END OF SECTION

SECTION 16207/TRANSFER SWITCHES - CONTACTOR TYPE

1 GENERAL

1.1 Related Documents

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

1.2 Summary

1.2.1 This Section includes transfer switches rated 600 V and less.

1.3 Quality Assurance

1.3.1 Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

1.3.2 Source Limitations: Obtain switches through one source from a single manufacturer.

1.3.3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3.4 Comply with NEMA ICS 1.

1.3.5 Comply with NFPA 70.

1.3.6 Comply with NFPA 99 (where applicable).

1.3.7 Comply with NFPA 110.

1.3.8 Comply with UL 1008 unless requirements of these Specifications are stricter.

1.4 Approval Submittals:

1.4.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each product provided.

1.4.2 Shop Drawings:

1.4.2.1 Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

1.5 Test Reports and Verification Submittals:

1.5.1 Training: Submit letter verifying that Owner training has been received by factory

representative.

1.5.1.1 Perform the following field tests and inspections and prepare test reports:

1.5.1.1.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing. See section 3 of this specification for more information.

1.5.1.1.2 NETA ATS: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22. Certify compliance with test parameters. See section 3 for more information.

1.6 O&M Data Submittals:

1.6.1 Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

2 PRODUCTS

2.1 Acceptable Producers:

2.1.1 Contactor Transfer Switches: Caterpillar, ASCO, Kohler, Onan/Cummins, Russelectric.

2.2 General Transfer-Switch Product Requirements

2.2.1 Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including 100% tungsten filament lamp loads.

2.2.2 Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

2.2.3 Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

2.2.4 Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

2.2.5 Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

2.2.6 Neutral Terminal: Switched and fully rated.

2.2.7 Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2.8 Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

2.2.9 Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.

2.2.10 Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

2.2.11 Control Wiring: Equipped with lugs suitable for connection to terminal strips.

2.2.12 Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

2.2.13 Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

2.2.14 Switch Action: Double throw; mechanically held in both directions.

2.2.15 Contacts: Fully rated silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

2.3 Automatic Transfer Switches

2.3.1 Comply with Level 1 equipment according to NFPA 110.

2.3.2 Microprocessor based.

2.3.3 Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

2.3.4 Manual "Test" Switch Operation: Under load and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

2.3.5 Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

2.3.6 Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

2.4 Automatic Transfer-Switch Features

2.4.1 Undervoltage Sensing for Each Phase of Normal Source: Senses voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2.4.2 Time delay for override of normal-source voltage sensing delays transfer and engine start signals.

Adjustable from zero to six seconds, and factory set for one second.

2.4.3 Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

2.4.4 Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

2.4.5 In-Phase Monitor: Provide in-phase monitor to compare phase angles of both sources and prevent transfer until the two are approximately in phase.

2.4.6 Test Switch: Simulates normal-source failure.

2.4.7 Switch-Position Pilot Lights: Indicate source to which load is connected.

2.4.8 Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

2.4.9 Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

2.4.10 Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

2.4.11 Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

2.4.12 Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

2.4.13 Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

2.4.14 Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

2.4.15 Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

2.4.16 Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

2.4.17 Push-button programming control with digital display of settings.

2.4.18 Integral battery operation of time switch when normal control power is not available.

2.5 Finishes

2.5.1 Enclosures: Manufacturer's polyester powder coat over corrosion-resistant pretreatment and primer.

2.6 Source Quality Control

2.6.1 Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

3 EXECUTION

3.1 Application

3.1.1 Four-Pole Switches: install neutral switching.

3.2 Installation

3.2.1 Floor-Mounted Switch: Anchor to floor by bolting.

3.2.2 Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."

