

**SECTION 26 32 13 – PACKAGED ENGINE GENERATORS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features and accessories:
  - 1. Diesel engine
  - 2. Unit-mounted cooling system
  - 3. Remote-mounting annunciator and stop-switch
  - 4. Outdoor enclosure
  - 5. Battery Charger
  - 6. Muffler
  - 7. Exhaust piping external to set
  - 8. Starting battery
  - 9. Day tank
  
- B. Related sections include the following:
  - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

**1.2 SUBMITTALS**

- A. Product Data: Include data on features, components, ratings, and performance. Include the following:
  - 1. Dimensioned outline plan and elevation drawings of engine generator set and other components specified.
  - 2. Thermal damage curve for generator
  - 3. Time-current characteristic curves for generator protective device
  
- B. Shop Drawings: Indicate fabrication details, dimensions, weights, loads, required clearances, and method of filed assembly, components, and location and size of each field connection.
  - 1. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
  - 3. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
  
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
  
- D. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.
  
- E. Certified summary of prototype-unit test report.
  
- F. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

- G. Factory Test Reports: For units to be shipped for this Project, showing evidence of compliance with specified requirements.
- H. Sound measurement test report.
- I. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.
- J. Field test report of tests specified in Part 3.
- K. Maintenance Data: For each package engine generator and accessories to include in maintenance manuals specified in Division 1. Include the following:
- L. Detail operating instructions for both normal and abnormal conditions.
- M. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
- C. Source Limitations: Obtain packaged engine generator and auxiliary components specified in this Section through one source from a single manufacturer.
- D. Manufacturer Qualifications: A qualified manufacturer. Maintain a service center capable of emergency maintenance and repairs at the Project with eight hours' maximum response time.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 99.
- J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- K. Comply with UL 2200.
- L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: minimum 2 years from date of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.6 MAINTENANCE SERVICE

- A. Maintenance: At Substantial Completion, begin 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper, starting, load transfer, and running under load. Include routing preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in the manufacture and installation of original equipment.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: One for every ten of each type and rating, but not less than one of each.
  - 2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
  - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide [**the product indicated on Drawings**] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
  - 1. Caterpillar, Inc; Engine Div.
  - 2. Generac Power Systems, Inc.
  - 3. Kohler Co.; Generator Division.
  - 4. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.

- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  - 2. Output Connections: Three-phase, four wire.
  - 3. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.
  - 4. Skid: Adequate strength and rigidity to maintain alignment of mounted components without depending on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
  - 5. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.
- D. Generator-Set Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  - 8. Start Time: Comply with NFPA 110, Type 10, system requirements
  - 9. Steady-State Voltage Modulation Frequency: Less than 1 Hz.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Engine Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set skid and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
  2. Sound level measured at a distance of **10 feet (3 m)** from exhaust discharge after installation is complete shall be **85 dBA** or less.
- J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 12-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article above.
  2. Cranking Cycle: **As required by NFPA 110 for system level specified.**
  3. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article above to provide specified cranking cycle at least twice without recharging.
  4. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
  5. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  6. Battery Cable: Size as required by generator set manufacturer for battery location within generator enclosure. Include required interconnecting conductors/connection accessories.
  7. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions"

Paragraph in "Service Conditions" Article above. Include accessories required to support and fasted batteries in place.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.
  - a. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
  - e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either condition closed contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  - f. Enclosure and Mounting: NEMA 250, Type 1, mounted in generator enclosure.

#### 2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
  1. Tank level indicator.
  2. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
  3. Vandal-resistant fill cap.
  4. Containment Provisions: Comply with requirements of local AHJ and all applicable standards of the Texas Department of Aging and Disability Services.

#### 2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for a Level 1 system, and the following:
  1. AC voltmeter.

2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
  2. Coolant low-temperature alarm.
  3. Control switch not in auto position.
  4. Battery-charger malfunction alarm.
  5. Battery low-voltage alarm.
- F. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

## 2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
  2. Trip Rating: Matched to generator rating.
  3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  4. Mounting: Adjacent to or integrated with control and monitoring panel.

## 2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

## 2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
  - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Convenience Outlets: Factory wired weatherproof, GFCI. Arrange for external electrical connection.

