SECTION 26 05 02 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Furnish all labor, material, services and skilled supervision necessary for the construction, erection, installation, connections, testing, and adjustment of all circuits and electrical equipment.

B. Equipment or Fixtures: Equipment and fixtures shall be connected to provide circuit continuity in accordance with the Specifications, whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures, and the point of circuit origin.

C. Work Installed but Furnished under Other Sections: The Electrical Work includes the installation or connection of certain materials and equipment furnished under other sections. Verify installation details. Foundations for apparatus and equipment will be furnished.

D. Provide conduit for all controls and other devices both line and low voltage. Install all control housings and back bone boxes required for installing conduit and wire to the controls. For networked web-based controls systems such as lighting that require Cat 6 cabling or any other similar system, conduits can be substituted with cable trays.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Protect cable ends from entrance of moisture.

B. Accept materials on site in original factory packaging, labeled with manufacturer’s identification.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

D. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, moisture, chemical, water, construction debris, mechanical damage, and traffic.

E. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided.

1.3 ENCLOSURES

A. Due to the corrosive exterior environment at Los Angeles International Airport, all electrical equipment and enclosures including but not limited to switchgear, switchboards, panel boards, motor control centers, electrical cabinets are to be located indoors in conditioned electrical rooms or spaces to the extent possible. Any equipment installation in wet outdoor areas or damp areas with moderate degree of moisture shall be listed for NEMA TYPE 4, TYPE 3R Stainless Steel Gasketed or better and have no top entry conduit installations. Any

equipment installation in dry areas but open to the environment and not normally subject to dampness, such as tunnels, tug and baggage conveyance areas, shall be listed for NEMA TYPE 3R/12. Canopies, terminal moats, tug and baggage conveyance areas within 25 feet from any opening to the outdoor environment shall be considered a damp location with moderate degree of moisture.

1.4 GENERAL REQUIREMENTS

A. Equipment Safety: All electrical materials and equipment shall be new and shall be listed by Underwriter's Laboratories and bear their label, or listed. Custom made equipment must have complete test data submitted by the manufacturer attesting to its safety.

B. Codes and Regulations:

1. Design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the latest publications or standard rules of the following:

a. Institute of Electrical and Electronic Designers - IEEE

b. National Electrical Manufacturers' Association - NEMA

c. Underwriters' Laboratories, Inc. - UL

d. National Fire Protection Association - NFPA

e. American Society for Testing and Materials - ASTM

f. American National Standards Institute - ANSI

g. American Standard Association - ASA

h. National Electrical Code - NEC, as modified by the city of Los Angeles

i. Insulated Power Cable Designers Association - IPCEA

j. InterNational Electrical Testing Association - NETA

C. Seismic Design of Electrical Equipment:

1. All electrical equipment shall be anchored per Airport Structural Design Standards and the applicable code.

D. Requirements of Regulatory Agencies:

1. Codes, Permits and Fees: Where provisions differ in regard to code application, size, quality, quantity or type of equipment, Contractor shall include in the bid, costs for the most costly provision either denoted in the specifications or on the drawings. This provision shall apply as an amendment to the California Public Contracts Code.

a. Comply with all requirements for permits, licenses, fees and Code. Permits, licenses, fees, inspections and arrangements required for the Work shall be obtained by the Contractor at his expense, unless otherwise specified.

b. Comply with the requirements of the applicable utility companies serving the Project. Make all arrangements with the utility companies for proper coordination

of the Work.

E. Shop Drawings and Submittals: Submittals are required on all material prior to installation. Shop drawings shall be submitted on, but not limited to, the following:

1. Equipment Wiring Connections
2. Medium Voltage Cables
3. Low Voltage Electrical Power Conductors and Cables
4. Grounding and Bonding for Electrical Systems
5. Hangers and Supports for Electrical Systems
6. Raceway and Boxes for Electrical Systems
7. Underground Ducts and Raceways for Electrical Systems
8. Vibration and Seismic Controls for Electrical Systems
9. Identification for Electrical Systems
10. Short Circuit and Overcurrent Protective Device Coordination Study
11. Web Based Power Monitoring Communications System
12. Lighting Control Devices
13. Network Lighting Control Systems
14. Medium Voltage Transformers
15. Metal Clad Switchgear (VacClad) B Medium Voltage
16. 34.5 kV Metering Switchgear
17. Low Voltage Transformers
18. Switchboards
19. Panelboards
20. Motor Control Centers
21. Enclosed Bus Assemblies
22. Electrical Cabinets and Enclosures
23. Wiring Devices
24. Fuses
25. Enclosed Switches
26. Enclosed Circuit Breakers
27. Enclosed Transfer Switches
28. Enclosed Controllers
29. Variable Frequency Motor Controllers
30. Engine Generators
31. Resistive Load Banks

32. Emergency Generators and Distribution Switchgear
33. Battery Equipment (Inverter)
34. Static Uninterruptible Power Supply
35. Emergency Circuit Conductors and Cable.
36. Metal Clad Drawout Switchgear B Low Voltage
37. Transient Voltage Suppression for Low Voltage Electrical Power Circuits
38. Interior Lighting
39. Exterior lighting
40. Fire Detection and Alarm
41. 3@ scale drawings of outdoor 34.5 kV switchgear yard, indoor 34.5 kV electrical vaults, all low voltage electrical rooms comply with all applicable LADWP, CEC and LA City requirements for equipment layout and installation. Also include associated grounding system grid drawings and details.
42. 1/8@ drawings for underground duct bank installation for normal and emergency feeders from main electrical rooms to sub electrical rooms with necessary conduit bank cross section details and equipment terminations.

F. Cutting and Patching:

1. Obtain written permission from LAWA before core drilling or cutting any structural members. Exact method and location of conduit penetrations and/or openings in concrete walls, floors, or ceilings shall be as approved by LAWA.
2. Use care in piercing waterproofing. After the part piercing the waterproofing has been set in place, seal openings and make absolutely watertight.
3. Seal all openings to meet the fire rating of the particular wall floor or ceiling.
4. In order to avoid severing any existing structural reinforcement, use ground penetrating radar or x-ray equipment to survey the existing concrete floor slabs/walls before cutting or drilling any new penetrations.

G. Miscellaneous:

1. LED control lights shall be used in all switchgear, switchboards, motor control centers and similar equipment.
2. Outdoor equipment enclosures shall be NEMA Type 4, Type 3R Stainless Steel, or better.
3. All floor mounted equipment shall be installed on a concrete housekeeping pad. Refer to Hangers and Supports for Electrical Equipment (26 05 30) Part 3.5 for requirements. (Added August 2013).

1.5 JOB CONDITIONS

A. Existing Conditions:

1. The contractor shall visit the site and verify existing conditions.
2. Electrical circuits affecting work shall be de energized while working on or near them.
3. Arrange the work so that electrical power is available to all electrical equipment within existing facility at all times. Schedule all interruptions at the convenience of LAWA, including exact time and duration, in accordance with LAWA's power shut down procedures. Provide temporary power during all periods of interruption, which are deemed excessive by LAWA.

B. Protection:

1. Protection of apparatus, materials and equipment. Take such precautions as necessary to properly protect all apparatus, fixtures, appliances, material, equipment and installations from damage of any kind. LAWA may reject any particular piece or pieces of material, apparatus or equipment scratched, dented or otherwise damaged.
2. Seal equipment or components exposed to the weather and make watertight and insect proof. Protect equipment outlets and conduit openings with temporary plugs or caps at all times that work is not in progress.
3. Provide weather protection, with heaters, for equipment stored outdoors.

1.6 POWER SHUTDOWN PROCEDURES

A. The contractor's construction schedule shall indicate dates of proposed electrical power shutdowns required to perform the installation. The contractor shall notify LAWA a minimum of thirty (30) days prior to each shutdown. Any shutdown coordination meetings shall be arranged by the contractor for each shutdown. LAWA Shutdown Control Center (SCC) representatives shall be invited to attend all shutdown coordination meetings.

B. Most power shutdowns will occur between the hours of 12:00 am and 4:00 am, as there are many that will start earlier or end later. Most switchboard level shutdowns will be no longer than 2 hours in duration.

C. Shutdowns to panelboard(s) shall require contractor to provide to LAWA Shutdown Control Center (SCC) with an electronic photo of:

1. EXISTING condition panelboard directory with time-date stamp (MM/DD/YYYY) in the lower right of photo for review & approval prior to shutdown.
2. NEW panelboard directory with time-date stamp (MM/DD/YYYY) in the lower right of the photo immediately upon successful completion of shutdown scope of work.

D. No interruptions to airport operations shall be allowed during periods deemed by LAWA as Holiday Construction Restriction Periods. These periods are typically from the Friday before the week of the Thanksgiving Holiday to the following Monday after the Thanksgiving Holiday (~9 calendar days), and the Friday before the week of the Christmas Holiday to the Monday following New Years Day (~16 calendar days). Contractor shall verify the Holiday Construction Restriction Periods with LAWA prior to preparing the construction schedule.

E. Refer to the LAWA Utility Shutdown Procedures for additional information.

1.7 TESTING AND ADJUSTMENT

A. Upon completion of all Electrical Work, the contractor shall provide all testing as follows:

1. Operational Test: Test all circuit breakers, receptacles and all other electrical equipment. Replace all faulty devices and equipment discovered during testing with new devices and equipment at no additional cost, and that part of the system (or devices or equipment) shall then be retested.
2. Secondary Grounding Resistance: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point.
3. Ground Fault System Test: Measure system neutral insulation resistances to ensure no shunt ground paths exist.
4. All grounding resistance and ground fault test procedures shall be performed by an independent testing firm.

1.8 MAINTENANCE, SERVICING AND INSTRUCTION MANUALS, AND WIRING DIAGRAMS

A. Prior to substantial completion, the contractor shall submit 4 copies of operating and maintenance and servicing instructions, as well as an equal number of copies of complete wiring diagrams all neatly bound in hard cover 3 ring binders with table of contents and tabs for the following items or equipment:

1. Lighting Control Devices System
2. Medium Voltage Transformers
3. Medium Voltage Vacuum Circuit Breakers
4. Medium Voltage Metering Switchgear
5. Low Voltage Transformers
6. Switchboards
7. Panelboards
8. Motor Control Centers
9. Enclosed Bus Assemblies
10. Wiring Devices
11. Fuses
12. Enclosed Switches
13. Enclosed Circuit Breakers
14. Enclosed Transfer Switches
15. Enclosed Controllers
16. Variable Frequency Motor Controllers

17. Engine Generators
18. Resistive Load Banks
19. Emergency Generators and Distribution Switchgear
20. Battery Equipment (Inverter)
21. Static Uninterruptible Power Supply
22. Transient Voltage Suppression for Low Voltage Electrical Power Circuits
23. Interior Lighting
24. Exterior Lighting
25. Fire Detection and Alarm
26. Web Based Power Monitoring System

B. All wiring diagrams shall specifically cover the installed system indicating zones, wiring, and components added to the system.

C. Include Product and calculations data with maintenance and Operations manuals. Include all testing reports with Maintenance and Operation manuals.

1.9 FINAL INSPECTION AND ACCEPTANCE

A. After all requirements of the specifications and/or the drawings have been fully completed, representatives of LAWA will inspect the Work. The Contractor shall provide competent personnel to demonstrate the operation of any item of system, to the full satisfaction of each representative. The Contractor shall provide 8 hours of minimum scheduled operation and maintenance training to staff to be trained on each system indicated above. See specific sections for additional training/operation hours required.

B. Provide manuals for attendees.

C. Final acceptance of the work will be made by LAWA after receipt of approval and recommendation of acceptance from each representative.

D. The Contractor shall furnish Record Drawings before final payment of retention.

1.10 WARRANTIES

A. Special Warranties:

1. All 34.5kV Electrical Equipment, Switchgear and Accessories for 3 years (parts and labor).

B. During the period between Substantial Completion and Partial Acceptance (Final Acceptance of a defined area of the work), the Contractor shall provide the necessary services to Operate and Maintain the equipment in proper working order including, but not limited to:

1. Operation and Maintenance Response:

a. Provide twenty (24) hour emergency service during this period consisting of:

1) Critical Issue: A prompt response (within 15 minutes) to emergency request by telephone or otherwise from LAWA or designated representative. Onsite within 30 minutes of notification to triage and assess the situation.

2) Non Critical Issues: A prompt response (within 15 minutes) to request by telephone or otherwise from LAWA or designated representative. Onsite within one (1) hour after receiving notice from LAWA representative or having knowledge of a need to service the system. If event occurs after business hours, weekends or holidays, response shall be within one (1) hour of commencement of next business day.

3) Scheduled Operational Needs: 24 hour notice of scheduled operational need. Failure to respond to scheduled operational need render need as a Critical Issue.

b. For Critical issues, on site response shall be within 30 minutes of notification. Repair or service of respective components and/or system shall be commenced immediately upon arrival on site. This requirement shall include after business hours, weekends, and holidays. Critical issues are defined as complete system failure, failure of controls, entrapments, and/or potential injury to persons, or other item that LAWA deems a critical operational need.

c. For Noncritical issues, on site response shall be within one (1) hour of notification. If event occurs after business hours, weekends, or holidays, response shall be within one (1) hour of commencement of next business day. Repair or service of respective components and/or system shall be commenced within (4) hours of the arrival on site.

2. Maintenance:

a. Inspection of completed installation and periodic testing to maintain equipment in completely operable, like new condition.

b. Perform any necessary regulatory testing to ensure system(s) are compliant with applicable code, all to the satisfaction of the Authority Having Jurisdiction.

c. Periodic lubrication of parts, filter changes and equipment components as per OEM's recommendation. Documentation to be provided for each piece of equipment when services are provided.

d. Spare Parts: The Contractor shall maintain adequate supply of spare parts during this period. Any spare parts utilized during this period that are part of the contractually obligated inventory of spare parts for Final Acceptance shall be replenished prior to Final Acceptance.

3. Operation:

a. All necessary work to operate/maintain the equipment in proper working order.

b. Perform daily maintenance and system health checks as applicable, and any necessary system backups, failover/failback testing.

c. Routinely monitoring equipment and systems for anomalies and respond or report to system maintenance team to respond and resolve.

d. Perform configuration changes as needed to support project, airport, tenant operations, etc.

e. Maintain logs of configuration changes.

4. Perform work without removing equipment from service during peak traffic periods (unless emergency and/or unless specifically authorized by LAWA) and those peak periods have been determined by LAWA as 7:00 a.m. to 12:00 a.m. (midnight) daily.
5. Unlimited regular time callbacks are included with the applicable response time. Regular time will be Monday through Friday, 8:00am to 4:30pm, exclusive of holidays. Overtime\Premium time call backs originating from an operational error related to the performance requirements of the equipment shall be borne by the Contractor.

END OF SECTION 26 05 02

SECTION 26 05 03 - EQUIPMENT WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

1.2 SUBMITTALS

A. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

PART 2 - PRODUCTS

2.1 CORD AND PLUGS

A. Manufacturers:
   1. **Hubbell Incorporated.**
   2. **Leviton Manufacturing Company, Inc.**
   3. **Pass & Seymour / Legrand.**

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction: Type SO (for heavy duty use) or SJO (for normal use) multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned equipment wiring connections, including abandoned connections above accessible ceiling finishes.

B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.

C. Extend existing equipment connections using materials and methods as specified.

3.2 INSTALLATION

A. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

B. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

C. Install receptacle outlet to accommodate connection with attachment plug.

D. Install cord and cap for field-supplied attachment plug.

E. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

G. Install terminal block jumpers to complete equipment wiring requirements.

H. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.3 ADJUSTING

A. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 26 05 03

SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Medium voltage cable.
2. Cable terminations.
3. Fireproofing tape.
4. Underground cable markers.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers

1. IEEE 48 – Standard Test Procedures and Requirements for Alternating Current Cable Terminations 2.5kV thru 765kV.
2. IEEE C2 – National Electrical Safety Code.

B. National Electrical Manufacturers Association

1. NEMA WC 74 – 5-46kV Shielded Power Cables for Use in the Transmission and Distribution of Electrical Energy.

1.3 SUBMITTALS

A. Product Data: Submit for cable, terminations, and accessories.

B. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

A. Manufacturers:

1. The Okonite Company.

2. General Cable.

3. Southwire.

B. Voltage: 5, 8, 15, and 35 kV.

C. Insulation Level: 133 percent of operating voltage.

D. Cable Continuous Operating Temperature Rating: MV-105.

E. Configuration: Single conductor.

F. Conductor Material: Copper.

G. Conductor Construction: Compact stranded.

H. Conductor Shield: Metal Tape.

I. Insulation: Ethylene Propylene Rubber (EPR).

J. Cable Jacket: Sunlight resistant PVC or Chlorosulfonated polyethylene, CPE.

2.2 CABLE TERMINATIONS

A. Manufacturers:

1. 3M.

2. Cooper.

3. Thomas & Betts.

B. Location: Indoor or Outdoor.

C. Conductor Quantity: Single core.

D. Type: Dual extrusion thick wall heat shrink.

2.3 FIREPROOFING TAPE

A. Manufacturers:

1. 3M.

2. Plymouth Rubber Co.

B. Product Description: Flexible, conformable fabric, coated on one side with flame retardant, flexible polymeric or chlorinated elastomer. Non-corrosive to and compatible with cable sheaths jackets. Does not support combustion.

C. Width: Approximately 3 inches.

D. Thickness: Not less than 0.03 inch.

E. Weight: Not less than 2.5 pounds per square yard.

2.4 UNDERGROUND CABLE MARKERS

A. Trace Wire: Magnetic detectable conductor, red colored plastic covering, imprinted with "Medium Voltage Cable" in large letters.