3.2.3 Identify components according to Division 16 Section "Basic Electrical Materials and Methods."

3.3 Wiring to Remote Components

3.3.1 Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.4 Connections

3.4.1 Ground equipment according to Division 16 Section "Grounding and Bonding."

3.4.2 Connect wiring according to Division 16 Section "Conductors and Cables."

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

3.5 BAS Communications

3.5.1 The generator shall communicate with the building automation system over MODBUS BacNET, LonWorks TCP/IP...

3.5.2 The following are the minimum required parameters to be communicated to the building automation system.

3.5.2.1 ATS AC Voltage - 3 phase (L-L & L-N)

3.5.2.2 ATS AC Current (per phase & average)

3.5.2.3 ATS kW (total & per phase)

3.5.2.4 ATS kVA (total & per phase)

3.5.2.5 ATS kVAR (total & per phase)

3.5.2.6 ATS % Line Voltage Unbalance

3.5.2.7 ATS % Current Unbalance

3.5.2.8 ATS Power Factor (PF, average & per phase)

3.5.2.9 ATS Frequency (Active, Normal, & Emergency Sources)

3.5.2.10 Neutral Current

3.5.2.11 Neutral Voltage Unbalance

3.5.2.12 Phase Shift

3.6 Field Quality Control

3.6.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

3.6.2 Perform the following field tests and inspections and prepare test reports:

3.6.3 After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3.6.4 Check for electrical continuity of circuits and for short circuits.

3.6.5 Inspect for physical damage, proper installation and connection, and integrity of barriers, covers,

and safety features.

3.6.6 Verify that manual transfer warnings are properly placed.

3.6.7 Perform manual transfer operation.

3.6.8 After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

3.6.9 Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

3.6.10 Simulate loss of phase-to-ground voltage for each phase of normal source.

3.6.11 Verify time-delay settings.

3.6.12 Verify pickup and dropout voltages by data readout or inspection of control settings.

3.6.13 Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

3.6.14 Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

3.6.15 Coordinate tests with tests of generator and run them concurrently.

3.6.16 Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6.17 Remove and replace malfunctioning units and retest as specified above.

3.7 Demonstration

3.7.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.

3.7.2 Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 16420 / PANELBOARDS

1 GENERAL

1.1 Related Documents

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

1.2 Summary

1.2.1 This Section includes the following:

1.2.1.1 Distribution panelboards.

1.2.1.2 Lighting and appliance branch-circuit panelboards.

1.2.1.3 Load centers.

1.3 Definitions

1.3.1 EMI: Electromagnetic interference.

1.3.2 GFCI: Ground-fault circuit interrupter.

1.3.3 RFI: Radio-frequency interference.

1.3.4 RMS: Root mean square.

1.3.5 SPDT: Single pole, double throw.

1.4 Quality Assurance:

1.4.1 Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

1.4.2 Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated.

1.4.3 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.

1.4.4 Comply with NEMA PB 1.

1.4.5 Comply with NFPA 70.

1.4.6 Panelboards shall be listed and labeled by Underwriters' Laboratories, Inc. in accordance with UL Standard 67.

1.4.7 Panelboards for use as service disconnecting means shall additionally conform to UL 869.

1.5 Project Conditions

1.5.1 Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1.5.1.1 Ambient Temperature: Not exceeding 104 deg F (40 deg C).

1.5.1.2 Altitude: Not exceeding 6600 feet (2000 m).

1.5.2 Service Conditions: NEMA PB 1, usual service conditions, as follows:

1.5.2.1 Ambient temperatures within limits specified.

1.5.2.2 Altitude not exceeding 6600 feet (2000 m).

1.6 Coordination

1.6.1 Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.6.2 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 Approval Submittals:

1.7.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of:

1.7.1.1 Panelboard

1.7.1.2 Overcurrent protective device

1.7.1.3 Transient voltage surge suppression device

1.7.1.4 Metering device

1.7.2 Shop Drawings:

1.7.2.1 For each panelboard provide dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

1.7.2.1.1 Enclosure types and details for types other than NEMA 250, Type 1.

1.7.2.1.2 Bus configuration, current, and voltage ratings.

1.7.2.1.3 Short-circuit current rating of panelboards and overcurrent protective devices.

1.7.2.1.4 Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.7.2.1.5 Time-current curves, including selectable ranges for each type of overcurrent protective device equal to and greater than 250 amp frame.

