns, all
claims demands, damages, costs and expenses, whether in contract or in tort, against
Lee County, Florida (the "County"), its Board of County Commissioners, employees and
agents relating in any way to the performance of the Agreement between Contractor and
the County, dated _____, _____, for the period from _____ to
_____.

(2) Contractor certifies for itself and its subcontractors, materialmen,
successors and assigns, that all charges for labor, materials, supplies, lands, licenses
and other expenses for which the County might be sued or for which a lien or a demand
against any Payment Bond might be filed, have been fully satisfied and paid.

(3) Contractor agrees to indemnify, defend and save harmless the County, its
Board of County Commissioners, employees and agents from all demands or suits,
actions, claims of liens or other charges filed or asserted against the County arising out
of the performance by Contractor of the Work covered by this Release and Affidavit.

(4) This Release and Affidavit is given in connection with Contractor's
[monthly/final] application for payment No. _____.

CONTRACTOR:

By: _____ (signature of the executive officer)

Its: _____ (title of the executive officer)

Date: _____

Witnesses

[Corporate Seal]

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me this _____ day of _____, _____, by _____, as _____ of _____, a _____ corporation, on behalf of the corporation. He/she is personally known to me or has produced _____ as identification and did (did not) take an oath.

My Commission Expires: _____
(Signature of Notary)

Name: _____
(Legibly Printed)

(AFFIX OFFICIAL SEAL)

Notary Public, State of _____

Commission No.: _____

EXHIBIT F CHANGE ORDER FORM



Lee County Construction Contract
Change Order

Print Form

Number: _____

A Change Order requires approval by the Department Director for expenditures under \$50,000, approval by the County Manager for expenditures between \$50,000.01 and \$100,000, or approval by the Board of County Commissioners for expenditures over \$100,000

Contract /
Project
Name: _____

Contractor: _____

Contract #: _____ Project #: _____ Bid #: _____

Lee County Project Manager: _____

Fiscal Staff: _____ Date of Request: _____

Upon the completion and execution of this Change Order by both parties to the Contract, the Contractor is authorized to and shall proceed to make the following changes in the Contract Documents:
(If you need space other than what has been provided, please attach additional sheets.)

Attachments:
(List documents supporting change) _____

Description: _____

Purpose of
Change Order: _____

Change in Contract Price	Dollar Amount	Change in Contract Time	Calendar Days
Original Contract Price		Original Contract Time	
Previous Change Order No. _____		Net Change from Previous Change Orders	
Contract Price Prior to this Change Order		Contract Time Prior to this Change Order	
Net Increase (Decrease) of this Change Order		Net Increase (Decrease) of this Change Order	
Contract Price with All Approved Change Orders		Contract Time with All Approved Change Orders	

It is understood and agreed that the acceptance of this modification by the CONTRACTOR constitutes an accord and satisfaction, and represents payment in full (both time and money) for all costs arising out of, or incidental to, the above mentioned change.

_____ Name of Contractor	_____ Date Accepted
_____ Contact Email Address	_____ Contact Phone #

Rev. 12/2015

Lee County Board of County Commissioners
2115 Second St. - Fort Myers, FL 33901
PO Box 398 - Fort Myers, FL 33902-0398
Main Phone: (239) 533-2111