2.5 CABLE IDENTIFICATION

A. Colored Conductor Tape for Phases: Yellow colored, self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide; 1 stripe for the Phase A conductor, 2 stripes for the Phase B conductor, 3 stripes for the Phase C conductor. Tape shall be located at all terminations, splices and pull boxes.

B. Metal Tags: Brass with ¼ inch embossed legend, punched for use with self-locking nylon tie fastener. Tags shall be located at all terminations, splices and pull boxes. Legend shall include the feeder circuit breaker identifier and phase.

PART 3 - EXECUTION

3.1 PREPARATION

A. Use swab to clean conduits and ducts before pulling cables.

3.2 EXISTING WORK

A. Remove abandoned medium-voltage cable.

B. Maintain access to existing medium-voltage cable and other installations remaining active and requiring access. Modify installation or provide access panel.

3.3 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.

B. Use suitable manufacturer approved lubricants and pulling equipment.

C. Sustain cable pulling tensions and bending radii below manufacturer’s recommended limits.

D. Ground cable shield at each termination and splice.

E. Install cables in manholes along wall providing longest route.

F. Arrange cable in manholes to avoid interference with duct entrances.

3.4 FIREPROOFING

A. Apply fireproofing tape to cables when installed in manholes, cable rooms, pull boxes, or other enclosures.

B. Smooth out irregularities, at splices or other locations, with insulation putty before applying fireproofing tape.

C. Apply fireproofing tape tightly around cables spirally in half-lapped wrapping or in butt jointed wrapping with second wrapping covering joints first.

D. Extend fireproofing 1 inch into conduit or duct.

E. Install tape with coated side toward cable.

F. Install random wrappings of plastic tape around fireproofing tape to prevent unraveling.

G. Install fireproofing to withstand a 200 Ampere arc for 30 seconds.

3.5 FIELD QUALITY CONTROL

A. Inspect exposed cable sections for physical damage.

B. Inspect cable for proper connections.

C. Inspect shield grounding, cable supports, and terminations for proper installation.

D. Inspect and test in accordance with NETA ATS.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect installed cables from entrance of moisture.

END OF SECTION 26 05 13

SECTION 26 05 16 – EMERGENCY CIRCUIT CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices and terminations for emergency or critical circuits rated 600 V and less.

1.2 SUBMITTALS

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

1.3 INSTALLATION

A. Run smoke control system evacuation cable/conduit in accordance with applicable sections of these specifications. Install fire pump conduits.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and side wall pressure valves.

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

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

E. Support cables according to the applicable UL Listing for each product type being installed.

F. Seal around cables penetrating fire-rated elements.

G. Identify and color-code conductors and cables.

1.4 CONNECTIONS

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

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

END OF SECTION 26 05 16

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes 600V building wire and cable; and wiring connectors and connections.

1.2 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Solid conductor for feeders and branch circuits 12 AWG and smaller.
2. Stranded conductors for control circuits.
3. Conductor not smaller than 12 AWG for power and lighting circuits.
4. Conductor not smaller than 14 AWG for control circuits.
5. Increase wire size in branch circuits to limit voltage drop to the maximum allowed by California (CA) Title 24 Coordinate with upstream feeder voltage drop.

B. Wiring Methods: Provide the following wiring methods:

1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway.
4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
5. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
6. Underground Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
7. Other Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

1.3 QUALITY ASSURANCE

A. Provide wiring materials located in plenums with: peak optical density not greater than 0.5; average optical density not greater than 0.15; and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:

1. **General Cable Co.**
2. **Southwire Co.**
3. **The Okonite Company.**

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation Voltage Rating: 600 volts.

E. Insulation Temperature Rating: 75 degrees C.

F. Insulation Material: Thermoplastic.

2.2 TERMINATIONS

A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.

B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 - EXECUTION

3.1 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.2 INSTALLATION

A. Neatly train and lace wiring inside boxes, equipment, and panelboards.

B. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.

C. Special Techniques--Building Wire in Raceway:

1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

D. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors.

2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

E. Install solid conductors for branch circuits 12 AWG and smaller. Do not place bare stranded conductors directly under screws.

F. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.

G. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

H. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

3.3 WIRE COLOR

A. General: All power and branch circuit conductors shall be provided with color-coded insulation or color-coded self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide. Vinyl tape shall be used in vaults, pull and junction boxes, manholes and handholes. Identify the source and circuit number of each set of conductors with write-on tags.

B. Colors: Color coding shall be as follows:

Phase	208Y/120V	480Y/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	White with Black Stripe
Ground	Green	Green

END OF SECTION 26 05 19

SECTION 26 05 27 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rod electrodes.
2. Wire.
3. Grounding well components.
4. Mechanical connectors.
5. Exothermic connections.

1.2 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:

1. Metal underground water pipe.
2. Metal building frame.
3. Concrete-encased electrode.
4. Rod electrode.
5. Plate electrode.

1.3 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.4 SUBMITTALS

A. Product Data: Submit data on grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

C. Manufacturer's Installation Instructions: Submit for active electrodes.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:

1. Erico, Inc.

2. O-Z Gedney Co.

3. Thomas & Betts.

B. Product Description:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch
3. Length: 10 feet

C. Connector: Connector for exothermic welded connection.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG.

C. Grounding Electrode Conductor: Copper conductor bare.

D. Bonding Conductor: Copper conductor bare.

2.3 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS (DN200) by 24 inches long fiberglass pipe with belled end.

B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.4 MECHANICAL CONNECTORS

A. Manufacturers:

1. Erico, Inc.

2. ILSCO Corporation.

3. O-Z Gedney Co.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.5 EXOTHERMIC CONNECTIONS

A. Manufacturers:

1. Copperweld, Inc.

2. ILSCO Corporation.

3. O-Z Gedney Co.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.2 INSTALLATION

A. Install rod electrodes as required. Install additional rod electrodes to achieve specified resistance to ground.

B. Install grounding and bonding conductors concealed from view.

C. Install grounding well pipe with cover at each rod location. Install well pipe top flush with finished grade.

D. Install 4/0 AWG bare copper wire in foundation footing.

E. Install grounding electrode conductor and connect to reinforcing steel in foundation footing.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

H. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

I. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter

enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

J. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

K. Permanently attach equipment and grounding conductors prior to energizing equipment.

L. The Ufer Ground grounding electrode shall consist of a 50-foot length of bare #4/0 copper wire extended its full length below ground level and embedded along the bottom of the concrete foundation footing which is in direct contact with the foundation earth and supported in such a manner that it cannot be less than 3 inches from the bottom or side of the concrete when the foundation concrete is poured.

A loop at the approximate center of this grounding electrode shall be brought out at the top of the foundation and a #4/0 copper ground conductor shall connect the ground electrode to the main ground electrode bus in the equipment room. The conductor shall be connected to the ground electrode by exothermic welding.

END OF SECTION 26 05 27

SECTION 26 05 30 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

1.2 SYSTEM DESCRIPTION

A. Firestopping Materials: Achieve fire ratings for adjacent construction, but not less than 1 hour fire rating.

1.3 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM, UL, and WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.4 SUBMITTALS

A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

B. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports. Include ICC-ESR reports, LA-research Reports (LARR numbers) for all applicable products and anchorages.

1.5 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings, but not less than 1-hour.

2. Floor and roof penetrations: Fire F-Ratings and temperature T-Ratings , but not less than 1-hour.

a. Floor Penetrations within Wall Cavities: T-Rating is not required.

b. Floor Penetrations subject to wet areas, prevent water from flowing floor to floor by providing W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.

2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating for assembly in which joint is installed.

D. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating for floor assembly.

1.6 DELIVERY, STORAGE, AND HANDLING

1.7 Accept materials on site in original factory packaging, labeled with manufacturer's identification.

1.8 Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:

1. HILTI.

2. Powerstrut.

3. Unistrut.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F (85 degrees C). Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:

1. HILTI.

2. Unistrut Corp.

3. Powerstrut.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center or equal hole configurations.

2.3 SLEEVES

A. Furnish materials in accordance with standards.

B. Sleeves for conduits through Non-fire Rated Floors: 18 gage (1.2 mm) thick galvanized steel.

C. Sleeves for conduits through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18gage thick galvanized steel.

D. Sleeves for conduits or cable pathways through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing:

1. Prefabricated fire rated sleeves including seals, UL listed.

E. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.

2. NMP Corporation.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.5 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.

2. Hilti Corp.

3. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with Intumescent lining strips, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Blocks: Intumescent preformed, used for large openings to accommodate cable trays, bundles, or electrical busways. Material can be cut to fit within irregular complex openings without voiding warranty or fire rating.
8. Firestop Plugs: Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles.

C. Color: Varies per manufacturer.

2.6 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:

1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL listed products or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing materials to arrest liquid material leakage.

D. Obtain permission from Designer before using powder-actuated Fasteners.

E. Do not drill or cut structural members.

F. Obtain permission from Structural Engineer before drilling or cutting structural members.

G. In order to avoid severing any existing structural reinforcement, use ground penetrating radar or x-ray equipment to survey the existing concrete floor slabs/walls before cutting or drilling any new penetrations.

3.2 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:

1. Concrete Structural Elements: Provide precast inserts systems, expansion anchors, powder actuated anchors and preset inserts.
2. Steel Structural Elements: Provide beam clamps with spring steel clips, steel Power Driven fasteners, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Supports:

1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.3 INSTALLATION – FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke

rating, to uniform density and texture.

D. Compress fibered mineral wool material to comply with UL listing or test reference.

E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

F. Place intumescent coating in sufficient coats to achieve rating required.

G. Remove dam material after firestopping material has cured. Dam material to remain.

H. Fire Rated Surface:

1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
    c. Pack void with backing material.
    d. Seal ends of sleeve with UL listed fire resistive compound to meet fire rating of structure penetrated.
2. Where cable tray and conduits penetrate fire rated surface, install firestopping product in accordance with manufacturer's instructions.
    a. Non-Rated Surfaces: For non fire rated assemblies, acoustical sealant may be used.
3. Seal opening through non-fire rated wall, floor, ceiling, and roof opening as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
    c. Install type of firestopping material recommended by manufacturer.
4. Install escutcheons floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
5. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Construct concrete housekeeping pads minimum 4 inches above the finished floor and not less than 6 inches larger in both directions than the supported equipment. Use 3000 psi, 28-day compressive-strength concrete. Pads shall be reinforced with #4 steel

reinforcing rods.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1inch above finished floor level. Caulk or seal sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install stainless steel escutcheons at finished surfaces.

END OF SECTION 26 05 30

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

1.2 SYSTEM DESCRIPTION

A. Raceway and boxes at locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground, underground below slab on grade, or in slab (on or above grade): Provide concrete encased PVC Schedule 40 conduit. Provide cast metal boxes or nonmetallic pull boxes.

C. Exterior Locations: Provide galvanized rigid steel conduit. Provide NEMA 3R stainless steel or NEMA 4 outlet, pull and junction boxes. Exterior locations are defined as any area exterior to the building envelope with at least one open wall or an open roof. This includes any areas under building overhangs.

D. Wet Locations: Provide galvanized rigid steel conduit. Provide boxes, conduit bodies, and fittings listed for use in wet locations. Provide flush mounting outlet box in finished areas.

E. Damp Locations: Provide galvanized rigid steel conduit. Provide boxes, conduit bodies, and fittings listed for use in damp locations. Provide flush mounting outlet box in finished areas. Locations in a building with partially open sides, areas below the soffit/header line and within 10’ of an opening are considered damp.

F. Dry Locations, Exposed and Concealed: Provide electrical metallic tubing conduit. Galvanized rigid steel conduit shall be used in areas subject to physical damage including all tug routes or tug areas. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas.

G. PVC conduit is restricted to underground use and shall be concrete encased.

1.3 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified. ½ inch may be used for connections to equipment or devices which have ONLY standard ½ inch knockouts so equipment does not need to be field modified.

1.4 SUBMITTALS

A. Product Data - Submit for the following:

1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. Nonmetallic conduit.
4. Raceway fittings.
5. Conduit bodies.

6. Surface raceway.
7. Wireway.
8. Pull and junction boxes.

PART 2 - PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   2. Republic Conduit.
   3. Wheatland Tube.

B. Rigid Steel Conduit: ANSI C80.1.

C. Intermediate Metal Conduit (IMC): Rigid steel.

D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.
   1. Manufacturers:
      a. Cooper Crouse-Hinds.
      b. O-Z/Gedney.
      c. Thomas & Betts.

2.2 PVC COATED METAL CONDUIT

A. Manufacturers:
   1. Ocal-Blue.
   2. Permacote.
   3. Plastibond.

B. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil thick.

C. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.3 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. AFC Cable.
   2. Electri-Flex.
   3. Southwire Co.

B. Product Description: Interlocked steel construction.

C. Fittings: NEMA FB 1.
   1. Manufacturers:
      a. AFC Cable.

b. Cooper Crouse-Hinds.
c. Thomas & Betts.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. AFC Cable.
2. Electri-Flex.
3. Southwire Co.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

1. Manufacturers:

a. AFC Cable.
b. Cooper Crouse-Hinds.
c. Thomas & Betts.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube & Conduit.
2. Republic Conduit.
3. Wheatland Tube.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, compression type or set-screw type.

1. Manufacturers:

a. Cooper Crouse-Hinds.
b. O-Z/Gedney.
c. Thomas & Betts.

2.6 NONMETALLIC CONDUIT

A. Manufacturers:

1. Allied Tube & Conduit.
2. Cantex.
3. JM Eagle.

B. Product Description: NEMA TC 2; Schedule 40 or 80 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.7 SURFACE METAL RACEWAY

A. Manufacturers:

1. Walker Systems Inc.
2. The Wiremold Co.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Finish: Gray or Buff enamel. Stainless steel.

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.8 WIREWAY

A. Manufacturers:

1. Cooper B-Line.
2. Hubbell.
3. Walker Systems Inc.

B. Product Description: General purpose, Oiltight and dust-tight, Raintight type wireway.

C. Cover: Hinged or Screw cover.

D. Connector: Slip-in or Flanged.

E. Fittings: Lay-in type with removable top, bottom, and side; captive screws drip shield.

F. Finish: Rust inhibiting primer coating with gray enamel finish.

2.9 OUTLET BOXES

A. Manufacturers:

1. Appleton.
2. Raco.
3. Steel City.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.10 PULL AND JUNCTION BOXES

A. Manufacturers:

1. Appleton.
2. Raco.
3. Steel City.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel. NEMA 4 for exterior.

C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:

D. Material: Galvanized cast iron.

E. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

F. Junction & pull boxes with at least one side 36 inches or larger shall have a hinged door capable of opening to 90 degrees.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to the limits of the remodel area.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods as specified.

3.2 INSTALLATION

A. Ground and bond raceway and boxes.

B. Fasten raceway and box supports to structure and finishes.

C. Identify raceway and boxes.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

E. Conceal all conduits from public view unless approved by LAWA.

3.3 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel.

H. Route exposed raceway parallel and perpendicular to walls. Conduit routed at any other angles is not allowed at any time.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of four 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

X. For new construction areas route all conduit above any mechanical ductwork. Do not install below ductwork.

3.4 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights specified in section for outlet device.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

C. Locate outlet boxes within 6’ of luminaires.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 26 05 33

SECTION 26 05 34 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.

1.2 SUBMITTALS

A. Product Data: Submit catalog data for floor boxes service fittings.

1.3 DESIGN REQUIREMENTS

A. Pedestal type and poke thru type boxes are not allowed without written LAWA approval.

B. The specified material for the floor box cover shall be aesthetically compatible with the adjacent floor finish and be approved by LAWA.

PART 2 - PRODUCTS

2.1 FLOOR BOXES

A. Manufacturers:

1. Wiremold Co.

2. Walker, Inc.

3. Hubbell.

B. Floor Boxes: NEMA OS 1.

C. Adjustability: Fully adjustable or semi-adjustable.

D. Material: Cast metal or Formed steel.

2.2 FLUSH-COVER-TYPE FITTINGS

A. Manufacturers:

1. Wiremold Co.

2. Walker, Inc.

3. Hubbell.

B. Material: Aluminum or Brass. Material for covers shall be aesthetically compatible with the adjacent floor finish and must be approved by LAWA prior to ordering.

2.3 FLUSH-COVER-SERVICE FITTING ACCESSORIES

A. Protective Ring: Aluminum or Brass finish.

B. Split Nozzle: Aluminum or Brass finish.

C. Carpet Ring: Aluminum or Brass.

2.4 ACCESS FLOOR BOX

A. Manufacturers:

1. Wiremold Co.

2. Tate.

3. Thomas & Betts.

B. Product Description: Sheet metal box suitable for mounting in access floor system.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect abandoned service fitting devices and remove service fittings. Install blank cover for abandoned floor boxes not removed.

B. Maintain access to existing floor boxes remaining active and requiring access. Modify installation or provide access panel.

C. Extend existing service fitting installations using materials and methods as specified.

3.2 INSTALLATION

A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet to accommodate intended purpose.

B. Floor Box Requirements: Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

C. Set floor boxes level. Most of the existing floors within the terminals are not level. Align all new floor boxes totally flush with the adjacent floor finish on all sides.

D. Install boxes and fittings to preserve fire resistance rating of slabs and other elements.

E. In order to avoid severing any existing structural reinforcement, use ground penetrating radar to survey the existing concrete slab before cutting or drilling any new floor penetrations.

F. When aligning floor boxes note that most of the existing floor within the terminals are not level. Align all new floor boxes totally flush with the adjacent floor finish on all sides.

END OF SECTION 26 05 34

SECTION 26 05 44 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Ducts in concrete-encased duct banks.
2. Handholds and handhole accessories.
3. Manholes and manhole accessories.