1.7.2.1.6 Power, signal, and control wiring diagrams.

1.7.2.1.7 Panelboard schedules for installation in panelboards.

1.7.2.2 Electrical Room Layouts: For each electrical room, provide ¼" scale drawing showing equipment layouts for clearance verification. Show all equipment including equipment in other specification sections.

1.7.3 Emergency System Selective Coordination Study:

1.7.3.1 In accordance with NEC 700.27, the Contractor shall provide the engineer with a protective device selective coordination study showing recommended settings for all emergency system overcurrent protective devices provided under this contract. Recommended settings shall achieve full short circuit and overload coordination with all upstream devices and provide protection to all cables and other current carrying conductors providing power to or taking power from protective devices provided under this contract. The study shall be prepared by a Florida registered professional engineer and six copies shall be submitted signed and sealed.

1.7.3.2 Report shall contain time-current curves (TCC) for all new devices plotted on four cycle by five cycle log-log paper with all devices clearly identified. Contractor shall indicate all devices studied on a single line diagram. Each TCC shall contain all the devices in each possible path from the generator to the final branch circuit OCPD.

1.7.3.3 Contractor shall set all devices provided under this contract in accordance with coordination study recommendations. Coordination shall be a warranty item under this contract.

1.7.3.4 It shall be the responsibility of the contractor to ensure a selectively coordinated system and to provide equipment that complies.

1.7.3.5 The study shall be submitted at the same time as the product data submittals to ensure a fully compliant system prior to manufacturer and installation.

1.8 Test Reports and Verification Submittals:

1.8.1 Training: Submit letter verifying that Owner training has been received by factory representative.

1.8.2 Perform the following field tests and inspections and prepare test reports:

1.8.2.1 NETA ATS: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers (Only Emergency system breakers 400A frame and larger shall be tested). Certify compliance with test parameters.

1.8.2.2 Insulation Resistance: Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit. Document results.

1.8.2.2.1 Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

1.8.2.3 Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Document results.

1.8.2.3.1 Measure as directed during period of normal system loading.

1.8.2.3.2 Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

1.8.2.3.3 After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

1.8.2.3.4 Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

1.9 Thermographic Survey: After Substantial Completion, but not more than 60 days after Final Acceptance, perform a thermographic survey of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1.9.1 Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

1.9.2 Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

1.10 O&M Data Submittals:

1.10.1 Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

2 PRODUCTS

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

2.1.1 Panelboards and Accessories:

2.1.1.1 Eaton Corporation; Cutler-Hammer Products.

2.1.1.2 General Electric Co.; Electrical Distribution & Protection Div.

2.1.1.3 Square D.

2.1.1.4 Siemens.

2.2 Panelboards

2.2.1 Enclosures: Galvanized surface-mounted cabinets. NEMA 250, Type 1 .

2.2.1.1 Rated for environmental conditions at installed location.

2.2.1.2 Outdoor Locations: NEMA 250, Type 3R.

2.2.1.3 Hinged Front (Indoor units only): Trim shall have a hinged inner door over the branch disconnect area secured with one or two lockable flush latches. Tools shall not be required to open the inner hinged door. There shall also be a hinged outer door that covers the gutter area secured by screws. Tools shall be required to open the outer hinged door. All locks shall be keyed alike.

2.2.1.4 Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

2.2.1.5 Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

2.2.1.6 Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

2.2.1.7 Directory Card: Type written with transparent protective cover, mounted in metal frame, inside panelboard door.

2.2.1.8 Provide a plastic nameplate 1" high by 3" wide with minimum 1/4" letters indicating the panelboard identification, voltage and upstream protective device. The panelboard shall also have a nameplate affixed to the panelboard with the following information stamped therein:

2.2.1.8.1 Nameplate: Manufacturer, Voltage, Ampacity, Type of Panelboard, Manufacturer's Order No. and Date, Interrupting Rating - RMS Sym.