## 2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
  - 2. Report factory test results within 10 days of completion of test.



PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
  - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- G. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- H. Connect engine exhaust pipe to engine with flexible connector.
- I. Connect fuel piping to engines with a gate valve and union and flexible connector.
  - 1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."
  - 2. LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-Petroleum Gas Piping."
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- L. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  6. Exhaust Emissions Test: Comply with applicable government test criteria.
  7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Remove and replace malfunctioning units and retest and re-inspect as specified above.
- H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 32 13

**SECTION 26 36 00 - AUTOMATIC TRANSFER SWITCHES**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnish and install an automatic transfer switch for transferring selected emergency loads from normal utility source to on site generator upon loss of normal power and back to utility source upon return of normal power. The transfer switch shall be as indicated on the drawings and as specified herein. The transfer switch together with the package engine generator set specified in Section 16210 shall automatically provide continuous electrical power for the duration of any failure of the normal utility power supply.
- B. In the event that any item is not available exactly as specified, the contractor shall so notify the Architect in writing as early as possible to allow ample time for an alternate item to be selected without delay to the project.

**1.2 SHOP DRAWINGS**

- A. Submit six (6) sets of shop drawings and manufacturer's data which show the following items in tabulated form in accordance with Section 16010.
  - 1. Wiring diagrams (both internal and external)
  - 2. Physical arrangements
  - 3. Accessories list
  - 4. Operating instructions
  - 5. Test data

**1.3 ENVIRONMENTAL CONDITIONS**

- A. The equipment specified is intended for application in an environment as described below:
  - 1. Altitude: 564 feet above sea level.
  - 2. Maximum Temperature: 95 degrees F.
  - 3. Minimum Temperature: 2 degrees F.

**PART 2 - PRODUCTS**

**2.1 ACCEPTABLE MANUFACTURERS**

- A. Russelectric
- B. ASCO
- C. Onan
- D. Kohler
- E. Zenith

**2.2 RATINGS**

- A. The automatic transfer switch shall have the following ratings when installed at the specified site and all

derating factors including those for temperatures and altitude are considered.

1. Current Capacity: as specified.
2. Voltage: 120/208
3. Phase: 3
4. Poles: 3
5. Frequency: 60 Hz
6. Enclosure: NEMA 1 wall mounted.

### 2.3 QUALIFICATIONS OF SUPPLIERS

- A. The transfer switch shall be manufactured by a company who is regularly engaged in the manufacture of similar units and who has been in business for at least ten (10) years.
- B. The local representative of the transfer switch equipment shall have full service capability for the equipment including a factory trained technician located within one hours drive from job site, equipment to service and test the transfer switch.

### 2.4 COORDINATION WITH OTHER EQUIPMENT

- A. The equipment supplied under this section shall be fully coordinated with and form a complete operational system with equipment supplied under other sections. The contractor shall coordinate between suppliers to insure compatibility of equipment for the intended function.

### 2.5 AUTOMATIC TRANSFER

- A. The transfer switch shall be inherently double pole and shall be actuated by a single electrical operator, either solenoid or motor device.
- B. The switch shall be mechanically interlocked to assure only one position can be obtained (normal or emergency) and that no intermediate positions can be obtained.
- C. The electric operator shall be energized from the source to which the load is to be transferred.
- D. Contacts shall be silver alloy complete with arc chutes.
- E. A manual operator with handle shall be furnished with mechanism to insure acceptable transfer time when manually activated.
- F. Controls shall be either electro-mechanical or electronic. Controls shall be capable of being accurately field adjusted without need for special testing or timing apparatus. Controls may be mounted in switch cabinet or on cabinet door but must be accessible while energized with complete operator safety.
- G. Switches which are manufactured using circuit breakers or parts of circuit breakers as main contact mechanisms are not acceptable.
- H. Where neutral is switched, the neutral contacts shall be full phase capacity. Nonoverlapping neutral contacts are preferred, however, overlapping neutral contacts are acceptable providing overlap time does not exceed 100 milliseconds.
- I. The automatic transfer switch or prototype thereof shall have passed all requirements of UL Standard UL1008 as a complete enclosed unit.
- J. The automatic transfer switch shall be provided with the following accessories.
  1. Time delay to override momentary outages, adjustable 0-5 min.
  2. Time delay retransfer to normal source, adjustable 0-30 min. with bypass push-button.
  3. Unloaded running time delay (cool down) adjustable 0-5 min.
  4. Time delay transfer to emergency, adjustable 0-1 min.