1.2 SYSTEM DESCRIPTION

A. Interconnected system of encased conduits, ducts, manholes and handholes to distribute power and telecommunications.

B. Conduit and duct routing, manhole, and handhole locations are shown in approximate locations unless dimensions are indicated. Route and locate to complete duct bank system.

C. Use concrete encased rigid steel or concrete encased rigid plastic conduits for all underground ducts.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Manholes.
2. Handholes.
3. Hardware.
4. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
5. Duct-bank materials, including spacers and miscellaneous components.
6. Warning tape. Detectable type.

B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For manholes:
    a. Duct sizes and locations of duct entries.
    b. Reinforcement details.
    c. Manholes cover design and engraving.
    d. Step details.
    e. Grounding details.

f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.

C. Coordination Detailing Activity Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

D. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

E. Product Test Reports: Indicate compliance of manholes with ASTM C857 and ASTM C858, based on factory inspection.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes and handholes. Provide dimensions off of fixed elements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage.

C. Arrange so identification markings are visible.

D. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Comply with LAWA power shut-down procedures.
2. Do not proceed with utility interruptions without LAWA's Representative written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field

conditions and to ensure duct runs drain to manholes and handholes, and as approved by the LAWA Representative.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Manufacturers:

1. Underground Precast Concrete Utility Structures:
   - **a. Jensen Precast.**
   - **b. Utility Vault Co.**
   - **c. Brooks**
2. Frames and Covers:
   - **a. Alhambra Foundry**
   - **b. Campbell Foundry Co.**
   - **c. East Jordan Iron Works, Inc.**

2.2 DUCTS

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

2.3 HAND HOLES

A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks.

B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks. Cover Legend: All underground pull box covers shall have the following cast-in or bead welded and galvanized identification label permanently affixed to the exterior:

1. “ELEC-LV” for electrical power circuits 600 volts or less.
2. “ELEC-HV” for electrical power circuits over circuits over 600 volts.
3. “COMM” for communications circuits.
4. A custom 3-digit number shall be added to the cover. Contact the LAWA Engineer for number assignment. The minimum letter height shall be one (1) inch.

2.4 PRECAST MANHOLES

A. Precast Units: Interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Entry way diameter: 36 inches minimum.

C. Design and fabricate structure according to ASTM C858.

D. Structural Design Loading: ASTM C857, Class A-16 (AASHTO HS20).

E. Base section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.

F. Riser Sections: 4-inch minimum thickness, and lengths to provide required depth.

G. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

H. Steps: ASTM A615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches. Adjust to custom manhole locations.

I. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.

J. Joint Sealant: ASTM C990, bitumen or butyl rubber.

K. Protective Coating: Plant-applied, coal-tar, epoxy-polyamide paint 15-mil minimum thickness applied to exterior and interior surfaces.

L. Source Quality Control: Inspect structures according to ASTM C1037.

M. Access Ladder: Provide permanent metal access ladder.

2.5 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.

B. Manhole Frames and Covers: Comply with AASHTO loading specified for manhole; Ferrous frame 36 inch clear ID by 6 inch minimum riser with 4-inch-minimum width flange and 38-inch-diameter cover.

1. All manhole and underground pullbox covers shall have the following cast-in or bead welded and galvanized identification label permanently affixed to the exterior:

a. "ELEC-LV" for electrical power circuits 600 volts or less.

b. "ELEC-HV" for electrical power circuits over circuits over 600 volts.

c. "COMM" for communications circuits.

d. A custom 3-digit number shall be added to the cover. Contact the LAWA Engineer for number assignment. The minimum letter height shall be one (1) inch.

2. Cast iron with cast-in legend as indicated above subsection 1: Milled cover-to-frame bearing surfaces.

3. Manhole Frames and Covers: ASTM A48; Class 30B gray iron, 36-inch size, machine-finished with flat bearing surfaces.

C. Sump Frame and Grate: ASTM A48, Class 30B gray cast iron.

D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-by-4¬inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling and Lifting Irons in Floor: 7/8-inch- diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

H. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

I. Cable Arms: 3/16-inch- thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide by 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.

J. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Warning Tape: Provide underground-line detectable warning tape specified under section "Identification for Electrical Systems."

2.6 CONSTRUCTION MATERIALS

A. Seal manhole section joints with sealing compound recommended by the manhole manufacturer.

B. Damp proofing: Comply with "Bituminous Damp proofing."

C. Mortar: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.

D. Brick for Manhole Chimney: Sewer and manhole brick, ASTM C32, Grade MS.

E. Concrete: Use 3000-psi- minimum, 28-day compressive strength and 1-inch maximum aggregate size.

F. Provide red dye added to concrete during batching.

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Cables Higher than 600V: Type EPC-40-PVC, concrete-encased duct bank.

B. Manholes: Underground precast concrete utility structures.

C. Manholes: Cast-in-place concrete.

3.2 EARTHWORK

A. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Soil compaction at all locations shall be as specified by civil and structural specifications.

B. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

C. Restore disturbed pavement.

3.3 CONDUIT AND DUCT INSTALLATION

A. Exercise care in excavating, trenching, and working near existing utilities. Locate any existing buried utilities before excavating.

B. Duct bank trench shall be shored, framed and braced for installing ducts. Frames, forms, and braces shall be either wood or steel. Variations in outside dimensions of the installed duct bank shall not exceed 2 inches on the vertical or the horizontal from the design. Remove forms and bracing after 24 hours and before backfilling.

C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. Duct banks shall be laid to a minimum grade slope of 4 inches per 100 feet. This slope may be from one manhole to the next or both ways from a high point between manholes, depending upon the contour of the finished grade.

D. Duct banks shall be installed so that the top of the concrete encasement shall be no less than 36 inches below grade or pavement for primary power. As a general rule, depths shall be a minimum of three feet, but not more than six feet.

E. Curves and Bends: Use manufactured 48 inches minimum elbows for stub-ups at equipment, and enclosures, and at building entrances. Use manufactured long sweep bends with a minimum radius of 4 feet minimum, both horizontally and vertically, at other locations. Manufactured long radius bends may be used in runs of 100 feet or less on approval from the LAWA's representative. Vertical feeder sweep into buildings shall be coated steel. Multiple conduit sweeps shall be concentric and maintain spacing throughout. Medium-voltage conduit sweeps shall be 12' minimum radius sweeps.

F. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

G. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Where connection to bulkhead of duct bank is made to vaults or existing duct banks, the concrete encasement shall be doweled with on No. 4 reinforcement rod 36 inches long per conduit to the existing encasement.

H. Building Entrances: Make a transition from underground duct to rigid steel conduit 5 feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall. Expand duct bank at building entry to provide 6" spacing between sealing system sleeves. Coordinate sleeve placement with structural reinforcement bar placement.

2. Provide methane penetration EYS sealing fitting at each conduit penetration into building – both vertical and horizontal. Arrange so that sealant parts remain accessible.

3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction

with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight. Seals shall be Link Seal Assembly with precast 'CS" model – non-metallic sleeve by Link Seal or equal.

I. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators 6'-0" O.C. to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 inches vertically. Joints shall be made in accordance with manufacturer's recommendations for the particular type of duct and coupling selected. In the absence of specific recommendations, plastic duct connections shall be made by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of duct's ends. The duct and fitting shall then be slipped together with a quick one-quarter turn to set the joint.

3. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope. At connection to manholes, dowel concrete encasement with on No. 4 reinforcing bar 36 inches long per duct.

4. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 24 inches below finished grade in no traffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.

J. Direct-Buried Ducts: Direct-Buried Ducts are for temporary construction only and only as determined and approved by LAWA. Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators not more than 4 feet center-to-center along entire length of duct bank including top pipes.
2. Install expansion fittings as required.
3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms for pipes less than 6 inches in nominal diameter.
4. Backfill: Install backfill. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally. Do not place backfill for a period of at least 24 hours after pouring of concrete.
5. Minimum Clearances between Ducts: 3 inches between ducts for like services and 6 inches between power and signal ducts.
6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

K. Warning Tape: Bury metal backed detectable warning tape approximately 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

L. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete. Galvanized steel conduits installed below grade shall be painted with two coats of Koppers Bitumastic paint before installing in ground.

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

N. Pulling Cord: Install 100-lbf- test nylon cord in all ducts, including spares. Identify opposite terminal points of duct.

3.4 MANHOLE AND HANDHOLE INSTALLATION

A. Elevation: Install manholes with rooftop at least 15 inches below finished grade. Install handholes with depth as required. Place and align precast manholes to provide horizontal tolerance of 2 inches in any direction and vertical alignment with not greater than 1/8 inch maximum tolerance for 6 foot of depth. Completed manhole shall be rigid, true to dimensions and alignment, and shall be watertight.

B. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage

provisions indicated. Sumps shall be knocked out at time of installation.

C. Access: Install cast-iron frame and cover.

1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.

D. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days. Seal manhole section joints with sealing compound recommended by the manhole manufacturer. Penetration into manholes and/or boxes shall be sealed. Provide conduit duct plugs for unused terminator openings of spare conduits in manhole. Do not water seal top removable cover until cable pulling has been completed.

E. Damp proofing: Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days.

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

G. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Grounding: Install ground rod through floor in each structure with top protruding 6 inches above floor.

1. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.

I. Precast Concrete Manhole Installation: comply with ASTM C 891.

1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

2. Unless otherwise indicated, support units on a 12” level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Provide a minimum 6-inch level base of ¾ inch crushed rock under manhole to ensure uniform distribution of soil pressure on floor.

3. Manholes below building floor shall have all earth work compacted to match compaction required by structural specifications.

3.5 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance .

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

END OF SECTION 26 05 44

SECTION 26 05 49 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It complements optional seismic construction requirements in the various electrical component Sections.

1.2 SUBMITTALS

A. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic restraint component used.

1. Anchor Bolts and Studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by LA Research Reports or another agency acceptable to authorities having jurisdiction for all applicable products and anchorages.

B. Shop Drawings: Provide for anchorage and bracing not defined by details and charts. Indicate materials, and show designs and calculations signed and sealed by a professional Structural Engineer.

1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

2. Details: Detail fabrication and arrangement. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacing, identifying components and listing their strengths. Indicate direction and value of forces transmitted to the structure during seismic events.

3. Preapproval and Evaluation Documentation: By LA-Research Reports (LARR numbers) or another agency acceptable to authorities having jurisdiction for all applicable products and anchorages, showing maximum ratings of restraints and the basis for approval (tests or calculations).

C. Coordination Drawings: Plans and sections drawn to scale and coordinating seismic bracing for electrical components with other systems and equipment, including other seismic restraints, in the vicinity.

D. Product Certificates: Signed by manufacturers of seismic restraints certifying that products furnished comply with requirements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Manufacturer's Field Reports: Indicate seismic control device or isolation installation is complete and in accordance with instructions.

1.3 QUALITY ASSURANCE

A. Comply with seismic restraint requirements in California Building Code/Code of Regulations, unless requirements in this Section are more stringent.

B. Professional Engineer Qualifications: A professional Engineer who is legally qualified to practice in California and who is experienced in providing seismic engineering services, including the design of seismic restraints.

C. Testing Agency Qualifications: An independent testing agency, acceptable to LAWA with minimum of 5 years experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mason Industries, Inc

2. ISAT.

3. Tolco seismic bracing.

2.2 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.
3. Corrosive Locations: Stainless steel.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by LA Research Reports or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

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

2.4 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch- thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A570, GR 33.
2. Materials for Fittings and Accessories: ASTM A575, ASTM A576, or ASTM A36.
3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Galvanized, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.
2. Wire Rope Cable: Comply with ASTM 603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by the LAWA's Representative, unless more stringent requirements are indicated.

3.2 STRUCTURAL ATTACHMENTS

A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses in accordance with the Structural Engineer of

record approval.

B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.

C. Attachments to Existing Concrete: Use expansion anchors. In order to avoid severing any existing structural reinforcement, use ground penetrating radar or x-ray equipment to survey the existing concrete floor slabs/walls before cutting or drilling any new penetrations.

D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.

F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.

G. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.3 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

B. Anchor panel boards, motor-control centers, motor controls, switchboards, switchgear, transformers, unit substations, fused power-circuit devices, transfer switches, busways, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:

1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.
3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.4 SEISMIC BRACING INSTALLATION

A. Install bracing according to spacing and strengths indicated by approved analysis.

B. Expansion and Contraction: Install to allow for thermal movement of braced components.

C. Cable Braces: Install with maximum cable slack recommended by manufacturer.

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

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in raceways, cables, wire ways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Test pull-out resistance of seismic anchorage devices.

1. Provide necessary test equipment required for reliable testing.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to LAWA's Representative.
3. Schedule test with the LAWA Representative before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
4. Obtain Structural Engineer's approval before transmitting test loads to the structure. Provide temporary load-spreading members.
5. Test at least four of each type and size of installed anchors and fasteners selected by LAWA's Representative.
6. Test to 90 percent of rated proof load of device.
7. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
8. Record test results.

END OF SECTION 26 05 49

SECTION 26 05 54 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Permanent Marking.
6. Underground Warning Tape.
7. Lockout Devices.

1.2 SUBMITTALS

A. Product Data:

1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 - PRODUCTS

2.1 Nameplates on Equipment

A. Engraved Plastic Nameplates and Signs:

1. Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Engraved legend with white letters on black face for normal power, white letters on red face for emergency power.
    a. Punched or drilled for mechanical fasteners.
    b. Text is at 1/2-inch (13 mm) high lettering

B. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage, phase and wire. The next item shall be either: LAWA, Concessions, or Airline panel, depending on loads served. In addition, describe where the panel is fed from. New panelboards & switchboards (including retrofit kits) shall additionally include LAWA project tracking number under which equipment was installed.

For example,
PANEL 1LA, 120/208V, 3PH, 4W
LAWA PANEL
FED FROM MS
(T-LAX-1234)

C. Nameplates shall be secured to equipment front using stainless steel screws or rivets.

D. Concessions feeder breakers shall additionally include permanent marking (separate from the nameplate) indicating concessions name (e.g. STARBUCKS) & produced by P-TOUCH or other label machine having black lettering on white tape.

E. Custom metal master nameplates shall be furnished and installed by the manufacturer on each distribution section, switchboard section, and motor control center indicating the manufacturer's name, ampere rating, short-circuit rating (bus bracing) and date. Paper stickers are not acceptable.

For example,
ABC SWITCHBOARD CO.
AMPERE RATING: 5000A
SHORT CIRCUIT RATING: 100KAIC
SATE: 01/01/2011

2.2 PERMANENT MARKINGS

A. All conduits, busways, cable trays and pull boxes shall be identified with permanent stenciled black letters and numbers which indicate the source panel (feeder supply source), circuit numbers and designated panel or load. For example, "PA-1, 3, 5 TO MG." For conduits, the letter height shall be one-third (1/3) the conduit size with ¼ inch minimum height. For pull boxes and busways, the letter height shall be ½ inch minimum height and not larger than ¾ inch in height.

B. The identifications for conduits, busways and cable trays shall be placed at every 50 feet intervals and within 10 feet of wall and floor penetrations, pull boxes, panels, distribution boards, switchboards and electrical equipment.

C. Spare conduits, pull boxes, busways, and abandoned raceways (that are to remain) shall be identified as described above (A, B).

D. The permanent marking identifications on the raceways and pull boxes shall be visible after the installations are made.

E. All receptacle and switch faceplates shall be labeled with the source panel and circuit number. Label shall be Arial font, produced by a P-Touch or other label machine. Black lettering on white tape for normal power and white lettering font on red tape for emergency power.

F. All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked in red with the words, "EMERGENCY SYSTEM", so they will be readily identified as a component of an emergency circuit or system.

2.3 LABELS

A. Labels: Embossed adhesive tape, with 3/16 inch black letters on white background for normal power; white letters on red background for emergency power.

2.4 WIRE MARKERS

A. Description: Cloth tape, split sleeve, or tubing type wire markers.

B. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number.
2. Control Circuits: Control wire number.

2.5 UNDERGROUND RACEWAY MARKERS

A. Description: Permanent, detectable, red colored, continuous printed, polyethylene tape with suitable warning legend describing burial electrical lines. Taps shall be minimum 6 inches wide by 4 mils thick.

B. Color:

1. (Normal Power): Black lettering on white background;
2. (Emergency Power): White lettering on red background.

C. Legend:

1. Medium Voltage System: 5k, 15kV or 35kV as applicable.
2. 480 Volt System: 480 VOLTS.
3. 208 Volt System: 208 VOLTS.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:

1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

2.7 PANELBOARD DIRECTORIES

A. Panelboard directories shall be computer generated, arranged in numerical order, and shall list each circuit load and room number in which each load is located. Directories shall be mounted in a 6 by 8 inch metal frame under transparent plastic inside each panelboard door.

B. Changes to existing circuiting, loads or room number shall require updated typed panelboard directories. Revised panelboard directories shall be made available at the time of change.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:

1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front using screws, or rivets.

5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
    a. Switchgear.
    b. Switchboards.
    c. Panelboards.
    d. Transformers.
    e. Disconnect Switches
    f. Motor Control Centers.
    g. Pushbutton Stations,
    h. Terminal Cabinets.
    i. Control Panels.
    j. Enclosed circuit breakers.
    k. Generators.
    l. Transfer Switches.
    m. Enclosed Controllers.
    n. Variable-Frequency Controllers.
7. Install nameplate to maintain NEMA rating of enclosure.

C. Label Installation:
1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations.
3. Install labels for permanent adhesion and seal with clear lacquer.
4. Wire Marker Installation:
    a. Install wire marker for each conductor at panelboard gutters; pull boxes, outlet and junction boxes, and each load connection.
    b. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
    c. Install labels at data outlets identifying patch panel and port designation.

D. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

3.2 CONDUIT DEVICE & COLOR CODE

A. All conduits shall be color coded as follows:
1. Normal power – no color/bare factory silver.
2. Emergency power – Orange.
3. Fire Alarm – Red
4. Data – Blue.
5. BAS – Blue strip every 10’.
6. Normal power receptacles – White.

7. Emergency power receptacles – Red.
8. Isolated ground receptacles – Orange.
9. Normal power toggle switches – White.
10. Emergency power toggle switches – Lighted red.
11. Transient Suppressed Receptacles “triangle” engraved marked symbol.

END OF SECTION 26 05 54

SECTION 26 05 73 – SHORT CIRCUIT AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes computer-based, fault current and overcurrent protective devices coordination including ground fault protection and arc fault hazard analysis studies to be performed by the contractor. Protective devices shall be set based on the result of the protective device coordination study. Arc fault hazard analysis warning nameplates shall be printed and affixed to the electrical system equipment after the final protective relay settings have been applied and confirmed operational. Settings and adjustments of the relays shall be performed by an independent qualified agency familiar with this work and the agency is to be retained by the contractor. The person performing this work shall have a minimum of five years experience.

B. Contractor shall retain a 3rd party independent consultant to perform the study indicated in this section.

C. This coordination study shall include the existing distribution equipment that feeds the new equipment and is in addition to the short circuit study performed by the Electrical Engineer of Record during the course of preparing his design.

D. It is the responsibility of the entity performing the Short Circuit and Coordination Study to collect all data to fully perform the study, including but not limited to engine generator data, motor data, circuit breakers, utility company short circuit, available new and existing device ratings, conductor data, transformer ratings, etc.

E. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the source. The study shall reflect the operation of each device ratings, conductor data, transformer ratings, etc.

F. The short circuit portion of the study shall be submitted prior to or along with the switchgear submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchgear (including all equipment which has and AIC rating) shall reflect the findings of short circuit study (i.e, the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system). Series ratings are not acceptable.

1.2 DESIGN REQUIREMENTS

A. Report Preparation:

1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.

2. Perform study with aid of computer software program.

3. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
    a. Utility supply bus.
    b. Medium voltage air interrupter switchgear.
    c. Automatic transfer switch.
    d. Manual transfer switch.
    e. Engine generator.
    f. Medium voltage motor controllers.
    g. Low-voltage switchgear.
    h. Switchboards.
    i. Motor control centers.
    j. Distribution panelboards.
    k. Branch circuit panelboards.
4. Each other significant equipment location throughout system.

B. Report Contents (similar to SKM Power Tools):
1. Include the following:
    a. Calculation methods and assumptions.
    b. Base per unit value selected.
    c. One-line diagram, with short circuit values, arc flash values, feeder values and lengths.
    d. Source impedance data including power company system available power and characteristics.
    e. Typical calculations.
        1) Fault impedance.
        2) X to R ratios.
        3) Asymmetry factors.
        4) Motor fault contribution.
        5) Short circuit kVA.
        6) Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
        7) Tabulations of calculation quantities and results.
    f. One-line diagram revised by adding actual instantaneous short circuits available.
    g. State conclusions and recommendations.
        1) Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.

2) Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.

3) Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

4) Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following:

h. Power company relay characteristics.

i. Power company fuse characteristics.

j. Medium voltage equipment protective relay characteristics.

k. Medium voltage equipment protective fuse characteristics.

l. Low voltage equipment circuit breaker trip device characteristics.

m. Low voltage equipment fuse characteristics.

n. Cable damage point characteristics.

o. Pertinent transformer characteristics including:
   1) Transformer full load current.
   2) Transformer magnetizing inrush.
   3) ANSI transformer withstand parameters.
   4) Significant symmetrical fault current.

p. Pertinent motor characteristics.

q. Generator characteristics including:
   1) Phase and ground coordination of generator protective devices.
   2) Decrement curve and damage curve.
   3) Operating characteristic of protective devices.
   4) Actual impedance value.
   5) Time constants.
   6) Current boost data.
   7) Do not use typical values for generator.

r. Transfer switch characteristics.

s. Other system load protective device characteristics.

1.3 SUBMITTALS

A. Qualifications Data: Submit the following for review prior to starting study.

1. Submit qualifications and background of firm.

2. Submit qualifications of Professional Engineer performing study.

B. Software: Submit for review information on software proposed to be used in performing study.

C. Product Data: Submit the following:

1. Report: Summarize results of study in report format including the following:
   a. Descriptions, purpose, basis, and scope of study.
   b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
   c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   d. Fault current calculations including definition of terms and guide for interpretation of computer printout.

D. Submit copies of final report signed by Professional Engineer. Make additions or changes required by review comments.

E. Short Circuit Study:

1. Systematically calculate the fault impedance to determine the available short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. Entire system shall be modeled under both normal and emergency power. If any closed transition transfer switches are used, normal and emergency power shall be combined.
3. The short circuit study shall incorporate the actual feeder types, sizes and lengths proposed to be used by the Professional Engineer.
4. The calculations may be prepared by means of a digital computer. All pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
5. Present the data determined by the short circuit study in a table format. Include the following:
   a. Device identification.
   b. Operating voltage.
   c. Protective device.
   d. Device rating.
   e. Calculated short circuit current, indicating worst-case fault current incorporating all system models as outlined above.

F. Coordination Curves:

1. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists (where possible) between series devices, including the utility company upstream device. Plot the specific time-current

characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet. Where a switchboard or panelboard has multiple devices of different sizes, it is not necessary to plot curves for each device when coordination for one device is demonstrated graphically and it is intuitively obvious that the other devices coordinate as well.

2. The following specific information shall also be shown on the coordination curves:
    a. Device identification.
    b. Voltage and current ratio for curves.
    c. 3-phase and 1-phase ANSI damage points for each transformer.
    d. No-damage, melting, and clearing curves for fuses.
    e. Cable damage curves.
    f. Transformer inrush points.
    g. Maximum short circuit cutoff point.
    h. Short-time withstand capability of main 480V circuit breakers.
    i. Coordination between the directional overcurrent relays and the main 480V breaker.
3. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:
    a. Device identification.
    b. Relay CT ratios, tap, time dial, and instantaneous pickup.
    c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
    d. Fuse rating and type.
    e. Ground fault pickup and time delay.

1.4 QUALIFICATIONS

A. Study Preparer: Company specializing in performing work of this section with minimum five years documented experience and having completed projects of similar size and complexity within the past three years.

B. Perform study under direct supervision of Professional Engineer experienced in design of this Work and licensed at in State of California with minimum of five years experience in power system analysis.

1.5 SEQUENCING

A. The short circuit portion of the study shall be submitted prior to or along with the switchgear submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchgear (including all equipment which

has an AIC rating) shall reflect the findings of short circuit study (i.e., the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system.). No series rated devices will be allowed.

B. When formal completion of study will cause delay in equipment manufacturing, obtain approval from LAWA for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

C. All short circuit calculated values shall be tabulated and added to the Bid drawing's feeder schedule

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Provide assistance to electrical distribution system equipment manufacturer during startup of electrical system and equipment.

B. Delta-wye connected transformers: to provide secondary Line-To-Ground fault protection select a primary protective device operating band within transformer's characteristic curve, including a point equal to 58 percent of ANSI withstand point.

C. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults.

D. Separate medium-voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

E. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, CT ranges, etc.).

F. After developing the coordination curves, highlight areas lacking coordination. Present a technical valuation with a discussion of the logical compromises for best coordination.

3.2 ADJUSTING

A. Protective devices shall be set based on the results of the protective device coordination study.

B. Arc fault hazard analysis warning labels shall be printed and affixed to the electrical

system equipment after the final protective relay settings have been applied and confirmed operational.

C. Settings and adjustments of the relays shall be performed by and independent qualified agency familiar with this work and the agency is to be retained by the contractor. The person performing this work shall have a minimum of five years experience.

D. Accomplish necessary field settings, adjustments, and minor modifications to conform with the study without cost to LAWA.

END OF SECTION 26 05 73

SECTION 26 09 13 – POWER MONITORING COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Work included: Labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but not limited to:

1. Power monitoring equipment.
2. Data acquisition server "Gateway" for interface with LAWA network.
3. Miscellaneous monitoring systems.

B. Related Work: Consult all other Sections, determine the extent and character of related Work and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

1. American National Standards Institute, Inc. (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):
   a. ANSI/IEEE 802.3; Ethernet Standard.
2. American National Standards Institute, Inc. (ANSI):
   a. ANSI C12.20; For Electricity Meters – 0.2 and 0.5 Accuracy Classes.
   b. ANSI C37.90.1; Surge Withstand Capability (SWC) Test.
3. Federal Communications Commission (FCC) Regulations:
   a. FCC Part 15; Subpart B for Unintentional Radiators that Generate Radio Frequency Emissions. Class A for Digital Devices that Market use for Commercial applications.
4. Underwriters Laboratories, Inc. (UL):
   a. UL 61010A-1; General Safety Requirements for Electrical Equipment intended for Laboratory Use.

1.3 SYSTEM DESCRIPTION

A. This section describes the metering, communications, and visualization requirements for a modular, scalable Power Monitoring Communications System. This system shall allow the user to directly connect to the LAWA network equipment using gateway.

B. The Contractor shall furnish and install the equipment specified herein. The equipment shall be as shown on the drawings and outlined below.

C. This section includes the supply and installation of a complete Power Monitoring Communications System (PMCS) as detailed on the drawings and as described in this specification. The PMCS is defined to include, but not to be limited to, remote devices for metering, monitoring, control and protection, a network time server, all Ethernet communications gateways, a server class computer, software, intercommunication wiring,

ancillary equipment, startup and training services, and ongoing technical support. The system shall act as a stand-alone system but also connect to the LAWA network/FMCS.

1.4 SUBMITTALS

A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:

1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
2. Describe product operation, equipment and dimensions and indicate features of each component.
3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
4. Shop Drawings to include:
    a. Front, plan and side view elevations with overall dimensions.
    b. Wiring diagrams showing all components and the connections between the components.
5. Furnish structural calculations for equipment anchorage as described in Section 260010: Basic Electrical Requirements.
6. Submit Manufacturer's installation instructions.
7. Complete bill of material listing all components.
8. Warranty.

B. Hardware and software description shall be provided in detail for all communications hardware, software, including sensor devices and gathering data to be transmitted over the network, and master display unit. This description will include a list of all the communicating devices to be connected to the network.

C. Typical software screen displays shall be provided in printout form and/or on disk.

1.5 OPERATION AND MAINTENANCE MANUAL

A. Supply operation and maintenance manuals in accordance with the requirements of Section 260010: Basic Electrical Requirements, to include the following:

1. A detailed explanation of the operation of the system.
2. Instructions for routine maintenance.
3. Parts list and part numbers.
4. Pictorial and schematic Electrical Drawings of wiring systems, including operating, hardware, flat screens, instrumentation and annunciators.
5. Telephone numbers for authorized parts and service distributors.
6. Final testing reports.

1.6 QUALITY ASSURANCE

A. All materials, equipment and parts comprising the units specified herein shall be new, unused and currently under production.

B. Only products and applications listed in this Section may be used on the Project unless otherwise submitted.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Energy information system shall not be delivered to the Project site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable. Equipment damaged during shipment shall be replaced and returned to Manufacturer at no cost to Owner.

B. Storage: Store in a clean, dry, ventilated space free from temperature extremes. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris and traffic. Provide heat where required to prevent condensation.

C. Handling: Handle in accordance with Manufacturer's written instructions. Be careful to prevent internal component damage, breakage, denting and scoring. Damaged units shall not be installed. Replace damaged units and return equipment to Manufacturer.

1.8 WARRANTY

A. Units, components and programming offered under this Section shall be covered by a 1 year parts and labor warranty for malfunctions resulting from defects in materials and workmanship from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products furnished by the following Manufacturers shall be acceptable if in compliance with all features specified herein and indicated on the Drawings.

1. Eaton Electrical/Cutler-Hammer.
2. General Electric.
3. Square D.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 POWER MONITORING COMMUNICATION SYSTEM

A. The PMCS shall provide a monitoring and management system for all communicating devices in the power system.

B. The PMCS shall communicate to all devices over an industry standard Ethernet communication backbone. For devices that cannot communicate directly on Ethernet, a gateway can be provided as long as it complies with Section 2.05.

C. The PMCS shall provide a real time system to allow the user to easily view the key operational characteristics of the system. These features of the system shall not require any custom screen development or configuration to provide the following functions:

1. The PMCS shall provide the ability to view the current value of all operational variables available from all supported devices connected to the Ethernet network without the need for any additional system software.

2. The PMCS shall not require specific knowledge of a device to be able to display information from that device. No custom screen development shall be required to display data from any device able to connect to the system.
    a. The software shall support the ability to automatically establish a connection to any device added to a gateway without the user doing any configuration in the software.
3. The PMCS shall automatically build a one-line network hierarchy for all connected devices so the user can easily view them and display the corresponding data, status for those devices.
4. The PMCS shall provide the ability to trend one or more variables (volts, amps, kW, kWh, etc.) from one or more devices on a trend graph. The trend viewer shall support the following features:
    a. Option to display all variables on a single chart.
    b. Support for Min and Max value generation and graphing.
    c. Ability to select trend date ranges from a calendar.
    d. Ability to save the selected trend data to a CSV file.

D. The PMCS shall provide an energy graph on the home page and shall include:
1. Ability to show either demand or usage.
2. Ability to show the peak value for selected time periods and load factor.
3. Compare energy usage across devices.
4. Display peak periods for each device.
5. Ability to display line, bar, stacked bar, and cumulative usage for each selected period.
6. Move cursor to view energy values at any given time.
7. Calendar based date and time selection.

E. The PMCS shall support displaying of the waveform data collected by the power monitoring devices that can capture waveforms. The graphic format will display the data in an oscillio-graphic format and in a Fourier Amplitude Spectrum graph.
1. The PMCS shall provide time stamped sequential order of events for trips, analog alarms, motor start profiles, and operator actions based on the information received from the actual devices.
2. The PMCS shall have the ability to manage alarm and event conditions detected by the devices. Alarm management shall include:
    a. Ability to acknowledge alarms.
    b. Ability to flag priority alarms.
    c. Ability to export alarms.
    d. Ability to sort and analyze alarms by time, device or priority.

F. The PMCS shall provide navigation system to easily:
1. Drill down” in the one-line hierarchy.
2. Upload any .jpeg or, png file as a one-line background.

G. The PMCS shall be easy to operate and manage and shall include:

1. Ability to have a favorite's list of devices.
2. Ability to add and remove devices from the favorites list.
3. Ability to see devices current status and key parameters at a glance.
4. Ability to navigate to main software views with a single mouse click.

H. The PMCS shall be scalable such that the system can be expanded without requiring the user to reconfigure a new system.

1. The PMCS shall be sized to support the number of devices shown on the drawings, plus the capacity to accommodate 20% additional devices.
2. The PMCS shall not restrict the number of simultaneous users except based on the computing resources provided to support the system.
3. The PMCS shall allow users to be granted privileges based on their user ID and password, to perform various functions in the system. The software shall support, at a minimum 2 levels of access with one supporting Read only access and the other provide full Administration access.
4. The PMCS shall provide onboard embedded memory that is not external to the system or resident on a separate computer.

2.3 POWER MONITORING HARDWARE COMPONENTS

A. All devices in the PMCS shall provide any authorized user on the customer's network access to the critical data listed below.

1. Meter Screen providing:
    a. Volts: L-L and L-N, and average
    b. Frequency
    c. Current and average phase A, B, and C, N & G
2. Power Screen providing:
    a. Energy
    b. Demand
    c. Power Factor
3. Quality Screen providing:
    a. Total Harmonic Distortion (THD) of volts and current
4. Events screen providing:
    a. Latest events
    b. Enabled Triggers
    c. Historical Events

B. The power monitoring hardware shall support multiple protocols over Ethernet to ensure the system can easily be integrated into the PMCS software system as well as existing systems. These protocols shall include:

1. Modbus TCP/IP
2. BACnet/IP

3. SNMP
4. HTTP
5. SMTP
6. NTP
7. File System for exporting CSV trend files

2.4 DATA ACQUISITION SERVER GATEWAY

A. General:

1. The data acquisition server allows users to connect and secure data from virtually any meter type and convert the raw meter output into usable information. This information can be integrated with almost any level of software system or database, from an enterprise software suite to a simple Excel spreadsheet.
2. The data acquisition server is scalable for energy monitoring applications, including the ability to access and configure devices.
3. The data acquisition server employs “plug & play” technology, and automatically detects and configures downstream Modbus devices in seconds. Data from downstream devices are time stamped and stored in non-volatile memory at user- selected intervals. The data can be stored or uploaded to a destination of user’s choice through a number of different formats.
4. Using the Ethernet port, data is sent via the network to the LAWA network and Facilities Monitoring and Control System (FMCS).

2.5 MONITORING SYSTEMS

A. The following devices / equipment shall be part of the PMCS:

1. Meters:
    a. Meters on the medium voltage switchgears & main switchgears less than 600V
    b. Meters on the unit sub-station main breakers in each electrical room.
        (1) Meters on distribution equipment through 2 levels below main switchgear less than 600V.
    c. Meters on breakers serving Concession spaces.
    d. Meters on all gate equipment (chargers, PC Air, 400Hz and ramp bridges).
    e. Meters for all main BHS distribution boards
    f. Meters for disaggregated loads per Title 24 Table 130.5-B “Services greater than 1000Kva”.
    g. Meters for all emergency/standby distribution boards directly served by generator.
2. Emergency Power / Generator:
    a. Connection to generators for alarms, status, etc.
    b. Connection to generators for alarms, status, etc.
    c. Connection to ATS’s for alarms, status, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall thoroughly examine Project site conditions for acceptance of metering equipment installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

A. Install energy information system components in accordance with Manufacturer's written instructions, as indicated on the Drawings and as specified herein.

B. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment Manufacturers published instructions.

C. Coordinate the software installation after all hardware has been completely installed, connected and activated.

3.3 PROGRAMMING

A. The contractor shall insure the on-site programming of the system by a manufacturer’s representative, as well as to assist in the system startup. On-site services shall include:

1. Setting all the addresses of all devices in the equipment.
2. Verifying and troubleshooting the integrity of the data.
3. Assisting the Owner in correcting any data line problems.
4. Coordinating any possible warranty problems.
5. Configure the software to match the field devices.

3.4 FIELD QUALITY CONTROL

A. Refer to Specification Section 260800: Electrical Commissioning.

B. Refer to Specification Section 260810: Electrical Third Party Testing.

C. Independent testing: Contractor shall arrange and pay for the services of an independent Testing Agency to perform all quality control electrical testing, calibration and inspection required herein. Testing Agencies objectives shall be to:

1. Assure energy information system equipment installation conforms to specified requirements and operates within specified tolerances.
2. Field test and inspect to insure operation in accordance with Manufacturer's recommendations and Specifications.
3. Prepare final test report including results, observations, failures, adjustments and remedies.
4. Verify settings and make final adjustments.

D. At least three weeks prior to any testing, notify the Engineer so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the Engineer's witnessed test.

E. The Contractor shall supply a suitable and stable source of electrical power to each test site. The Testing Agency shall specify the specific power requirements.

F. Testing of energy information system equipment shall be done only after all devices are installed and prior to system being energized.

G. Pre-functional testing:

1. Provide Testing Agency with Contract Documents and Manufacturer instructions for installation and testing.

2. Visual and mechanical inspection per Specification Section 260810.

3. Electrical tests per Specification Section 260810.

H. Contractor shall replace at no costs to the Owner all devices which are found defective or do not operate within factory specified tolerances.

I. Contractor shall submit the Testing Agency's final report for review prior to Project closeout and final acceptance by the Owner. Test report shall indicate test dates, devices tested, results, observation, deficiencies and remedies. Test report shall be included in the operation and maintenance manuals.

3.5 CLEANING

A. Upon completion of Project prior to final acceptance the Contractor shall thoroughly clean energy information system equipment per Manufacturer's approved methods and materials.

3.6 TRAINING

A. Refer to Specification Section 260800: Electrical Commissioning.

B. Factory authorized service representative shall conduct an 8-hour training seminar for Owner's Representatives upon completion and acceptance of system. Instructions shall include operation, maintenance and testing of equipment with both classroom training and hands-on instruction.

C. Contractor shall schedule training with a minimum of 7-days advance notice.

END OF SECTION

SECTION 26 09 23 – LIGHTING CONTROL DEVICES AND CONTROL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Remote control lighting relays.
2. Lighting contactors.
3. Switches.
4. Switch plates.
5. Occupancy sensors.
6. Photocells.
7. Photocell control unit.

1.2 SYSTEM DESCRIPTION

A. The devices are to be connected to the Network Lighting Control System.

B. Distributed switching control using self-contained individually mounted lighting relays.

1.3 SUBMITTALS

A. Provide lighting design narrative with sequence of operations defining overall intended owner performance. Clarify, at minimum, how system shall: satisfy code, perform during normal/after-hours, and emergency (loss of normal power) conditions.

B. Shop Drawings shall include

1. Dimensioned floor plans with lighting control system components and accessories.
2. Wiring Diagram: Identify panels, number and type of switches or devices with room/area information.
   a. Define all parameters
      (1) Occupancy/Vacancy sensors: time delay/sensitivity
      (2) Loads: On/off or dimming, Manual/Auto on, Partial on/off, Blink warning
      (3) Daylighting: Type of photocell, completely off or to minimum level, Foot-candle trigger points
      (4) Time Clock: time for each event (schedules), after-hours time delay.
3. Include typical wiring diagrams for each component.

C. Product Data: Submit manufacturer’s standard product data for each system component.

1.4 WARRANTY

A. Furnish five year manufacturer warranty for components.

PART 2 - PRODUCTS

2.1 REMOTE CONTROL LIGHTING RELAYS

A. Manufacturers:

1. LC & D.

2. Lutron.

3. General Electric.

B. Product Description: Heavy duty, single-coil momentary contact mechanically held remote control relays.

C. Contacts: Rated 20 amperes at 120 or 277 volts. Rated for lighting applications with high intensity discharge (HID), quartz halogen, tungsten, or fluorescent lamps.

D. Line Voltage Connections: Clamp type screw terminals.

E. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Location: Type 1
2. Exterior Locations: Type 4

2.2 LIGHTING CONTACTORS

A. Manufacturers:

1. Cutler-Hammer.

2. Square D.

3. General Electric.

B. Product Description: NEMA ICS 2, magnetic lighting contactor.

C. Configuration: Mechanical held, 3 wire control.

D. Coil Operating Voltage: 120 or 277 volts, 60 Hertz.

E. Poles: To match circuit configuration and control function.

F. Contact Rating: 20A

G. Accessories:

1. Cover Mounted Pilot Devices: NEMA ICS 5, standard-duty heavy-duty oil-tight type with Form Z contacts, rated A150.

2. Pushbutton: ON/OFF function, with unguarded recessed covered configuration.
3. Selector Switch: ON/OFF/AUTOMATIC functions, with rotary action.
4. Auxiliary Contacts: One field convertible in addition to seal-in contact.
5. Relays: NEMA ICS 2
6. Control Power Transformers: 120 volt secondary, in each enclosed contactor. Furnish fuse primary and secondary, and bond unfused leg of secondary to enclosure.

H. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Location: Type 1.
2. Exterior Locations: Type 4.

2.3 SWITCHES

A. Manufacturers:
1. Hubbell Incorporated.
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour.

B. Wall Switch: Specification Grade unlighted, momentary pushbutton type for overriding relays.
1. Material: Plastic.
2. Color: White.

C. Wall Switch: Industrial Grade non-pilot light toggle switches for overriding relays.
1. Color: White

D. Key Switch: Cylinder lock type. Match non-key switch rating.

2.4 SWITCH PLATES

A. Manufacturers:
1. Hubbel Incorporated.
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour.

B. Product Description: Specification Grade.
1. Material: Stainless steel, type 302.
2. Color: to be selected by Designer.

2.5 OCCUPANCY SENSOR

A. Manufacturers:

1. LC & D.

2. Novitas.

3. **Watt Stopper**.

B. Compatible with modular relay panels. Capable of being wired directly to Class 2 wiring without auxiliary components or devices.

C. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.

D. Furnish with manual override.

E. Operation: Silent.

F. Room Sensors: Dual Technology.

G. Corridor and Hallway Sensors:

1. Capable of detecting motion 14 feet wide and 80 feet long with one sensor mounted 10 feet above floor.

2. Capable of detecting motion in warehouse aisle 10 feet wide and 60 feet long or 100 feet long when mounted 22 feet above floor.

3. Capable of being wired in master-slave configuration to extend area of coverage.

2.6 PHOTOCELLS

A. Manufacturers:

1. LC & D.

2. Novitas.

3. Watt Stopper.

B. General: Consist of sensor mounted with separate control-calibration module. Sensor connected to control-calibration module via single shielded conductor with maximum distance of 500 feet (150 m).

C. Control-Calibration Module: Furnish with the following:

1. Capable of being switched between 4 measurement ranges.

2. Separate trip points for high and low response settings.

3. Momentary contact device to override photocell relays.

4. Three minute time delay between switching outputs to avoid nuisance tripping.

D. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.

1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens, and working range 1-10 foot-candles in 10 percent increments. Entire sensor encased in optically clear epoxy resin.
2. Indoor Lighting: Sensor with Fresnel lens providing for 60 degree cone shaped response area to monitor indoor office lighting levels.
3. Atriums: Sensor with translucent dome with 180 degree field of view and respond in range of 100-1,000 foot-candles.
4. Skylights: Sensor with translucent dome with 180 degree field of view and respond in range of 1,000-10,000 foot-candles.

2.7 PHOTOCELL CONTROL UNIT

A. Manufacturers:

1. LC & D.

2. Novitas.

3. Watt Stopper.

B. Product Description: Photodiode control unit with PHOTOCELL ENABLE and MASTER OVERRIDE input for remote control, 3 minute time delay, and with selectable ranges for 1-10 foot-candle, 10-100 foot-candle, 100-1,000 foot-candle, and 1,000-10,000 foot-candle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount switches, occupancy sensors, and photocells.

B. Use only properly color coded, stranded wire, installed in conduit.

C. Label each low voltage wire clearly indicating connecting relay panel.

D. Mount relays. Provide wiring to numbered relays in panel to control each load.

E. Install relays to be accessible. Allow space around relays for ventilation and circulation of air.

F. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

G. Label each low voltage wire with relay number at each switch or sensor.

3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish services for minimum of one day for check, test, and start-up. Perform the following

services:

1. Check installation of panel boards.
2. Test operation of remote controlled devices.
3. Repair or replace defective components.

3.3 TRAINING

A. Demonstrate operation of the following system components to staff to be trained:

1. Operation of switches.
2. Operation of each type of occupancy sensors.
3. Operation of each type of photocell.

B. Furnish 4 hours to instruct LAWA's personnel in operation and maintenance of system. Schedule training with LAWA, provide at least 7 days notice to Designer of training date.

C. Provide manuals for attendees.

END OF SECTION 26 09 23

SECTION 26 09 43 – NETWORK LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a network lighting control system with the following features:

1. Distributed or centralized relay power pack and switching system.
2. Control provided by switches, photocells, occupancy sensors through relay packs and dimming control devices. Provide controls for discrete functions, dimming and scene presets.
3. Provide networking using Cat 5 cabling between devices and through bridging units, routers, and other network interface devices utilizing IP based addressability.
4. Allow user programming for each fixture and zone over a data network.
5. Provide all control software and programming.
6. Provide capability to control individual fixtures and zones from apps for user computers, tablets or smartphones.
7. Provide a system complying with Title 24 Energy Code requirements.

1.2 SUBMITTALS

A. Shop Drawings: Submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, photocells and other interfaces.

B. Product Data: Submit for approval 6 copies of manufacturer's data on the specific lighting control system and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at manufacturer facility. Submit a complete bill of materials with part numbers, description and voltage specifications.

C. Wiring Diagram: Submit a Wiring diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical riser diagrams are not acceptable. Provide completely filled out control schedules, switch engraving schedules and panel schedules.

1.3 QUALITY ASSURANCE

A. Manufacturers:

1. LC&D.
2. LUTRON
3. nLight.

B. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.

C. A licensed electrician shall functionally test each system component after installation, verify proper operation and confirm that all relay panel and switch wiring conform to the wiring documentation, and as per manufacturer recommendations.

D. Comply with NEC and all local and state codes as applicable to electrical wiring work.

E. Lighting control panels shall be ETL listed to UL 916. LCPs controlling emergency circuits shall be ETL listed to UL 924.

F. The lighting control system shall also be listed or approved by all national, state and local energy codes to include but not limited to California Title 24 and Los Angeles Building Code.

G. System shall have open software protocol to interface with BMS and central utility plant monitoring systems. Verify the BMS protocol required with LAWA. This protocol may involve providing a connection to the Central Utility Plant (CUP). All system devices shall be available for polling & control.

H. Specifications are based on LC&D system. Lutron or nLight shall comply with the compatibility and functionality to achieve the design intent.

1.4 MAINTENANCE MATERIALS

A. Execution Requirements: Spare parts and maintenance products.

B. Provide 8 spare relays per LCP, 4 Micro panels.

C. Provide extra CD version of manufacturers operating software to include graphical interface software.

D. Provide 2 extra sets of as-built and operating manuals.

PART 2 - PRODUCTS

2.1 MATERIAL AND COMPONENTS

A. Provide devices required for complete integrated system.

B. BMS interface to be provided and coordinated with mechanical controls contractor as required.

C. Provide network connection to fire alarm system; turn on lights in event of fire.

D. Smart Panelboards shall be made up of the following components:

1. NEMA rated enclosure with hinged door, available with main lug or main breaker and in voltages of 120/240, 208Y/120 and 480Y/277. Continuous main current ratings as indicated on the panelboard schedule. Minimum AIC rating to be 10,000. NEMA4 rating for outdoor installation.

2. Control electronics mounted internally to each smart panelboard shall be capable of driving up to 42 controllable breakers, control any individual or group of breakers, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each breaker and every zone and be able to control a Micro Relay panel located downstream of non-controllable breaker.

3. Lighting control system shall be digital and consist of a Master LCP with up to 31 controllable, Slave LCPs with up to 42 controllable breakers in each panel, a Micro LCP with up to 4 individual relays, digital switches and digital interface cards (see interfaces). One individual bus network each for North Concourse + North Core and

South Concourse + South Core. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time two-way communication with each system component. Analog systems are not acceptable.

4. Lighting control system shall have the capability to output 4 independent 0V to 10V signals in a Micro LCP. Micro LCP shall control 4 independent 20a fluorescent lighting circuits. Each circuit shall have an adjustable fade rate and take inputs from a wall device, DTC system controller or a digital photocell.
5. Quantity and rating of breakers as required.
6. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120V and 277V.

E. Controllable Breakers

1. Solenoid operated thermal magnetic breakers.
2. Ratings of 120/240 Vac; 15, 20 and 30 Amp; 1- and 2-pole, 277/480 Vac, 15, 20 and 30 amp: 1 and 2-Pole.
3. Rated at 20 Amp, 277 Vac Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.

F. Standard Output Relays

1. Electrically held, electronically latched SPST relay.
2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two #10AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
3. Rated at 20 Amp, 277 Vac Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.
4. Relays to be rated for 250,000 operations minimum at 20a lighting load, use Zero Cross circuitry and be Normally Closed (NCZC). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.
5. Optional relay types available shall include: Normally Open (NO) relay rated for 100,000 operations, a 600V 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

G. Switches

1. All switches shall be digital and communicate via RS 485. Contact closure style switches shall not be acceptable. Any switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
2. Switches shall be available in 1 through 6-button version with engraveable buttons, red LED annunciation for each button and a constantly on green LED locator.
3. Switches may be programmed to be Momentary ON, Momentary OFF, Toggle or Maintained. These functions shall be able to be changed locally (at the DTC or a PC) or remotely, via modem.
4. Contractor to verify all switch types and quantities per plans and specifications.
5. Accessories available to include digital key switch and digital key enable switch.

H. DTC - Digital Electronic Time Clock:

1. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.
2. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
3. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.
4. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.
5. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.
6. Software pre-installed to accept standard Unity Graphical Management Software (GMS) pages. GMS software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone.
7. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.
8. DTC shall provide system wide timed overrides. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

I. Interfaces: For future expansion capability, system to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans.

1. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
2. Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
3. An exterior (PCO) or interior (PCI) photocell that provides readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through programming only. Photocells which requires the use of setscrews or which must be programmed at the photocell control card shall be not acceptable.
4. An interface card that allows the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats to be able to done locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
5. A voice prompted telephone override interface module. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.

6. Software pre-installed to run Unity GX Graphical Management Software (GMS-GX) pages. GMS-GX software shall provide via local or remote PC a visual representation of a specific area or the total area of the project. GMS full graphic pages shall be designed to the LAWA's specifications. Provide 2 GMS pages.
7. Direct digital interface to Smart Panelboards. Smart Panelboard circuits shall appear on the system software as distinct items and maintain all functions and features of the system software to include GMS pages.
8. Direct digital interface to DMX 512 based systems. Lighting control system shall provide 14 global DMX commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time two-way communication between lighting control system and a DMX based system.
9. BMS interface to be provided and coordinated with mechanical controls contractor as required.

2.2 MODES OF OPERATIONS

A. DTC – Digital Electronic Time Clock: DTC shall control any relay or group of relays by the following modes: ON only, OFF only, Maintained, Maintained with timer and OFF sweep warning (Blink warn), maintained with timer (No blink warning). Timers adjustable from 1 minute to 4 hours. When the scheduled program in the DTC is ON the associated timers are disabled. When the scheduled program in the DTC is off and a relay or zone is overridden, the DTC will put that relay or zone into the timer mode and automatically sweep off at the end of the programmed timer period (Maximum 2-Hour Timed Override). All DTC settings, schedules, photocell trip points, temperature settings, longitude and latitude, time zone offset to sunrise and sunset and any other LAWA settings shall be able to be changed though software locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet. No exceptions.

B. Switches: All system switches shall be digital and daisy chained on a single category 5, 4 twisted pair cable with all LCPs. Any switch button shall be able to control any relay or group of relays anywhere on the system in the following modes: ON, OFF, Mixed (Some relays ON some OFF), Toggle (first push ON, next OFF etc.) Maintain. Timer ON with a time set from 1 minute to 4 hours. Timer ON with Off sweep warning, (Blink warning 5 min or as programmed prior to OFF sweep). Timer ON with Horn Warning (Horn output turns ON for the warning 5 min or as programmed prior to OFF sweep). Any switch function shall be able to changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Mount smart breaker panelboards to wall. Attach to backing or structure similar to standard panelboards. Locate strategically to allow access to low and live voltage compartments. Vacuum all construction debris prior to installing electronics.

B. Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. EC is specifically responsible to supply and install the required low voltage cable, Category 5, 4 twisted pair, with pre-assemble RJ45 connectors and snagless boots (commonly referred to as a Cat 5 patch cable) between all switches and panels. Field-test all Cat 5 patch cable with a recognized cable tester. All low voltage wire to be run in conduit, per local codes.