2.2.2 Phase and Neutral Buses:

2.2.2.1 Material: Hard-drawn copper, 98 percent conductivity.

2.2.2.2 Neutral Bus: Neutral bus shall be rated 100 or 200 percent of phase bus as indicated on the drawings.

2.2.3 Equipment Ground Bar: Copper or tin plated copper. Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

2.2.4 Conductor Connectors: Suitable for use with conductor material.

2.2.4.1 Main and Neutral Lugs: Mechanical Compression type. Crimp not allowed.

2.2.4.2 Ground Lugs and Bus Configured Terminators: Compression type.

2.2.5 Service Equipment Label (where indicated): UL labeled for use as service equipment for panelboards with main service disconnect switches.

2.2.6 Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 Panelboard Short-circuit Rating

2.3.1 Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 Distribution Panelboards

2.4.1 Main Overcurrent Protective Devices: Circuit breaker.

2.4.2 Branch Overcurrent Protective Devices: Circuit breaker.

2.5 Lighting and Appliance Branch-circuit Panelboards

2.5.1 Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.6 TVSS - Service Entrance Suppressors

2.6.1 Surge Protective Device Description: Modular design, UL 1449 3rd Edition Listed, mounted integral to panel enclosure with field-replaceable modules and the following features and accessories:

2.6.1.1 Fuses, rated at 200-kA interrupting capacity.

2.6.1.2 Fabrication using bolted compression lugs for internal wiring.

2.6.1.3 Integral disconnect switch.

2.6.1.4 Arrangement with copper busbars and for direct bolted connections to phase buses, neutral bus, and ground bus.

2.6.1.5 Red and green LED indicator lights for power and protection status.

2.6.1.6 Audible alarm, with silencing switch, to indicate when protection has failed.

2.6.1.7 One set of dry contacts rated at 2A and 24-V dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

2.6.1.8 Surge-event operations counter.

2.6.1.9 The TVSS system shall be duty life cycle tested to survive a minimum of 1,000 surges per phase of 10kV, 10 kA, IEEE C62.45 Category C3 surge current with less than 10% degradation of

clamping voltage.

2.6.1.10 The TVSS system shall have EMI/RFI filtering, UL1283 listed and per MIL-STD-220A.

2.6.1.11 Per NEC Article 285.6, TVSS shall be marked by a Short Circuit Current Rating (SCCR), equal to or greater than the available fault current where connected (as noted on drawings).

2.6.2 Peak Single-Impulse Surge Current Rating: 200kA per phase (L-N + L-G), 100kA per mode.

2.6.3 Protection modes and UL1449 clamping voltage for grounded wye circuits with voltages of 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

2.6.3.1 Line to Neutral: 400V for 208Y/120.

2.6.3.2 Line to Ground: 400V for 208Y/120.

2.6.3.3 Neutral to Ground: 400V for 208Y/120.

2.7 TVSS - Panelboard Suppressors

2.7.1 Surge Protective Device Description: Modular design, UL 1449 2nd Edition Listed, mounted integral to panel enclosure with field-replaceable modules and the following features and accessories:

2.7.1.1 Fuses, rated at 200-kA interrupting capacity.

2.7.1.2 Fabrication using bolted compression lugs for internal wiring.

2.7.1.3 Integral disconnect switch.

2.7.1.4 Arrangement with direct bus connections to phase buses, neutral bus, and ground bus.

2.7.1.5 Red and green LED indicator lights for power and protection status.

2.7.1.6 Audible alarm, with silencing switch, to indicate when protection has failed.

2.7.1.7 One set of dry contacts rated at 2A, 24-V dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

2.7.1.8 Surge-event operations counter.

2.7.1.9 The TVSS system shall be duty life cycle tested to survive a minimum of 2,500 surges per phase of 20kV, 10 kA, IEEE C62.41 Category C3 surge current with less than 5% degradation of clamping voltage.