5. Close differential voltage sensing on all phases of normal source, adjustable.
  6. Engine start contact.
  7. Test switch to simulate source failure with "load-no load" selector.
  8. Auxiliary contacts on shaft:
    - 1 closed in normal position.
    - 1 closed in emergency position.
  9. Exercise timer.
- K. Lugs for connection of power conductors shall be provided to accommodate the cabling indicated on the drawings.
- L. The enclosure shall be fabricated of heavy gauge sheet steel and shall be finish painted in accordance with the manufacturer's standards. Enclosures shall be suitable for the intended environment. Enclosures for indoors shall be NEMA 1. Suitable room for cable termination and bending shall be provided. Pilot devices for control functions shall be mounted on the front of the hinged door and shall be clearly labeled with black lamacoid nameplates with white letters screwed to the sheet steel. Pilot devices shall be of the "oil-tight" type. Miniature type lights and switches are not acceptable.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install the automatic transfer switch in accordance with the drawings and these specifications. Make all necessary connections.
- B. Final connections and control checkout shall be done under supervision of equipment manufacturer's field representative.
- C. Manufacturer's wiring diagrams shall be used to connect the equipment. All wiring and conduit shall be as called for in these specifications.

#### **3.2 TESTING**

- A. Manufacturers standard factory tests shall be performed prior to shipment. Records of these tests shall be certified and submitted to the Architect/Engineer for his review.
- B. On site tests shall be performed as follows:
  1. Control check to show that all control functions are operational. Provide certified documentation of results of this test.
  2. Load building testing, as specified in Section 16210, shall be done with the transfer switch specified herein connected to the system and operational. During and immediately after the testing, the transfer switch shall be inspected for evidence of overheating and malfunction. Any abnormalities shall be reported to the Architect.

#### **3.3 WARRANTY**

- A. The total equipment installation shall be warranted for a period of one year from date of final test or acceptance. All parts and labor shall be covered under the terms of the warranty.

**END OF SECTION**

**SECTION 26 43 13 - SURGE PROTECTION DEVICES (SPD's)**

**PART 1 GENERAL**

**1.1 SCOPE**

- A. These specifications describe the electrical and mechanical requirements for a hybrid electrical Surge Protection Device/filter system integrating both surge protection devices (SPD's) and electrical high frequency noise filtering for exposure locations as defined in the latest edition of ANSI/IEEE C62.41.

**1.2 REFERENCE STANDARDS**

- A. ANSI/IEEE C.62.41 and C62.45
- B. UL 1449 – 3rd Edition 2009 Revision (effective 9/29/2009)
- C. UL 1283
- D. NEC – NFPA 70
- E. NEMA LS1 and LS2
- F. NFPA
- G. OSHA
- H. IEEE Std. 1100

**1.3 QUALITY ASSURANCE**

- A. The unit shall be designed and assembled in the USA by a qualified manufacturer of TVSS products and line conditioning equipment. The manufacturer shall have been engaged in the design and manufacture of such products for a minimum of 10 years.

**1.4 SUBMITTALS**

- A. Submittals shall be in accordance with Division 1 and shall include:
  - 1. Manufacturer's catalog information showing dimensions, configurations, and specifications.
  - 2. Copies of independent test reports UL 1449 and NEMA LS1 and LS2.
- B. Provide actual UL 1449, Third edition Type 1 20kA nominal discharge current documentation showing the Voltage Protection Ratings (VPR) as well all engineering considerations for the specific catalog number submitted. Typical UL 1449 data is not acceptable.