C. Wiring

1. Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.
2. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
3. Place manufacturer supplied “terminators” at each end of the system bus per manufacturer instructions.
4. Neatly lace and rack wiring in cabinets.
5. Plug in Category 5, 4-twisted pair patch cable that has been field tested with a recognized cable tester at the indicated RJ45 connector provided with each lighting control device, per manufacturer instructions.
6. Use Category 5, 4 twisted pair patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information. Use shielded cable for dry contact inputs to lighting control system.
7. Do not exceed 4,000ft-wire length for the system bus.
8. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.
9. The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. EC to wire per manufacturer instructions.

D. All lighting control related servers shall reside in BAS room, not in IT room.

3.2 DOCUMENTATION

A. Each Smart breaker Panelboard shall have properly filled up directory. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate “as built” shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to LAWA, copies placed inside the door of each LCP.

3.3 SERVICE AND SUPPORT

A. Start Up: EC shall contact manufacturer at least 7 days before turnover of project. Manufacturer will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required. EC is responsible for coordinating with GC and LAWA the installation of a dedicated telephone line or a shared phone line with A/B switch. Phone jack to be mounted

within 12" of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP.

B. Telephone factory support shall be available at no additional cost to the LAWA both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional programming via modem as required by LAWA for the operation life of the system. Manufacturer warrants that the DTC software can be upgraded and monitored remotely. Upon request manufacturer to provide remote dial up software at no added cost to LAWA. No exceptions.

C. Provide a factory technician for on-site training of the LAWA's representatives and maintenance personnel. Coordinate timing with General Contractor. Provide 2 days of factory on-site training for a minimum of ten people.

D. On Call Service

1. Control contractor shall perform monthly system diagnostics (viewing system log files and review of performance/error data logged in the system).

2. Provide one technician for 120 hours total (duration of site visit determined on time required to perform the system review) for a period of six (6) months after final acceptance of the project. Time may also be utilized by LAWA to provide as-needed modifications, troubleshooting, and/or clarifications to the system. Use of time is as the sole discretion of LAWA.

3.4 WARRANTY

A. Two (2) years parts and labor.

B. Five (5) years limited parts and labor warranty for repair and replace of defective system components from the date of substantial completion.

END OF SECTION 26 09 43

SECTION 26 13 13 – METAL-CLAD SWITCHGEAR (VACCLAD) – MEDIUM VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This section applies to any 4160V installation or system.

B. The Contractor shall furnish and install the equipment as specified herein.

1.2 REFERENCES

A. The metal-clad switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA SG-4 and SG-5, and but not limited to, ANSI/IEEE 37.20.2.

1.3 SUBMITTALS FOR REVIEW / APPROVAL

A. The following information shall be submitted to LAWA:

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line diagram.
6. Nameplate schedule.
7. Component list.
8. Conduit entry/exit locations.
9. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage.
    c. Continuous current.
    d. Basic impulse level for equipment over 600 volts.
10. Major component ratings including:
    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.
11. Cable terminal sizes.
12. Product data sheets.

B. Where applicable, the following additional information shall be submitted to LAWA:

1. Busway connection.

2. Connection details between close-coupled assemblies.
3. Composite floor plan of close-coupled assemblies.
4. Key interlock scheme drawing and sequence of operations.
5. Descriptive bulletins.

C. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings submitted without approved study will be returned and not reviewed.

D. The AIC ratings of all submitted equipment must conform to the approved Short Circuit and Overcurrent Protective Device Coordination Study.

E. The electrical contractor shall submit ¼"=1'0" scale sketches of all electrical rooms and areas including actual dimensions of all equipment in electrical rooms and indicate clearances per NEC, as well as door swings or other obstacles. Sketches shall be submitted along with or prior to shop drawing submittals. Shop drawing submittal without sketches shall be returned and not reviewed.

1.4 SUBMITTALS FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as built drawings and information for items listed in Section 1.3 above, and shall incorporate all changes made during the manufacturing process.
2. Wiring diagrams.
3. Certified production test reports.
4. Installation information including equipment anchorage provisions.
5. Seismic certifications as specified.

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of twenty-five (25) years. When requested by LAWA, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide Seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the International Building Code (IBC) & California Building Code (CBC) Sections 1704 through 1708 for Site Classification D application and highest 1.5 importance factor. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing

of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, IBC: a peak of 2.45g's (3.2-11 Hz), and a ZPA of 0.98g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz. The certificate of compliance with the requirements shall show that the shake table tested forces that the equipment can withstand exceed the Site Classification D requirements by a 15% margin. Equipment must utilize the shake table test method; computer modeling, calculations or historical data are not acceptable.

2. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

   a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.

   b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

   c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

E. All switchgear shall have Los Angeles Department of Building and Safety approved lab test certification.

1.6 DELIVERY, STORAGE AND HANDLING

A. All new switchgear delivered to the jobsite, shall be stored in a covered and conditioned area where it is protected from the corrosive marine environment at the airport.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Split shipping packages are a must to accommodate designed access hatchway.

E. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

F. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals. It shall also include original shop drawings, and recommended maintenance, Manufacturer's Certification.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Cutler Hammer.

B. Square D.

C. General Electric.

D. The listing of specific manufacturers above does not imply acceptance of their products which do not meet the specified ratings, features, or functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The switchgear described in this specification shall be designed for medium voltage, three-phase, 3 wire, solidly grounded, 60-hertz system.

B. Each circuit breaker shall have the following ratings (values are to be verified by the engineer of record and compared to the specific voltage requirements for any improvement work at the airport):

1. Maximum Voltage: 5 kV.
2. BIL Rated: 170 kV Peak.
3. Continuous Current:
   a. 1200A for mains and tie.
   b. Feeders – 600 A.
4. Short-Circuit Current at rated Maximum kV: 40 kA RMS SYM
5. Rated Voltage Range Factor K: 1.0
6. Closing and Latching Capability: 108 kA Crest
7. Maximum Symmetrical Interrupting and 3-Second Rating: 40 kA RMS SYM
8. Rated Interrupting Time: Cycle 3

2.3 CONSTRUCTION

A. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and

solid removable metal barriers shall isolate the major primary sections of each circuit. Hinged rear doors, complete with provisions for padlocking, shall be provided.

B. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. The circuit breakers shall be a roll-out design to allow withdrawal for inspection and maintenance without the use of a separate lifting device.

2.4 BUS

A. The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, cycloaliphatic epoxy for medium voltage class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

B. A copper ground bus shall extend the entire length of the switchgear.

2.5 WIRING / TERMINATIONS

A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

B. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

2.6 CIRCUIT BREAKERS

A. The circuit breakers shall be horizontal drawout type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.

B. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily. The vacuum interrupter pole unit shall be mounted on cycloaliphatic epoxy supports for medium voltage class. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

E. The breakers shall be electrically operated by the following control voltages: 240V AC close and AC capacitor trip.

F. Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

G. AC control voltage shall be derived from control transformers mounted in the switchgear. A separate control transformer shall be provided on each side of the tie breaker. An automatic throwover control scheme shall be provided and factory wired to provide reliable control power to the entire lineup when one incoming source has failed, but the other source is available. Each control transformer shall be sized to handle the control load of the entire lineup.

2.7 PROTECTIVE RELAYS

A. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays and described hereafter in this specification.

B. Microprocessor-Based Protective Relay.

C. FP-5000 Protective Relay.

1. The protective relays for the Mains/Tie & Feeder circuit protection shall be a single multifunction, microprocessor-based relay that provides three-phase and ground instantaneous and time overcurrent protection, ANSI 50/51, 50/51G, or 50/51N, and voltage protection, metering and control functions as described below. The relay shall be Cutler-Hammer device type FP-5000 or approved equal having all the features and functions herein specified.

2. The relay shall be a solid-state microprocessor-based multifunctional type that operates from the 5 ampere secondary output of current transformers. The relay shall provide ANSI 50/51 protective functions for each of the three (3) phases, and ANSI 50/51N or 50/51G ground fault protection functions as shown on the plans or as determined by the coordination study. The relay shall be true rms sensing of each phase and ground. Ground element shall be capable of being utilized in residual, zero sequence, ground source connection schemes, or deactivated.

3. The relay shall provide the following protection functions:

a. Phase overcurrent (forward/ reverse (67) or both (50/51)): Two inverse time overcurrent (51P-1, 51P-2) functions and two instantaneous overcurrent (50P-1, 50P-2) functions with adjustable time delay.

b. Directional Ground inverse time overcurrent and two instantaneous overcurrent functions from calculated values with adjustable time delay (forward/reverse (67G), or both (51G, 50G-1, 50G-2)).

c. Directional Ground inverse time overcurrent and two instantaneous overcurrent functions from measured values with adjustable time delay (forward/reverse (67G), or both (51X, 50X-1, 50X-2)).

d. Ground directional option for Zero Sequence Voltage Polarizing, Negative Sequence Polarizing or Ground Current Polarizing.

e. Negative sequence overcurrent protection with adjustable time delay (46).

f. Three-phase overvoltage protection with adjustable time delay (59).

g. Three-phase undervoltage protection with adjustable time delay (27).

h. Overfrequency protection with adjustable time delay (81O).

1) Negative sequence overvoltage protection with adjustable time delay (47).

i. Underfrequency protection with adjustable time delay (81U).

j. Breaker failure protection with adjustable time delay (50BF).

k. Reverse/Forward Power (32-1, 32-2).

l. Sync Check (25).

m. Power Factor (55).

1) The primary current transformer ratings being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 1 through 6,000 amperes, in 1 ampere steps.

2) The ground current input and ground protection elements shall be independent of the phase inputs and shall be capable of being connected to the phase residual current transformer connection or to a zero sequence current transformer.

3) Both the phase and ground protection curves shall be independently field selectable and programmable with or without load. Curves shall be selectable from the following:
   I). ANSI/IEEE: Moderately inverse, very inverse, and extremely inverse.
   II). IEC: A, B or C.
   III). Thermal: Flat, It, I2t, I4t.
   IV). Thermal curves shall be similar to those on low voltage trip units for close coordination with downstream devices.

4) The relay shall have six trip rated contact outputs that may be programmed for any protection function operation output.

5) The relay shall have a front panel display of relay condition, breaker status and trip condition.

6) The relay shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy phase current +/- 0.5% or +/- 0.025A from 0.02 to 20.0 per unit, ground current +/- 0.5% of full scale (In) from 0.2 to 2.0 per unit.

n. Individual phase and ground currents with phase angles.

o. Phase-to-ground and phase-to-phase voltages with phase angles.

p. Watts.

q. VARs.

r. VA.

s. Frequency.

t. Power factor – apparent and displacement.

u. Demand and Peak demand (ampere, Watt, VAR, and VA) with date and time stamp since last reset.

1) Forward, reverse and net watthours with start date and time stamp.

v. Lead, lag and net VAR hours with start date and time stamp.

w. VA-hours with start date and time stamp.

x. Minimum/maximum values of current, voltage, watts, VARs, VA, frequency, apparent pf and displacement pf with date and time stamping.

y. Percent THD of voltage and current.

z. Positive, negative and zero sequence components of voltage and current with phase angles.

4. Relay shall have the following features:

a. Integral manual testing capability for both phase and ground overcurrent protection functions.

b. Zone selective interlocking capability for phase and ground fault protection. This function shall be provided and factory wired. Where zone selective interlocking is not an integral part of the protective device, a full bus differential scheme shall be required for both phase and ground, in addition to specified time overcurrent and instantaneous overcurrent phase and ground fault protection. Bus differential scheme shall be provided with separate differential current transformers for all incoming and outgoing loads, as well as appropriate differential relays (ANSI 87 and 87G) as approved by LAWA.

c. Real-time clock for stamping of events, trips and minimum/maximum values with 1 mS time resolution.

d. Trip coil-monitoring circuits.

e. User interface for programming and retrieving data from the front of the unit without additional equipment.

f. Eight (8) contact inputs that are user programmable.

g. Continuous self-testing of internal circuitry.

h. Self-diagnostic capability and a relay healthy alarm output.

i. Integral test program for testing the relay operation by simulating current and voltage conditions internally.

j. Unit failure alarm contact for customer use.

k. Programmable lockout/self-reset after trip function.

l. Programmable set points for device curve selection.

m. Programmable inputs, such as current transformer ratios.

n. Access to program and test modes shall be via sealable hinged cover and password protected for security.

5. Relay shall record information on the last 16 faults including:

   a. Date, time, currents and voltages at the time of fault.

   b. Waveforms of the voltages and currents.

6. Relay shall record the last 100 events into an event log with date and time stamping.

7. Relay shall have programmable logic control functions including logic gates and timer for control of auxiliary functions

8. Relay shall provide and retain relay communication address and check sum setting verification in non-volatile memory chip within the permanently installed case.

9. Relay shall be suitable for operating temperatures from -30 degrees to 55 degrees C. Relay shall be suitable for operating with humidity from 0 to 95% relative humidity (non-condensing).

10. Relay shall have the following communications ports:

    a. A rear communication port that is FSK based and supports local area network compatible to Cutler-Hammer PowerNet or IMPACC systems.

    b. A rear communication port that is RS-485 based and supports the Modbus RTU protocol.

    c. A front communication port supporting ASCI communications to a personal computer or laptop computer.

    d. Relay shall be capable of the following over the communication network: Ability to transmit all information contained in the relay such as currents, set points, cause of trip, magnitude of trip current, waveforms and open-close trip status. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is configured in remote close/open mode.

11. Relay shall have communication ability to open and close the breaker remotely via password protected access or locally from the front of the relay.

12. Relay shall store four setting groups which can be called for via communications, front panel operation or contact input.

13. Relay trip contacts shall not change state if power is lost or an undervoltage occurs. These contacts shall only cause a trip upon detection of an overcurrent or fault condition based upon programmed settings.

14. A relay healthy alarm output shall be normally energized and shall drop out if a relay failure is detected in the self-test function or if control power is lost.

15. The relay shall be suitable for operating on control power with a nominal input voltage of 125 Vac or 250 Vac (60 Hz). When AC control power schemes required, in addition to control power transformer or remote control power are specified, a single-phase uninterruptable power supply shall be included to supply control power to protective devices.

2.8 AUXILLIARY DEVICES

A. Ring type current transformers shall be furnished. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

B. Voltage and control power transformers of the quantity and ratings indicated in the detailed specification shall be supplied. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in drawout drawers. Rails shall be provided as applicable for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

C. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

D. Automatic load shedding system and sequence shall be provided for the 4160V and 1st level 480V at the double ended switchgear. Full redundancy at LAWA 4160V switchgear and 1st level 480V switchgear is required. Substation, switchgear estimated demand loads not to exceed 50% of substation/switchgear ratings.

2.9 AUTOMATIC THROWOVER SYSTEM OPEN TRANSITION

A. Dual Source, With Tie, Open Transition Automatic Transfer Control System.

1. Provide an automatic transfer control system for control of three circuit breakers. The logic of the transfer control system functions shall be provided via a microprocessor. The set points shall be field adjustable without the use of special tools

2. The transfer control system shall be provided with a local display. The display shall show the status of the system as it is operating. When timers are functioning, the display shall show the timer counting down. All time delays shall be capable of being set from the front of the display using a timer setting screen.

3. The transfer control system includes the following features:

   a. Time delay to transfer on loss of Source 1, adjustable.

   b. Time delay to transfer on loss of Source 2, adjustable.

   c. Time delay re-transfer to Source 1, adjustable.

   d. Time delay re-transfer to Source 2, adjustable.

   e. Time delay neutral (main and tie open), adjustable.

   f. The local system display shall show the following: Main- Tie- Main one line diagram; main and tie breaker status (open, closed, tripped, out of cell); readout marked “Source 1” and “Source 2” to indicate that respective source voltages are available; automatic/manual mode select pushbutton; pushbuttons for manual breaker control; and alarm information (loss of source, breaker trip).

4. Sequence of Operation – Automatic Mode

   a. Under normal conditions, the main breakers are closed and the tie breaker is open.

b. Upon phase loss or loss of phase-to-phase voltage of either utility source to between 80% and 100% of nominal, and after a time delay, adjustable from 1 to 60 seconds to override momentary dips and outages the transfer control system shall open the affected main breaker and close the tie breaker.

c. When normal voltage has been restored after a time delay, adjustable from 10 to 600 seconds (to ensure the integrity of the source), the transfer control system shall open the tie breaker. The transfer control system shall have an adjustable neutral position timer (0-10 seconds) to allow voltage to decay sufficiently before the affected main breaker is then closed (open transition retransfer).

d. If Source 2 should fail while carrying the load, transfer to Source 1 shall be made instantaneously upon restoration of Source 1 to satisfactory conditions.

e. If both sources should fail simultaneously, no action shall be taken.

f. If the main or tie breakers trip due to a fault, the transfer control system shall be reset to manual mode and manual operation of that breaker shall be prevented until its overcurrent trip switch is reset.

5. Sequence of Operation – Manual Mode

a. While in manual mode, breakers shall be capable of being opened and closed using control switches or pushbuttons on the transfer control system display. Electrical interlocking shall be provided to prevent the closing of both mains and the tie simultaneously.

6. Provide a control power transformer for each source with control power transfer scheme.

7. Provide electrically operated main and tie circuit breakers.

8. Provide a programmable logic controller with 24 volts dc ride-through power supply.

9. Provide an industrial display panel.

2.10 LAWA METERING

A. Provide a separate LAWA metering devices and compartment with front hinged doors. Include associated instrument transformers.

B. Provide current transformers for metering. Current transformers shall be wired to shorting type terminal blocks.

C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering.

D. Microprocessor-based metering system. Power Xpert 8000

1. Provide a microprocessor based line of Power Quality complete 8000 Meters, designated PX-M consisting of a Power Quality Meter Base(s) designated PX-B along with an integrally mounted Power Quality Meter Display designated PX-D. The PX-M shall be equal to Cutler-Hammer type PowerXpert 8000 as herein specified. PX-B shall be NEMA 1 rated and PX-D shall be NEMA 12 rated.