2.7.1.10 The TVSS system shall have EMI/RFI filtering, UL1283 listed and per MIL-STD-220A.

2.7.2 Peak Single-Impulse Surge Current Rating: 100kA per phase (L-N + L-G), 50kA per mode.

2.7.3 Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

2.7.3.1 Line to Neutral: 400V for 208Y/120.

2.7.3.2 Line to Ground: 400V for 208Y/120.

2.7.3.3 Neutral to Ground: 400V for 208Y/120.

2.8 Overcurrent Protective Devices

2.8.1 Circuit breakers shall be molded case with trip units of size, type and quantity shown on the drawings. The circuit breakers shall be bolt-on type, equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Paper stickers are not acceptable for individual circuit numbers. Individual circuit numbers shall be phenolic. Trip indication shall be clearly shown by the breaker handle. Provisions for additional breakers shall be such that no additional connectors will be required to add circuit breakers. Breaker terminals shall be UL listed as suitable for type and size of conductor provided for.

2.8.2 The following are general/minimum requirements. Provide features trip units, etc. per the selective coordination study as required to achieve coordination.

2.8.2.1 Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.8.2.2 Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK.

2.8.2.3 Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Unless indicated otherwise, breakers smaller than 250A frame shall be thermal-magnetic.

2.8.2.4 Adjustable Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. Unless indicated otherwise, breakers smaller than 800A frame and at least 250A frame shall be adjustable thermal-magnetic.

2.8.2.5 Electronic Trip-Unit Circuit Breakers: Unless indicated otherwise, breakers 800A frame and larger shall be electronic trip type. RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

2.8.2.5.1 Instantaneous trip.

2.8.2.5.2 Long- and short-time pickup levels.

2.8.2.5.3 Long- and short-time time adjustments.

2.8.2.5.4 Ground-fault pickup level, time delay, and I^2t response.

2.8.3 Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.9 Digital Metering Device

2.9.1 Provide where indicated on the drawings a digital power monitoring device (University compliant SATEC) on the front of the panel fully connected with CT's with the following capabilities:

2.9.1.1 LCD alpha-numeric display.

2.9.1.2 Certified ANSI C12 revenue accuracy.

2.9.1.3 Current per phase and neutral.

2.9.1.4 Volts L-L and L-N.

2.9.1.5 Real Power (kW) A, B, C, total.

2.9.1.6 Reactive Power (kVAR) A, B, C, total.

2.9.1.7 Apparent Power (kVA) A, B, C, total.

2.9.1.8 Power Factor (true) A, B, C, total.

2.9.1.9 Frequency (Hz).

2.9.1.10 Real Energy (kWh) 3 phase total.

2.9.1.11 Reactive Energy (kVARh) 3 phase total.

2.9.1.12 Apparent Energy (kVAh) 3 phase total.

2.9.1.13 RS-485 communications.

2.9.1.14 THD voltage and current A, B, C.

2.9.1.15 Real power demand (kWd) 3 phase total present & peak.

2.9.1.16 Reactive power demand (kVARd) 3 phase total present & peak.

2.9.1.17 Apparent power demand (kVAd) 3 phase total present & peak.

2.9.1.18 Date and time stamping on peak demands.

2.10 Accessory Components and Features

2.10.1 Furnish accessory set including tools and miscellaneous items required for overcurrent protective

device test, inspection, maintenance, and operation.

3 EXECUTION

3.1 Installation

3.1.1 Install panelboards and accessories according to NEMA PB1.1.

3.1.2 Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

3.1.3 Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

3.1.4 Install overcurrent protective devices and controllers.

3.1.4.1 Set field-adjustable switches and circuit-breaker trip ranges.

3.1.5 Install filler plates in unused spaces.

3.1.6 Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.1.7 Provide four spare ¾" conduits from all recessed panelboards to above accessible ceiling for future use.

3.2 Identification

3.2.1 Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

3.2.2 Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Indicate load type (REC, LTG, AHU-1, etc.) and room numbers served for every branch circuit and panelboard served for every circuit breaker.