- C. Provide third party test documentation demonstrating that the device is capable of surviving the specified maximum surge current rating without failure or component degradation greater than 10%. Test documentation shall clearly show that tests were performed on a complete device including all necessary fusing and disconnects.
- D. Provide data confirming that the device is capable of surviving the published number of repetitive ANSI/IEEE 62.41, Category C3, 20kV/10KA impulses without failure or performance degradation.
- E. Provide test documentation demonstrating that the device is capable of surviving the specified short circuit fault current rating.
- F. Provide a complete test documentation package per the recommendations of NEMA LS1 and LS2.
- G. Line by Line compliance matrix demonstrating adherence to these specifications.

## **PART 2 PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Liebert Corporation
- B. Current Technology
- C. Siemens
- D. Square D
- E. Cutler Hammer

### **2.2 SERVICE ENTRANCE SWITCHBOARD (1200 AMPERES and LARGER) Protective DEVICE**

- A. General
  - 1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
  - 2. Maximum Continuous Operating Voltage (MCOV). The MCOV shall be greater than 115% of nominal voltage for all products.
  - 3. Operating frequency range shall be 47-63 Hertz.
  - 4. Surge Rating shall be 200kA per mode
  - 5. Monitoring System shall include as a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the SPD for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring. Additionally, the unit shall include a visual status of suppression protection available, shown in a percentage from 0% to 100%; indication of the number of swells (voltage > 110% of nominal); surges (voltage > 130% of peak voltage); sags (voltage < 90% of nominal); and outages (power interruptions > 1 cycle) the device has encountered.
  - 6. Acceptable Products shall be, no substitutions:



- a. Liebert # SI040 Series
  - b. Current Technology # TG200 Series.
- B. Physical
1. Enclosure: The specified system shall be provided in a heavy duty NEMA 4 dust-tight, drip-tight enclosure with no ventilation openings.
  2. Provide a plastic lexan cover with lock for outdoor applications.
- C. Electrical
1. Unit shall be UL1449, 3rd Edition (September 29, 2009) Type 1 20kA nominal discharge current Listed. A SPD that is a UL "Recognized" component will not be accepted.
  2. Each surge suppression and filter element shall be individually fused so that a failure of one element and/or fuse shall not affect nor operate any other fuse element. SPD shall have a short-circuit rating of 200kAIC. Devices that accomplish this rating by requiring or providing additional fusing to the SPD system will not be accepted.
  3. All fusing elements shall be UL Listed or Recognized as a complete fusing system.
  4. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of the unit.
  5. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.
- D. Performance
1. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be no less than 200,000 Amps per mode, based on ANSI/IEEE C62.41 Standard 8X20  $\mu$ sec current waveform.
  2. Tested Single Pulse Surge Current Capacity. Suppression filter systems shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. The test shall include a UL1449 Third Edition surge defined as a 1.2X50  $\mu$ sec, 6000V open circuit voltage waveform and an 8X20  $\mu$ sec, 3000A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an 8X20  $\mu$ sec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
  3. Minimum Life Cycle Rating. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45, Test suppression filter systems in every mode utilizing a 1.2X50  $\mu$ sec, 20 KV open circuit voltage, 8X20  $\mu$ sec, 10 KA short circuit current Category C3 bi-wave at one minute intervals without suffering performance degradation of more than 10% deviation of clamping voltage. Tested life under these conditions shall be no less than 5,000 impulses per mode.
  4. UL1449 Voltage Protection Rating. All suppression filter system clamping voltages shall be in compliance and listed by UL1449 3rd edition Type 1 with a nominal discharge current of 20kA. Maximum listed clamping voltages shall be as follows:
    - a. Unit shall provide maximum UL1449 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:
      - L-N = 700V
      - L-G = 700V
      - N-G = 700V
      - L-L = 1000V
    - b. Unit shall provide maximum UL1449 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:
      - L-N = 1000V
      - L-G = 1200V
      - N-G = 1000V
      - L-L = 1800V

5. Noise Attenuation - The unit shall be UL1283 in Type 2 locations Listed as an electromagnetic interference filter. The filter shall provide 41dB at 100kHz, 31dB at 1MHz, 35dB at 10MHz, 53dB at 100MHz, per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120-dB insertion loss from 100 kHz to 100 MHz when used in a coordinated facility system.
6. Overcurrent Protection - Each suppression element shall be individually fused such that the failure of a single component or the operation of a single fuse element remains isolated and does not render the entire mode, or product, deficient by more than 5%. Fusing shall be present in all modes, including Neutral-to-Ground. The device shall be capable of withstanding the full single pulse surge current capacity for every mode without the operation or failure of overcurrent / fault current protection or fuses.
7. Internal Conductor Path. All full magnitude transient current shall be conducted utilizing low-impedance copper bus bar. No plug-in component modules or quick-disconnect terminals shall be used in surge current-carrying paths.