2. Complete PX-8000 shall be have the following minimum listings and/or certifications:

a. Safety: UL 61010A-1, EN 610101.

b. Accuracy: ANSI C12.20 Class 0.2, IEC/EN60687 0.2 for revenue meters.

c. EMC: FCC Part 15 Subpart B Class A immunity.

d. IEC Standards: 50081-2, 61000-3, 61000-4, and 61000-6.

3. Meter shall be supplied suitable for standard 120/240 Vac as required.

4. Current inputs for each channel shall be from standard instrument current transformers.

   a. The analog current input shall be converted to 1024 samples per cycle with a delta-sigma converter digitally filtered down to 256 samples per cycle for anti-aliasing.

   b. Meter burden shall be less than 10 milliohms.

   c. Overload withstand capability shall be a minimum of 500A for 1 second, non-repeating.

   d. Input range capability shall be 0.005 to 20 amperes.

5. Voltage inputs for each channel shall allow for connection into circuits with the following parameters:

   a. Input range of 600V L-L, 347V L-N direct connected.

   b. PT primary input of 120 volts to 500,000 volts.

   c. Nominal full-scale value of 700 volts rms.

   d. Input impedance of 2 mega ohms.

   e. The analog voltage input shall be converted to 1024 samples per cycle by means of a delta sigma converter and digitally filtered down to 256 samples per cycle for anti-phasing.

6. The PX-Metering series shall be capable of monitoring, displaying, and communicating the below true rms minimum information where applicable with the accuracy as indicated of read or calculated values based on 3 to 300% full scale. The PX-Metering series shall be suitable for installation in single phase, two or three wire systems or in three phase, three or four wire systems.

   a. AC current (amperes) in A, B and C phase, 3-phase average, Neutral (N) and Ground (G). A total of five (5) current inputs shall be provided. Accuracy of all current inputs shall be 0.05% reading, +/- 0.01% of full scale. Provide neutral and ground current transformers. The 5 ampere current inputs shall withstand 40 amperes continuous and 300 amperes for 1 second. Current transformer ratios shall be selectable.

   b. AC voltage (volts) for A-B, B-C and C-A, phase average, A-N, B-N and C-N, average phase to N, and N to G. Accuracy of all voltage inputs shall be +/- 0.1% reading, +/-0.05% maximum of full scale. Capable of metering up to 600 volt without external Potential Transformers (PTs) and up to 500 kV with appropriate PTs.

   c. Real Power (Watts), Reactive Power (VARs), Apparent Power (VA), for each phase and system. Accuracy +/- 0.10% reading and +/- 0.0025% full scale. Forward/Reverse indication shall be provided.

   d. Accumulated, Incremental and conditional measurement for Real Energy (WH), Reactive Energy (VARH), Apparent Energy (VAH) for each phase and system.

Accuracy +/- 0.10% reading and +/- 0.0025% full scale. Forward/Reverse and Net difference indication shall be provided.

e. Frequency (Hz) Accuracy +/- 0.01 hertz.

f. Demand values including present, running average, last complete interval and peak for System Current (Amperes). Demand values including present, running average, last complete interval, peak and coincident with peak kVA and kW demand for System Real Power (Watts), System Reactive Power (VARs), and System Apparent Power (VA).

g. Power Factor for both Displacement only 60-cycle fundamental Watts to VA and Apparent total Watts to total VARs including harmonics for A, B and C phase and 3 phase average. Accuracy +/- 0.10% at unity PF and +/-0.30% at 0.5 PF.

h. Current percent Total Harmonic Distortion (THD) in A, B and C phase and N.

1) Voltage percent THD in A-B, B-C and C-A phase, A-N, B-N and C-N.

i. K-Factor (sum of the squares of harmonic currents times the square of their harmonic numbers).

j. Transformer Derating Factor (1.414 divided by the Crest Factor).

k. Crest Factor (ratio of peak current to rms current).

l. CBEMA (ITIC) curve data.

m. Flicker data.

n. Nines (9's) availability data.

o. Power Quality Index.

7. The PX series shall provide the following sampling capabilities:

a. A/D technology, sampling at 1024 samples per cycle.

b. Over-sampling and quantizing filtering to eliminate false signal noise.

c. ITIC representation of power events.

d. DV/dt triggers for sub-cycle oscillatory transients. Both dv/dt and absolute threshold triggering shall be supported on all voltage inputs, including N-G voltage.

e. Six (6) MHz/ one (1) MHz capture of impulsive transients. 20 ms of data shall be captured at six (6) MHz or 120 ms of data shall be captured at one (1) MHz.

f. Waveform recorded at 100,000 high rate samples per cycle. Waveforms shall be displayed on standard web browser without requiring separately purchased and installed software.

g. Three-phase voltage and neutral-to-ground fast transient capture.

h. Absolute threshold and dV/dt triggering.

8. The PX series shall provide the following advanced analysis features:

a. Calculation of harmonic magnitudes and phase angle for each phase voltage and current through the 85th harmonic.

b. Waveforms shall be available in non-volatile memory and retrievable via file transfer protocol (FTP) in COMTRADE file format over the Internet network. No

special software shall be required to download or view waveforms. Waveforms shall be viewable within standard web browser.

c. Historical Trending: Historical trend logging for graphical viewing from the Local PX-D display or from an embedded WEB server. The graphical views of historical data shall support both pan and zoom functions. All standard metering parameters shall be logged as part of the standard meter functionality including minimum, maximum and average for each metered parameter. The minimum and maximum readings shall be based on 200ms calculations. The averages shall be calculated over the user selected time interval period. Minimum storage capacity for standard trend plots shall be as follows:

   1) One-minute intervals for 9 days.

   2) Sixty-minute intervals for 540 days.

   3) Data storage up to 512 MB.

d. Time of Use Monitoring: Time of use monitoring shall include:

   1) Four rate periods for time of use revenue metering.

   2) Total rate independent of time of use.

   3) Up to 4 rate schedules (weekdays and weekends).

e. Energy Profile: Energy profile data shall include recording of real and reactive energy forward, reverse, net and absolute sum as well as apparent energy (KVAH). Up to eight (8) status inputs shall be configurable as energy accumulators for counting KYZ pulse inputs. These readings shall be stored over a configurable interval from 1 to 60 minutes as well as in daily and weekly totals. Storage capacity shall be as follows:

   1) Sixty-two (62) days of fifteen (15) minute interval energy and pulse interval data (Fixed interval capacity shall equal 5,952 intervals configurable from 1 to 60 minutes).

   2) Three hundred and seventy-two (372) days of 1 day accumulated energy and pulse interval data.

   3) Two Hundred and eight (208) weeks of one (1) week accumulated energy and pulse interval data.

f. Event Triggers: The PX-M shall have a quantity of five (5) types of configurable event triggers configurable using a web browser consisting of 1) Out of limits, 2) Demand overload, 3) ITIC, 4) Sub-Cycle disturbance and 5) Fast Transient. The web browser shall not require any user-installed software. These triggers shall permit pickup, reset and pickup delay to be user configurable. When a trigger occurs, actions shall include Performance monitoring (Nines (9s) analysis, Capturing Waveform, Capture all metered parameters, and ability to send by email and/or activate a relay output. The meter graphic display PX-MD shall flash an LED to annunciate the alarm condition and an audible alarm shall be available. The following trigger options shall be included:

   1) Out of limits – one hundred and five (105) triggers.

   2) Demand overload – Ten (10) triggers.

   3) ITIC curve display sag or swell voltage events – Eight (8) triggers.

4) Fast transient – dV/dt and absolute per phase.

5) Sub-cycle disturbance – dV/dt and absolute.

g. Event Logging: The PX-M or embedded WEB Server shall allow the user to view a list of triggered events along with any captured parameters, event details, and triggered waveforms. In addition, a separate event log shall include logging of activities including acknowledged triggers, new minimum and maximum events, and systems operations, such as resets. The size of each event log shall be virtually unlimited based only on the memory option selected.

h. ITIC Analysis Plot: The PX-M or embedded WEB Server shall include a graphic display of the Information Technology Industry Council (ITIC) plot with counts of disturbances and transients that have occurred. The ITIC plot shall organize events into eight (8) distinct disturbance zones corresponding to the severity of the event and a ninth (9th) zone for transients. A pass/fail count shall be displayed to indicate how many events are outside the ITIC limits. Operator clicking of any counter, or the event itself in the ITIC WEB page shall link the user to the event view and display all triggered events in the selected zone making it easy to view disturbance waveforms associated with the ITIC plot.

i. Sag/Swell and Waveform recording: Sixty (60) cycles of waveform shall be recorded at 256 samples per cycle including 30 cycles of pre and post event data. The embedded WEB server shall be capable of supporting viewing of all triggered waveforms one channel at a time and shall include the ability to zoom and to scroll horizontally using a slider bar. Waveforms shall be stored in non-volatile flash memory using industry standard COMTRADE format. Waveforms shall be automatically sent out as COMTRADE attachments to an email following an event, or shall be retrievable from an FTP directory structure from the meter's memory.

j. Minimum and Maximum values for the following parameters:

1) Voltage L-L and L-N.

2) Current per phase.

3) Apparent Power Factor and Displacement Power Factor.

4) Real, Reactive, and Apparent total Power.

5) THD voltage L-L and L-N.

6) THD Current per phase.

7) Frequency.

9. The PX-8000 meter base and display shall have a digital Input/Output (I/O) card which shall include:

a. Eight (8) digital inputs – self sourced 24 Vdc. These shall be interrupt driven, allowing for 1ms accuracy of digital events time stamps when utilizing local NTP server. Inputs shall be configurable for demand synch, and pulse counting. Inputs selected for pulse counting shall be scalable. Interval by interval pulse recordings shall be maintained in the PX-M/PX-B profile memory and shall be capable of being displayed graphically.

b. Three (3) relay outputs – 5A maximum form C continuous, 380Vac maximum, 125Vdc maximum. Outputs shall be suitable for KYX or alarm annunciation. Relay outputs shall have the following minimum ratings:

1) Make: 30A, 30 Vdc, 120-240 Vac.

2) Break: 5A, 30 Vdc, 120-240 Vac.

3) Resistive load: 0.5A, 125Vdc; 0.25A, 250 Vdc.

4) Mechanical Operations: 1,000,000 no-load and100,000 under rated voltage and current.

5) Output Relay when event triggered shall be capable of operating in timed, normal or latched mode.

c. Two (2) solid state outputs – 80 mA maximum continuous, 30 Vdc maximum.

10. The PX-8000 base and display shall be provided with multiple communications ports and protocols, including the following minimum capability:

a. RS-232

b. RS-485

c. RJ-45 10/100 Base-T Local Ethernet Configuration Port for local WEB server connection

d. Modbus RTU

e. Modbus TCP

f. HTML web pages

g. File transfer protocol (FTP)

h. Ethernet TCP/IP

11. The PX-8000 graphically display shall utilize a simple “twist and click” navigation control dial to easily navigate the menus, select links to related pages, and to drill down into increasing levels of further details. A “back” key shall be provided for easy navigation to higher level screens. The graphical display shall have the following features:

a. Backlight LCD remote graphics display with 320 x 240 pixels. This display must supporting reviewing, displaying and scrolling through waveform captures without requiring a separate computer or separately purchased software.

b. Capable of being mounted to the Meter base unit or remote mounting of display up to 2000 ft away with capability of displaying up to 16 base units or complete Meters.

c. A set of screens including real time data, trend lots, waveform views and ITIC plot.

d. Allow basic device setup and password protected resets.

e. An audible alarm to annunciate alarm conditions.

12. The WEB server shall provide the user with remote WEB access to all the metered, trend and waveform information. The WEB server shall include real time monitored information in both numeric and graphical visual formats.

13. The meter shall be cable of providing the graphically display of the following Main Meter Menu Screens:

a. Meter Screen providing:
   1) Volts: L-L and L-N, and average.
   2) Frequency.
   3) Current and average phase A, B, and C, N & G.

b. Power Screen providing:
   1) Energy.
   2) Demand.
   3) Power Factor.

c. Quality Screen providing:
   1) Total Harmonic Distortion (THD) of volts and current.
   2) Flicker.
   3) Percent Nines (9s) reliability.

d. Events screen providing:
   1) Latest events.
   2) Enabled Triggers.
   3) Historical Events.

e. Set-up screen providing:
   1) View set-up.
   2) Edit set-up.
   3) Login.
   4) Logout.

14. A tool bar for screen selection which is always present and viewable shall be provided along the bottom of the graphical display. Selection of one of the main screens shall be by turning the navigation knob and highlighting the desired screen. Once selected, pressing the knob shall make the selection.

2.11 ENCLOSURES

A. This switchgear shall be installed indoor in NEMA 1 Enclosure. Outdoor installations will have to be justified, NEMA 4 or NEMA 3R Stainless steel gasketed and approved by LAWA.

2.12 NAMEPLATES

A. Refer to Identification for Electrical Systems for information pertaining to nameplates on equipment.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.13 FINISH

A. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.14 ACCESSORIES

A. The switchgear manufacturer shall furnish accessories for test, inspection, maintenance and operation, including:

1. One – Maintenance tool for manually charging the breaker closing spring and manually opening the shutter.
2. One – Levering crank for moving the breaker between test and connected positions.
3. One – Test jumper for electrically operating the breaker while out of its compartment.
4. One – Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails, when applicable.
5. One – Set of rail extensions and rail clamps, when applicable.
6. One – Test cabinet for testing electrically operated breakers outside housing.
7. One – Electrical levering device.

2.15 CORONA FREE DESIGN

A. The switchgear shall be corona free by design and shall be tested for partial discharges in accordance with EEMAC standard G11-1. The corona discharges measured during the tests shall be less than 100 picocoulombs.

2.16 PARTIAL DISCHARGE SENSING EQUIPMENT

A. The switchgear shall be equipped with factory installed partial discharge sensors and relay for continuous monitoring of the partial discharges under normal operation. The purpose of partial discharge sensing is to identify potential insulation problems (insulation degradation) by trending of PD data over time so that corrective actions can be planned and implemented before permanent insulation deterioration develops.

B. The PD sensing and monitoring system shall consist of sensors and relay specifically developed for such applications, such as Eaton's RFCT sensor and InsulGard relay, or equivalent. One RFCT sensor shall be installed over floating stress shields of specially designed bus or line side primary bushings, at every two vertical section for detection of partial discharges within the switchgear compartments. An RFCT sensor shall also be provided for installation around ground shields of the incoming or outgoing power cable termination for detection of PD activity in the cables up to 100 feet from the switchgear. Output signals from each RFCT shall be factory wired to PD monitoring relay for continuous monitoring.

2.17 CONTROLS AND CONTROL TRANSFORMERS

A. The metal-clad switchgear auxiliary section for control and instrumentation shall include the following:

1. Line-to-line voltage transformers.
2. Current transformers.
3. Single-phase control power transformers with automatic throwover system. The size of the transformers shall be determined by the VacClad lineup manufacturer and each transformer shall handle the full control power load of the lineup (tie breaker closed, single source available).
4. Microprocessor-based PowerXpert 8000 metering system.
5. Automatic load shedding system and sequence shall be provided for the 4160V and 1st level 480V at the double ended switchgear. Full redundancy at LAWA 4160V switchgear and 1st level 480V switchgear is required. To accomplish, consider having new substation, switchgear estimated demand loads not exceed 50% of substation/switchgear ratings.

2.18 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing in accordance with NEMA PB 2.

B. Make completed switchboard available for inspection at manufacturer's factory prior to packaging for shipment. Notify LAWA at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify LAWA at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

1. Alignment test with master cell to verify all interfaces and interchangeability.
2. Circuit breakers operated over the range of minimum to maximum control voltage.
3. Factory setting of contact gap.
4. One-minute dielectric test per ANSI standards.
5. Final inspections and quality checks.

B. The following production test shall be performed on each breaker housing:

1. Alignment test with master breaker to verify interfaces
2. One-minute dielectric test per ANSI standards on primary and secondary circuits

3. Operation of wiring, relays and other devices verified by an operational sequence test
4. Final inspection and quality check

C. The manufacturer shall provide three (3) certified copies of factory test reports.

D. Factory tests as outlined above under 3.02.B shall be witnessed by LAWA.

1. The manufacturer shall notify LAWA two (2) weeks prior to the date the tests are to be performed.
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) LAWA's representatives. The cost of meals and incidental expenses shall be LAWA's responsibility.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section for a period of 5 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.3 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.4 TRAINING

A. The Contractor shall provide a training session for up to ten (10) LAWA's representatives for 3 normal workdays at a job site location determined by LAWA.

B. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

3.5 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.6 FIELD ADJUSTMENTS

A. The relays shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required elsewhere in the contract documents.

END OF SECTION 26 13 13

SECTION 26 22 00 – LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE

A. Section includes two-winding transformers; K- factor rated shielded transformer.

1.2 SUBMITTALS

A. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

B. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:

1. Cutler Hammer

2. General Electric.

3. Square D.

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers.

C. Primary Voltage: 480 volts, 3 phase or unless otherwise noted.

D. Secondary Voltage: 208Y/120 volts, 3 phase or unless otherwise noted.

E. Insulation system and average winding temperature rise for rated kVA as follows:

1. 1-15 kVA: Class 185 with 115 degrees C rise.
2. 16-500 kVA: Class 220 with 115 degrees C rise.

F. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full

load.

G. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

H. Sound Levels: NEMA ST 20. Maximum sound levels are as follows:

1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.
6. 501-700 kVA: 62 dB.

I. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.

J. Mounting:

1. 1-15 kVA: Suitable for wall mounting.
2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

K. Coil Conductors: Continuous copper windings with terminations brazed or welded.

L. Enclosure: NEMA ST 20, Type 1 indoor, dry locations and Type 3R for wet locations. Furnish lifting eyes or brackets.

M. Isolate core and coil from enclosure using vibration-absorbing mounts.

N. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 K-FACTOR TRANSFORMERS

A. Manufacturers:

1. Cutler-Hammer

2. General Electric

3. Square D.

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers. K-factor 13 rated, 220 degree C insulation.