3.2.3 Panelboard Nameplates: Label each panelboard with engraved laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 Connections

3.3.1 Ground equipment according to Division 16 Section "Grounding and Bonding."

3.3.2 Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 Cleaning

3.4.1 On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 16510/OCCUPANCY SENSORS

1 GENERAL

1.1 Related Documents

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

1.2 Summary

1.2.1 This Section includes occupancy sensors for lighting control.

1.3 Definitions

1.3.1 DT: Dual Technology

1.3.2 LED: Light-emitting diode.

1.3.3 PIR: Passive infrared.

1.4 Quality Assurance

1.4.1 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.

1.4.2 All products shall be UL listed.

1.5 Coordination

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

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of product indicated.

1.6.2 Shop Drawings:

1.6.2.1 Show installation details for occupancy and light-level sensors.

1.6.2.2 ⅛" or ¼" scaled lighting plan showing location, orientation, and coverage area of each sensor.

1.6.2.3 Interconnection diagrams showing field-installed wiring.

1.7 Test Reports and Verification Submittals:

1.7.1 Training: Submit letter verifying that Owner training has been received by factory representative.

1.7.2 Perform the following field tests and inspections and prepare test reports:

1.7.2.1 Operational Test: After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements. Verify actuation of each sensor and adjust time delays. Set sensitivities, time delays, etc as required for each specific device based on the actual conditions of the environment in which it exists.

1.8 O&M Data Submittals:

1.8.1 Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

2 PRODUCTS

2.1 Manufacturers

2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.1.1.1.1 Hubbell Lighting Inc.

2.1.1.1.2 Watt Stopper (The).

2.1.1.1.3 Greengate.

2.1.1.1.4 Crestron.

2.1.2 General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

2.1.2.1 Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2.1.2.2 Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

2.1.2.3 Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2.1.2.4 Mounting:

2.1.2.4.1 Sensor: Suitable for mounting in any position on a standard outlet box.

2.1.2.4.2 Relay: Externally mounted though a ½-inch knockout in a standard electrical enclosure.

2.1.2.4.3 Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

2.1.2.5 Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.1.2.6 Bypass Switch: Override the on function in case of sensor failure.

2.1.2.7 Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.

2.1.3 PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

2.1.3.1 Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in.

2.1.3.2 Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

2.1.3.3 Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.

2.1.4 Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

2.1.4.1 Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2.1.4.2 Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.

2.1.4.3 Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on an 8-foot high ceiling.

2.1.4.4 Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.

2.1.4.5 Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot high ceiling in a corridor not wider than 14 feet.

2.1.5 Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.

2.1.5.1 Sensitivity Adjustment: Separate for each sensing technology.

2.1.5.2 Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in., and detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2.1.5.3 Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

2.1.6 Wall Switches: Mount at 48" AFF.

2.1.6.1 PIR Type: Single or Dual relay as indicated on plans with override off.

2.1.6.2 Digital Time Type: Automatically turns light off after preset time. LCD on front. Audible and visual alert prior to turning lights off.

2.2 Conductors and Cables

2.2.1 Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 16 Section "Basic Electrical Materials and Methods."

2.2.2 Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section "Basic Electrical Materials and Methods."

2.2.3 Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Basic Electrical Materials and Methods."

2.2.4 Provide plenum rated cable where required.

3 EXECUTION

3.1 Sensor Installation

3.1.1 Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 Wiring Installation

3.2.1 Wiring Method: Comply with Division 16 Section "Basic Electrical Materials and Methods."

3.2.1.1 Minimum conduit size shall be ½ inch.

3.2.2 Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

3.2.3 Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

3.2.4 Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

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

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

3.3 Identification

3.3.1 Identify components and power and control wiring according to Division 16 Section "Basic Electrical Materials and Methods."