### 2.3 DISTRIBUTION PANEL (400 AMPERES TO 1200 AMPERES) Protective DEVICE

- A. General
  1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
  2. Maximum Continuous Operating Voltage (MCOV). The MCOV shall be greater than 115% of nominal voltage for all products.
  3. Operating frequency range shall be 47-63 Hertz.
  4. Surge Rating shall be 80kA per mode
  
  5. Monitoring shall include: As a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the SPD for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm with battery backup, and a set of Form C contacts for remote monitoring.
  6. Acceptable Products shall be, no substitutions:
    - a. Liebert #AII Series.
    - b. Current Technology #TG80 Series.
- B. Physical
  1. Enclosure: The specified system shall be provided in a heavy duty NEMA 4 dust-tight enclosure with no ventilation openings.
  2. Provide a plastic lexan cover with lock for outdoor applications.
- C. Electrical
  1. Unit shall be UL1449, 3rd edition (September 29, 2009) Type 1 with a nominal discharge current of 20kA Listed. A SPD that is a UL "Recognized" component will not be accepted.
  2. Each surge suppression and filter element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect nor operate any other fuse element. SPD shall have a short-circuit rating of 200kAIC. Devices that accomplish this rating by requiring or providing additional fusing to the SPD system will not be accepted.
  3. All fusing elements shall be UL Listed or Recognized as a complete fusing system.
  4. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of the unit.
  5. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

- D. Performance
1. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be no less than 80,000 Amps per mode.
  2. Tested Single Pulse Surge Current Capacity. Suppression filter systems shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. The test shall include a UL1449 Third Edition surge defined as a 1.2X50  $\mu$ sec, 6000V open circuit voltage waveform and an 8X20  $\mu$ sec, 3000A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an 8X20  $\mu$ sec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
  3. Minimum Life Cycle Rating. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992, Test suppression filter systems in every mode utilizing a 1.2X50  $\mu$ sec, 20 KV open circuit voltage, 8X20  $\mu$ sec, 10 KA short circuit current Category C3 bi-wave at one minute intervals without suffering performance degradation of more than 10% deviation of clamping voltage at the specified surge current. Tested life under these conditions shall be no less than 4,000 impulses per mode.
  4. UL1449 Voltage Protection Rating. All suppression filter system clamping voltages shall be in compliance and listed by UL1449. Maximum listed clamping voltages shall be as follows:
    - a. Unit shall provide maximum UL1449 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:

L-N = 600V  
L-G = 700V  
N-G = 600V  
L-L = 900V
    - b. Unit shall provide maximum UL1449 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:

L-N = 1000V  
L-G = 1000V  
N-G = 900V  
L-L = 1800V
  5. Noise Attenuation. The unit shall be UL1283 Listed in Type 2 locations as an electromagnetic interference filter. The filter shall provide 30dB at 100kHz, 60dB at 500kHz, 40dB at 1MHz, 12dB at 10MHz, per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120-dB insertion loss from 100 kHz to 100 MHz when used in a coordinated facility system.
  6. Overcurrent Protection. Each suppression element shall be individually fused such that the failure of a single component or the operation of a single fuse element remains isolated and does not render the entire mode, or product, deficient by more than 5%. Fusing shall be present in all modes, including Neutral-to-Ground. The device shall be capable of withstanding the full single pulse surge current capacity for every mode without the operation or failure of overcurrent / fault current protection or fuses.