3.4 Adjusting

3.4.1 Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION

SECTION 16520/INTERIOR LIGHTING

1 GENERAL

1.1 Related Documents

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

1.2 Summary

1.2.1 This Section includes the following:

1.2.1.1 Interior lighting fixtures with lamps and ballasts.

1.2.1.2 Lighting fixtures mounted on exterior building surfaces.

1.2.1.3 Emergency lighting units.

1.2.1.4 Exit signs.

1.3 Quality Assurance

1.3.1 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.

1.3.2 Comply with NFPA 70.

1.3.3 NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.4 Coordination

1.4.1 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.

1.5 Approval Submittals:

1.5.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of lighting fixture scheduled.

1.5.1.1 Arrange data in the order as they appear in the Lighting Fixture Schedule.

1.5.1.2 Include with each light fixture product data the ballast and lamp product data for that particular fixture. This information must accompany the light fixture product data.

1.6 Test Reports and Verification Submittals:

1.6.1 Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal. Test every fixture and provide written documentation of results.

1.7 O&M Data Submittals:

1.7.1 Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

2 PRODUCTS

2.1 Manufacturers

2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

2.1.1.1 Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products specified.

2.2 Fixtures and Components, General

2.2.1 Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

2.2.2 Fluorescent Fixtures: Comply with UL 1570.

2.2.3 Metal Parts: Free of burrs and sharp corners and edges.

2.2.4 Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

2.2.5 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.

2.2.6 Plastic Diffusers, Covers, and Globes:

2.2.6.1 Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2.2.6.1.1 Lens Thickness: At least 0.156 inch (3.175 mm) minimum unless different thickness is scheduled.

2.2.6.1.2 UV stabilized.

2.2.6.2 Glass: Tempered glass, unless otherwise indicated.

2.2.7 Electromagnetic-Interference Filters: A component of fixture assembly. Suppress conducted electromagnetic-interference as required by MIL-STD-461D. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 Lighting Fixtures

2.3.1 Fixtures shall be as indicated in the Lighting Fixture Schedule.

2.4 Fluorescent Lamp Ballasts

2.4.1 Ballasts for Low-Temperature Environments: Fluorescent ballast having a minimum starting temperature of zero degrees F in fixtures mounted in outdoors, in unheated buildings, and as indicated.

2.4.2 Programmed Start Solid State Electronic Ballasts: Electronic ballasts shall include the following features, unless otherwise indicated:

2.4.2.1 The electronic ballast shall be physically interchangeable with standard electromagnetic ballasts and standard electronic ballasts.

2.4.2.2 The electronic ballast shall have a maximum height of 1.18 in. and maximum weight of 1.8 lbs.

2.4.2.3 The electronic ballast shall be furnished with integral leads, color-coded to ANSI C82.11.

2.4.2.4 The electronic ballast shall operate from a nominal line voltage of 120 or 277 volts, +/-10%, 60Hz.

2.4.2.5 The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when used with primary lamp.

2.4.2.6 The electronic ballast shall have a Power Factor greater than 98% when used with primary lamp.

2.4.2.7 The electronic ballast shall withstand a sustained short to ground or open circuit of any output leads.

2.4.2.8 The electronic ballast shall be Sound Rated A.

2.4.2.9 The electronic ballast shall be specifically designed for use with the specified lamps.

2.4.2.10 The electronic ballast output frequency to the lamps shall be above 40kHz to minimize interference with infrared control systems and eliminate visible flicker.

2.4.2.11 The electronic ballast shall meet ANSI C82.11, where applicable.

2.4.2.12 The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

2.4.2.13 The electronic ballast shall be CBM certified, where applicable.

2.4.2.14 The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

2.4.2.15 The electronic ballast shall comply with all applicable state and federal efficiency standards.

2.4.2.16 The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

2.4.2.17 The electronic ballast shall not contain Polychlorinated Biphenyl (PCB's).

2.4.2.18 The electronic ballast shall carry a five-year warranty from the date of manufacture. Warranty shall be valid for a maximum case temperature of 70°C.