#### 2.4 BRANCH PANEL (100 amperes to 225 amperes) Protective DEVICE

- A. General
1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
  2. Maximum Continuous Operating Voltage (MCOV). The MCOV shall be greater than 115% of nominal voltage for all products.
  3. Operating frequency range shall be 47-63 Hertz.
  4. Surge rating shall be 65kA per Mode
  5. Monitoring: Status LED's and Form C contacts.
  6. Acceptable Products shall be, no substitutions:
    - a. Current Technology #TG60 Series.
    - b. Liebert #ACV Series.

- B. Physical
1. Enclosure: The specified system shall be provided in a heavy duty NEMA 4 dust-tight, drip-tight enclosure with no ventilation openings.
  2. Provide a plastic lexan cover with lock for outdoor applications.
- C. Electrical
1. Unit shall be UL1449, 3rd Edition (September 29, 2009) Type 1 20kA nominal discharge current Listed. A SPD that is a UL "Recognized" component will not be accepted.
  2. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of the unit.
  3. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.
- D. Performance
1. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be no less than 65,000 Amps per mode.
  2. Tested Single Pulse Surge Current Capacity. Suppression filter systems shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. The test shall include a UL1449 Third Edition surge defined as a 1.2 X 50  $\mu$ sec, 6000V open circuit voltage waveform and an 8X20  $\mu$ sec, 3000A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an 8X20  $\mu$ sec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
  3. Minimum Life Cycle Rating. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992, Test suppression filter systems in every mode utilizing a 1.2X 50  $\mu$ sec, 20 KV open circuit voltage, 8X20  $\mu$ sec, 10 KA short circuit current Category C3 bi-wave at one minute intervals without suffering performance degradation of more than 10% deviation of clamping voltage at the specified surge current. Tested life under these conditions shall be no less than 2,500 impulses per mode.
4. UL1449 Voltage Protection Rating. All suppression filter system clamping voltages shall be in compliance and listed by UL1449. Maximum listed clamping voltages shall be as follows:
    - a. Unit shall provide maximum UL 1449 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:

L-N = 600V  
L-G = 700V  
N-G = 600V  
L-L = 900V
    - b. Unit shall provide maximum UL1449 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:

L-N = 1000V  
L-G = 1000V  
N-G = 900V  
L-L = 1800V
  5. Noise Attenuation the unit shall be UL 1283 for type 2 locations Listed as an electromagnetic interference filter. The filter shall provide 30dB at 100kHz, 60dB at 500kHz, 40dB at 1MHz, 12dB at 10MHz, per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120-dB insertion loss from 100 kHz to 100 MHz when used in a coordinated facility system.

## 2.5 DOCUMENTATION

- A. All non-approved manufacturers shall submit for 10-day pre-approval, and provide detailed compliance or exception statements to all provisions of this specification to allow consideration. Additionally, manufacturers shall submit independent test data from a nationally recognized testing laboratory verifying the following: life cycle testing, overcurrent protection, UL1449, noise attenuation and surge current capacity. Failure to do so will result in product disapproval.

## PART 3 EXECUTION

### 3.1 INSTALLATION AND TESTING

- A. The SPD shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturers recommended installation instructions. Cable connections to the bus or disconnect shall utilize cable sized and terminated in accordance with the manufacturer's recommendations. The SPD shall be connected via manufacturers low impedance connection system, installed using the shortest practical cable length, and avoiding all unnecessary bends.
- B. External Conductor Path. All external SPD's shall be connected via a special transient cable, UL approved, which must, through integrated testing with the SPD, reflect a minimum 300% reduction in voltage drop when compared to using standard THW or THHN wire, if length from panel to TVSS unit exceeds 10'0".
- C. Per NEMA Std. 1100-2005, Sec. 8.4.2.5, to eliminate collateral damage in the event of SPD failure, the SPD must be installed external to all switchboards and panelboards.
- D. System Testing: Upon completion of installation, a factory-authorized local service representative shall provide product start-up testing services. The tests shall include:
  - 1. On-Line Testing: verification that all suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage.
  - 2. Off-line Testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. To be compared to factory benchmark test parameters supplied with each individual unit.
- E. All local and national codes must be observed.