2.4.2.19 The manufacturer shall have a ten-year history of producing electronic ballast for the North American market.

2.4.2.20 The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

2.4.2.21 Ballast shall be produced in the United States of America.

2.4.2.22 Ballast shall have a minimum starting temperature of 0°F.

2.4.2.23 Approved Manufacturer: Universal Accustart, Phillips Advance Optanium series, G.E. Ultra Start.

2.4.3 Solid State 3-Wire Electronic 5% Dimming Ballasts: Electronic ballasts shall include the following features, unless otherwise indicated:

2.4.3.1 Dimming Range: 100% to 5% measured relative light output (RLO).

2.4.3.2 3-wire operation.

2.4.3.3 Lamp Starting: programmed rapid start.

2.4.3.4 Minimum Lamp Starting Temperature: 10°C (50°F).

2.4.3.5 Ambient Temperature Operating Range: 10°C (50°F) to 60°C (140°F).

2.4.3.6 Relative Humidity: maximum 90% noncondensing.

2.4.3.7 Operating Voltage: 120V, 60Hz nominal line.

2.4.3.8 Lamp Current Crest Factor: less than 1.7.

2.4.3.9 Lamp Flicker: none visible.

2.4.3.10 Light Output: constant ±5% light output for line voltage variations of ±10%.

2.4.3.11 Lamp Life: average lamp life meets or exceeds rating of lamp manufacturer.

2.4.3.12 Ballast Factor: greater than .85.

2.4.3.13 Power Factor: greater then .95.

2.4.3.14 Total Harmonic Distortion (THD): less than 10% at full light output.

2.4.3.15 Frequency of Operation: greater than 42kHz.

2.4.3.16 Maximum Inrush Current: 7 amps per ballast at 120V.

2.4.3.17 Sound Rating: Inaudible in a 27dBa ambient.

2.4.3.18 Maximum Ballast Case Temperature: 75°C (167°F).

2.4.3.19 UL Listed (evaluated to the requirements of UL935).

2.4.3.20 CSA certified (evaluated to the requirements of C22.2 No. 74).

2.4.3.21 Class P thermally protected.

2.4.3.22 Meets ANSI C82.11 High Frequency Ballast Standard.

2.4.3.23 Meets FCC Part 18 non-consumer requirements for EMI/RFI emissions.

2.4.3.24 Meets ANSI C62.41 Category A surge protection standards up to and including 6kV.

2.4.3.25 Manufacturing facilities employ ESD reduction practices that comply with the requirements of ANSI/ESD S20.20.

2.4.3.26 Manufacturer registered to ISO 9001.2000.

2.4.3.27 Approved Manufacturer: Lutron Tu-wire, Advance Mark 10 Powerline.

2.5 Exit Signs

2.5.1 General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

2.5.2 Internally Lighted Signs:

2.5.2.1 Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

2.5.3 Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

2.5.3.1 Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.

2.5.3.2 Charger: Fully automatic, solid-state type with sealed transfer relay.

2.5.3.3 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.

2.5.3.4 Shall have Self Verification and Test capability installed.

2.6 Emergency Lighting Units

2.6.1 General: Self-contained units complying with UL 924.

2.6.1.1 Battery: Sealed, maintenance-free, lead-acid type with minimum 5-year nominal life and special warranty.

2.6.1.2 Charger: Fully automatic, solid-state type with sealed transfer relay.

2.6.1.3 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.

2.6.1.4 1,400 lumen output for a minimum of 90 minutes during battery operation.

2.6.1.5 Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.

2.6.1.6 Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

2.6.1.7 Shall have Self Verification and Test capability installed.

2.7 Fluorescent Emergency Lighting Fixtures

2.7.1 Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

2.7.1.1 Emergency Connection: Operate one or more fluorescent lamps continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2.7.1.2 Night Light Connection: Operate one or more fluorescent lamps continuously.

2.7.1.3 Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

2.7.1.4 Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.

2.7.1.5 Charger: Fully automatic, solid-state, constant-current type.