### 3.2 WARRANTY

- A. The manufacturer shall provide a full ten (10) year parts warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL Listing requirements and any applicable national, state or local electrical codes. Manufacturer shall have a direct, factory trained, ISO 9001 certified employees must be available for 48-hour assessment. A 24-hour 800 number must be available to support warranty.

END OF SECTION

**SECTION 26 51 00 - INTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Interior lighting fixtures, lamps, and ballasts.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.
  - 5. Retrofit kits for fluorescent lighting fixtures.

**1.3 DEFINITIONS**

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

**1.4 SUBMITTALS**

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Emergency lighting units including battery and charger.
  - 3. Ballast.
  - 4. Energy-efficiency data.
  - 5. Life, output, and energy-efficiency data for lamps.
  - 6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

- a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
  - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- 1. Wiring Diagrams: Power and control wiring.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- D. Qualification Data: For agencies providing photometric data for lighting fixtures.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- G. Warranties: Special warranties specified in this Section.

### **1.5 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

### **1.6 COORDINATION**

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

### **1.7 WARRANTY**

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.
  2. Warranty Period for Emergency Fluorescent Ballast Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
  2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
- C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
1. Warranty Period: One year(s) from date of Substantial Completion.

## **1.8 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps:
    - a. Incandescent (each type/size) -1 case
    - b. Fluorescent (each type/size) - 4 cases
    - c. Metal Halide (each type/size) – 2 cases
  2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  3. Battery and Charger Data: One for each emergency lighting unit.
  4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.



3. Basis-of-Design Product: The design for each lighting fixture 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.

## **2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS**

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. 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.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
  4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
  1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
    - b. UV stabilized.
  2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

## **2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS**

- A. Electronic Ballasts: Comply with ANSI C82.11; instant, programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
  1. Sound Rating: A.

2. Total Harmonic Distortion Rating: Less than 10 percent.
  3. Transient Voltage Protection: IEEE C62.41, Category A or better.
  4. Operating Frequency: 20 kHz or higher.
  5. Lamp Current Crest Factor: 1.7 or less.
  6. BF: 0.85 or higher.
  7. Power Factor: 0.95 or higher.
  8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
  2. Automatic lamp starting after lamp replacement.
  3. Sound Rating: A.
  4. Total Harmonic Distortion Rating: Less than 20 percent.
  5. Transient Voltage Protection: IEEE C62.41, Category A or better.
  6. Operating Frequency: 20 kHz or higher.
  7. Lamp Current Crest Factor: 1.7 or less.
  8. BF: 0.95 or higher, unless otherwise indicated.
  9. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- D. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
  2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
- G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
    - a. High-Level Operation: 100 percent of rated lamp lumens.

- b. Low-Level Operation: 30 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

#### **2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS**

- A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
  1. Lamp end-of-life detection and shutdown circuit.
  2. Automatic lamp starting after lamp replacement.
  3. Sound Rating: A.
  4. Total Harmonic Distortion Rating: Less than 20 percent.
  5. Transient Voltage Protection: IEEE C62.41, Category A or better.
  6. Operating Frequency: 20 kHz or higher.
  7. Lamp Current Crest Factor: 1.7 or less.
  8. BF: 0.95 or higher, unless otherwise indicated.
  9. Power Factor: 0.95 or higher.
  10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
  11. Ballast Case Temperature: 75 deg C, maximum.
- B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
  1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

#### **2.5 EMERGENCY FLUORESCENT POWER UNIT**

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
  1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Night-Light Connection: Operate one fluorescent lamp continuously.
  3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  4. Battery: Sealed, maintenance-free, nickel-cadmium type.
  5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers

- simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
  3. Battery: Sealed, maintenance-free, nickel-cadmium type.
  4. Charger: Fully automatic, solid-state, constant-current type.
  5. Housing: NEMA 250, Type 1 enclosure.
  6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
  9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## **2.6 BALLASTS FOR HID LAMPS**

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. 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 deg F (Minus 30 deg C) for single-lamp ballasts.
  3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
  4. Open-circuit operation that will not reduce average life.
  5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Lamp end-of-life detection and shutdown circuit.
  2. Sound Rating: A.
  3. Total Harmonic Distortion Rating: Less than 15 percent.
  4. Transient Voltage Protection: IEEE C62.41, Category A or better.
  5. Lamp Current Crest Factor: 1.5 or less.
  6. Power Factor: .90 or higher.
  7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
  8. Protection: Class P thermal cutout.
  9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
  10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.

- a. High-Level Operation: 100 percent of rated lamp lumens.
  - b. Low-Level Operation: 35 percent of rated lamp lumens.
  - c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.
- a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
  - b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
- C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

## **2.7 EXIT SIGNS**

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
  2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
    - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## **2.8 EMERGENCY LIGHTING UNITS**

- A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

## **2.9 FLUORESCENT LAMPS**

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.
- C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.
- E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.
- F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
  1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
  6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

**2.10 HID LAMPS**

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
  - 1. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

**2.11 LIGHTING FIXTURE SUPPORT COMPONENTS**

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
  - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Adjust aimable lighting fixtures to provide required light intensities.

### **3.2 FIELD QUALITY CONTROL**

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**END OF SECTION 26 51 00**



**SECTION 26 56 00 - EXTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Exterior luminaires with lamps and ballasts.
  - 2. Poles and accessories.
- B. Related Sections include the following:
  - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

**1.3 DEFINITIONS**

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

**1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION**

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
- D. 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 (15 m) or less in height is 90 mph.

**1.5 SUBMITTALS**

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Ballasts, including energy-efficiency data.
  - 7. Lamps, including life, output, and energy-efficiency data.
  - 8. Materials, dimensions, and finishes of poles.
  - 9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - 10. Anchor bolts for poles.
- B. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- C. Qualification Data: For agencies providing photometric data for lighting fixtures.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For luminaries and poles to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

**1.6 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
  - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than 1 year from date of Substantial Completion.

**1.9 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Globes and Guards: 2 for every 10 of each type and rating installed. Furnish at least one of each type.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
  - 3. 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.

**2.2 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. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. 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.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.

- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. 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.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.
    - b. Color: Match Architect's sample of dark bronze finish color.
    - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - a. Color: Dark bronze.

### **2.3 FLUORESCENT BALLASTS AND LAMPS**

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F (minus 18 deg C) and higher.
- B. Ballast Characteristics:
  - 1. Power Factor: 90 percent, minimum.
  - 2. Sound Rating: A.
  - 3. Total Harmonic Distortion Rating: Less than 10 percent.
  - 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
  - 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
  - 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) and higher.
- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

#### **2.4 BALLASTS FOR HID LAMPS**

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp 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 deg F (Minus 30 deg C).
  - 3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
  - 4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
- B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
- C. 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 deg 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 deg F (Minus 40 deg C).

#### **2.5 HID LAMPS**

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
  - 1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

#### **2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS**

- A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
  2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
  2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

## **2.7 REQUIREMENTS FOR INDIVIDUAL EXTERIOR LIGHTING DEVICES**

- A. Exterior Lighting Device Type
1. Basis-of-Design Product: Gardco and Sistemalux
  2. Voltage: RTLFS
  3. Lamps: Refer to light fixture schedule
  4. Ballast Types and Features: Refer to schedule
  5. Lens: RTS
  6. Reflector: RTS
  7. IESNA Lateral Distribution Class: RTS
  8. IESNA Cutoff Category: Cutoff.
  9. Ballast Factor: 09.
  10. Minimum Luminaire Efficacy Rating: 57%
  11. Pole Description:
    - a. Material or Type: Round non-taped steel
    - b. Luminaire Support Components and Accessories: Metal pole bracket Intermediate handhole and cable support Grounding and bonding lug.
    - c. Mounting Provisions: Concrete foundation.
    - d. Luminaire Mounting Height above Finished Grade: 15'-0".

## **PART 3 - EXECUTION**

### **3.1 LUMINAIRE INSTALLATION**

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

### **3.2 POLE INSTALLATION**

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

### **3.3 CORROSION PREVENTION**

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### **3.4 GROUNDING**

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole, unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole.
  - 2. Install grounding conductor and conductor protector.
  - 3. Ground metallic components of pole accessories and foundations.

### **3.5 FIELD QUALITY CONTROL**

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.



**END OF SECTION 26 56 00**