C. Primary Voltage: 480 volts, 3 phase or unless otherwise noted.

D. Secondary Voltage: 208Y/120 volts, 3 phase or unless otherwise noted.

E. 200% neutral.

F. Insulation system and average winding temperature rise for rated kVA as follows:

1. 16-500 kVA: Class 220 with 115 degrees C rise.

G. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.

H. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

I. Sound Levels: NEMA ST 20. Maximum sound levels are as follows:

1. 0-9 kVA: 40 dB.
2. 10-50 kVA: 45 dB.
3. 51-150 kVA: 50 dB.
4. 151-300 kVA: 55 dB.
5. 301-500 kVA: 60 dB.
6. 501-700 kVA: 62 dB.

J. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.

K. Mounting:

1. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
2. Larger than 75 kVA: Suitable for floor mounting.

L. Coil Conductors: Continuous copper windings with terminations brazed or welded.

M. Enclosure: NEMA ST 20, Type 1 indoor, dry locations and Type 3R for wet locations. Furnish lifting eyes or brackets.

N. Isolate core and coil from enclosure using vibration-absorbing mounts.

O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

P. Provide an electrostatic shield.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformer on housekeeping pad as required in the hangers and supports for electrical systems section.

B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Support transformers.

1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.

2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

3. Mount trapeze-mounted transformers.

D. Provide seismic restraints.

E. Electrical transformer for toilets, urinals and sensors shall be located in ceiling and provided with ceiling access panels to the extent possible.

END OF SECTION 26 22 00

SECTION 26 23 00 - METAL-ENCLOSED DRAWOUT SWITCHGEAR - LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a deadfront type, low voltage metal-enclosed switchgear assembly utilizing drawout power circuit breakers for the Main Switchboard in each terminal.

1.2 REFERENCES

A. The low voltage metal-enclosed switchgear assembly and all components shall be designed, manufactured and tested in accordance with the following latest applicable standards:
   1. ANSI-C37.20 - Switchgear assemblies
   2. ANSI-C37.13 - Low voltage power circuit breakers
   3. ANSI-C37.17 - Trip devices
   4. NEMA SG-5 - Switchgear assemblies
   5. NEMA SG-3 - Low voltage power circuit breakers
   6. UL 1558
   7. UL 819

1.3 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to LAWA:
   1. Master drawing index
   2. Front view and plan view of the assembly
   3. Three-line diagram
   4. Schematic diagram
   5. Nameplate schedule
   6. Component list
   7. Conduit space locations within the assembly
   8. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current rating
   9. Major component ratings including:
      a. Voltage
      b. Continuous current rating

c. Interrupting ratings

10. Cable terminal sizes
11. Product data sheets

B. Where applicable, the following additional information shall be submitted to LAWA:

1. Busway connection
2. Composite front view and plan view of close-coupled assemblies
3. Key interlock scheme drawing and sequence of operations
4. Mimic bus size and color

C. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings submitted without approved study will be returned and not reviewed.

D. AIC ratings of all submitted equipment must conform to the approved Short Circuit and Overcurrent Protective Device Coordination Study, minimum 100,000AIC.

1.4 SUBMITTALS - FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
2. Wiring diagrams
3. Certified production test reports
4. Installation information
5. Seismic certification as specified

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten 10 years. When requested by LAWA, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals. It shall also include original shop drawings, and recommended maintenance, Manufacturer's Certification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Cutler-Hammer.**

B. **Square D.**

C. **General Electric.**

D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The entire assembly shall be suitable for 600 volts maximum ac service.

B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 100,000 amperes symmetrical at rated voltage.

C. The bus system shall have a minimum ANSI short-circuit withstand rating of 100,000 amperes symmetrical tested in accordance with ANSI C37.20.1 and UL1558.

D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 100,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

E. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2.3 CONSTRUCTION

A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. Hinged rear doors, complete with provisions for padlocking, shall be provided.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position.

C. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.

D. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension buses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.

E. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

F. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the “connected” and “test” positions.

G. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, “connected”, “test”, “disconnected” and “removed”. The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

H. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover

from the arc chutes to ground.

1. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

I. Provide a rear compartment barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.

J. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.

1. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.

K. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

2.4 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

B. Provide a full capacity neutral bus.

C. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

E. Provide bus extensions on ends for future sections.

2.5 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer’s wiring diagrams.

B. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.

C. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.

D. All control wire shall be type SIS. Control wiring shall be 16 ga for control circuits and 14 ga for shunt trip and current transformer circuits. Wire bundles shall be secured with nylon ties

and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire using a UV cured ink process. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker. Terminal blocks shall be of the latched pull-apart type.

E. NEMA 2-hole mechanical- type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size.

F. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided.

G. Provide 25% spare terminals.

2.6 CIRCUIT BREAKERS

A. All protective devices shall be low voltage power circuit breakers. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.

C. Breakers shall be provided in drawout configuration. The 800, 1600, 2000 and 3200 ampere frame power circuit breakers shall be provided in the same physical frame size, while 4000, 5000 and 6000 ampere frame power circuit breakers shall be provided in a second physical frame size. Both physical frame sizes shall have a common height and depth.

D. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

E. Breakers shall be electrically operated (EO).

F. Electrically operated breakers shall be complete with 120 Vac motor operators. The charging time of the motor shall not exceed 6 seconds. Control power for all switchgear control circuits shall be provided by a factory-sized control power transformer wired on the line side of the main breaker(s).

G. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

H. The power circuit breaker shall have a closing time of not more than 3 cycles.

1. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

I. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

J. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions, as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is tripped or opened.

1. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

K. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

L. Each power circuit breaker shall offer sixty (60) front-mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

2.7 TRIP UNITS

A. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.

B. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.

C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

E. Trip unit shall have selectable powered and unpowered thermal memory for enhanced circuit protection.

F. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

1. All circuit breakers shall have adjustments for long delay pickup and time.
2. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings.
3. All circuit breakers shall have an adjustable instantaneous pickup.
4. All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I^2t settings.

G. The trip unit shall have provisions for a single test kit to test each of the trip functions.

H. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the present time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

I. The trip unit shall include a power/relay module which shall supply control to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available.

J. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the voltage transformer module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

K. Provide a trip unit with Arc Reduction Module built into the trip unit, which includes multiple instantaneous trip set points, a normal/maintenance mode switch and indicating light to remind maintenance personnel when the switch is in the maintenance mode B all integral to the breaker trip unit. The ARMS reduction feature shall also have provisions for remote setting of the breaker into a maintenance mode.

L. For emergency Circuit breakers, provide individually adjustable ground fault alarm only.

M. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.

N. The trip unit shall include a power/relay module which shall supply control to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

O. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the voltage transformer module shall be connected internally to the

line side of the circuit breaker through a dielectric test disconnect plug.

P. The display for the trip units shall be a 24-character LED display.

Q. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

R. The unit shall be capable of monitoring the following data:

1. Instantaneous value of phase, neutral and ground current
2. Instantaneous value of line-to-line voltage
3. Minimum and maximum current values
4. Watts, VARs, VA, watthours, VARhours and VA hours

S. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alphanumeric display panel.

T. The trip unit shall display the following power quality values: crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.

U. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

V. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

W. Programming may be done via a keypad at the faceplate of the unit or via the communication network.

X. System coordination shall be provided by the following microprocessor-based programmable time current curve shaping adjustments. The short-time pickup adjustment shall be dependent on the long delay setting.

1. Programmable long-time setting
2. Programmable long-time delay with selectable I^2t or I^4t curve shaping
3. Programmable short-time setting
4. Programmable short-time delay with selectable flat or I^2t curve shaping, and zone selective interlocking
5. Programmable instantaneous setting
6. Programmable ground fault setting trip or ground fault setting alarm
7. Programmable ground fault delay with selectable flat or I^2t curve shaping and zone selective interlocking

Y. The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event.

Z. The trip unit shall have the following advanced features integral to the trip unit:

1. Adjustable undervoltage release
2. Adjustable overvoltage release
3. Reverse load and fault current
4. Reverse sequence voltage alarm
5. Underfrequency
6. Overfrequency
7. Voltage phase unbalance and phase loss during current detection

2.8 MISCELLANEOUS DEVICES

A. Key interlocks shall be provided. These interlocks shall keep the circuit breakers trip-free when actuated.

B. Fused control power transformers shall be provided as required for proper operation of the equipment. A manual disconnect shall be provided ahead of the primary fuses. Control power transformers shall have adequate capacity to supply power to all the control circuits within the lineup.

2.9 LAWA METERING

A. Provide a separate LAWA metering compartment with front hinged door, where required.

B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering.

D. Microprocessor-Based Digital Metering Unit (DMU) shall include branch circuit metering utilizing Eaton IQ-260 meters and main circuit metering utilizing IQ-2270 meters. All meters shall utilize RS-485 daisy-chained factory-supplied connection and a PowerXpert 600 Gateway per lineup for customer/contractor supplied network cable between lineups.

2.10 ENCLOSURES

A. This switchgear shall be installed indoor in NEMA 1 Enclosure. Outdoor installations will have to be justified, NEMA 4 or NEMA 3R Stainless steel gasketed and approved by LAWA

2.11 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits. Refer to Electrical Identification for additional information.

B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer's name.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings.

D. Refer to Identification for Electrical Systems for information pertaining to nameplates on equipment.

2.12 FINISH

A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61.

2.13 ACCESSORIES

A. Provide a floor running portable circuit breaker transfer truck with manual lifting mechanism, one for each concourse main electrical room.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.

C. A certified test report of all standard production tests shall be shipped with each assembly.

D. Factory test as outlined above shall be witnessed by LAWA's representative.

1. The manufacturer shall notify LAWA two (2) weeks prior to the date the tests are to be performed
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) LAWA's representatives. The cost of meals and incidental expenses shall be LAWA's responsibility

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a

period of 5 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.3 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment.

3.4 TRAINING

A. The Contractor shall provide a training session for up to ten (10) LAWA's representatives for 2 normal workdays at a job site location determined by LAWA.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

3.5 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations.

B. The Contractor shall ensure that the switchgear installation shall provide at a minimum physical floor space for one additional switchgear section at each line-up end. A double ended switchgear will require two section floor spaces, one at each end. The Contractor shall properly mark these spaces for future expansion.

C. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

D. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:

1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction
2. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations

E. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections.

F. Securing assemblies to foundation or floor channels.

G. Measuring and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only).

H. Inspecting and installing all circuit breakers in their proper compartments.

END OF SECTION 26 23 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes main and distribution switchboards according to UL 489 listings. For distribution panels rated 800A and below use panelboard construction.

1.2 SUBMITTALS

A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.

B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

C. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings without approved study will be returned and not reviewed.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

B. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.4 QUALIFICATIONS

A. The manufacturer of the switchboard assembly shall be the same as the manufacturer of the circuit breakers installed within the assembly.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 –– PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

A. Manufacturers:

1. **Cutler-Hammer.**
2. **GE Electrical.**
3. **Square D.**

B. Product Description: NEMA PB 2, enclosed switchboard.

C. Minimum Short Circuit Rating: 65,000 symmetrical amperes rms, fully rated, or higher to exceed 130 percent of the available fault current as indicated on the Short Circuit Study.

D. Device Mounting:

1. Main Section: Panel mounted, solid-state, molded case circuit breakers.
2. Distribution Section: Panel mounted, molded case circuit breakers.

E. Bus:

1. Material: Copper with silver or tin plating standard size.
2. Connections: Bolted, accessible from front for maintenance.
3. Provide bus extensions on ends for future sections.

F. Ground Bus: Extend length of switchboard.

G. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials.

H. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Leave space in design for one spare section to be added. Provide footprint area for future expansion.

I. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.

J. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.2 MOLDED CASE CIRCUIT BREAKER

A. Molded case circuit breakers are for typical frame sizes ranging from 110A to 2500A.

B. Manufacturers:

1. **Cutler-Hammer.**
2. **General Electric.**
3. **Square D.**
4. **Circuit breakers must match switchboard manufacturer.**

C. Product Description: UL 489, molded-case circuit breaker.

D. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 250 amperes and larger have mechanism for adjusting long time and short time continuous current, short time

and long time pickup current setting for automatic operation. Provide interchangeable trip unit.

E. Circuit breakers with frame sizes 225 amperes and smaller are thermal-magnetic, non-adjustable type.

F. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip; and adjustable short time trip. Listed for 100 percent continuous duty. Provide for circuit breakers rated 400A and above. Accessories:

1. Shunt Trip Device.
2. Undervoltage Trip Device.
3. Auxiliary Switch.
4. Alarm Switch.
5. Electrical Operator.
6. Handle Lock: Provisions for padlocking.
7. Grounding Lug: In each enclosure.

2.3 INSULATED CASE CIRCUIT BREAKER

A. Insulated case circuit breakers are for typical frame sizes ranging from 800A to 6000A.

B. Manufacturers:

1. Match switchboard manufacturer.
2. Substitutions: Not Permitted.

C. Product Description: UL 489, enclosed, insulated-case circuit breaker

D. Trip Unit: Electronic sensing, timing, and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing instantaneous trip; and adjustable short time trip.

E. Accessories (dependent on the design of the system):

1. Shunt Trip Device.
2. Undervoltage Trip Device.
3. Auxiliary Switch.
4. Alarm Switch.
5. Electrical Operator.
6. Handle Lock: Provisions for padlocking.
7. Grounding Lug: In each enclosure.

2.4 POWER METERS

A. Power meters are to meter the main circuit breaker and feeder breakers sized 800A and above. Tenant sub metering may be required

B. Manufacturers:

1. **Eaton.**
2. **Square D.**
3. **General Electric.**
4. Eaton is the basis for design. The existing Bradley West Terminal has an Eaton web-based metering system. All power meters must be compatible with the existing Eaton system. Use of the other manufacturers listed does not relieve the Contractor from providing a system that is equal in every respect to the Eaton system and is compatible in every respect with the Eaton system.
5. Substitutions: Not Permitted.

C. Provide metering in accordance with Section 26 09 13 for every main device and tie device. Tenant submetering may be required.

D. Power Meter:

1. Meter: Eaton IQ-260.
2. Gateway Ethernet Switch: Eaton Power Xpert Gateway, PMX-600E.
3. Eaton Multi-Point Metering Module, PXMP Series
4. Internally wire meters and connect to a network gateway ethernet switch for web-based power metering system. Provide all internal wiring, hardware, power supplies and equipment necessary for metering.
5. Provide network gateway ethernet switch in separate enclosure mounted in electrical room. Provide power supply and all wiring to connect gateway ethernet switch to meters, circuit breakers and to LAN network.

2.5 ACCESSORIES

A. Circuit Breaker Lifting Device: Portable, floor supported, elevating carriage with roller base, for movement of circuit breakers in and out of switchboard structure

B. Concrete Housekeeping Pad: 3,000 psi. Pad to extend 4 inches above finished floor and extend 6 inches beyond equipment in all directions. Provide steel reinforcing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall ensure that the switchboard installation shall provide at a minimum physical floor space for one additional switchgear section at each line-up end. A double

ended switchboard will require two section floor spaces, one at each end. The Contractor shall properly mark these spaces for future expansion.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install engraved nameplates.

D. Ground and bond switchboards.

3.2 ADJUSTING

A. Adjust operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections.

C. Adjust circuit breaker trip and time delay settings to values as indicated on short circuit study. Refer to Overcurrent Protective Device Coordination Study. Provide services of an independent third party to make all adjustments.

D. These above adjustments shall be performed by a third party. These adjustments shall include but are not limited to, the following studies: short circuit study, coordination study and arc flash study.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards rated 800A and below. For distribution boards rated greater than 800A use switchboard construction.

1.2 SUBMITTALS

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

B. Product Data: Submit catalog data showing specified features of standard products.

C. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings without approved study will be returned and not reviewed.

D. AIC ratings shown on the single line diagrams are approximate values only. The AIC ratings of all submitted equipment must conform to the approved Short Circuit and Overcurrent Protective Device Coordination Study.

E. The electrical contractor shall submit ¼”=1’0” scale drawings including interior elevations of all electrical rooms and areas including actual dimensions of all equipment in electrical rooms and indicate clearances per NEC, as well as door swings or other obstacles. These drawings shall be submitted along with or prior to shop drawing submittals. Shop drawing submittal without sketches will be returned and not reviewed. The equipment depicted on the plans and interior elevations shall match the equipment indicated on the shop drawings.

1.3 QUALIFICATIONS

A. The manufacturer of the panelboard shall be the same manufacturer of the major components within the assembly, including circuit breakers and fusible switches.

1.4 MAINTENANCE MATERIALS

A. Furnish two of each panelboard key. Panelboards keyed alike to LAWA’s current keying system.

PART 2 - PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:

1. Cutler-Hammer.

2. GE Electrical.
3. Square D.

B. Product Description: NEMA PB 1, circuit breaker type panelboard.

C. Panelboard Bus: Copper, current carrying components, and furnish copper ground bus in each panelboard.

D. Enclosure for outdoors installation: NEMA 3R Stainless Steel, NEMA 4 or better.

E. Minimum integrated short circuit rating: Amperes rms symmetrical shall be 42,000A rms symmetrical. Panelboards shall be fully rated; series rated equipment is not acceptable. The short circuit rating of the equipment shall exceed 130% of the available short circuit current at the equipment.

F. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

G. Circuit Breaker Accessories: Trip units and auxiliary switches.

H. Cabinet Front: Surface door-in-door type, fastened with screws, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel – NC16.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Cutler-Hammer.
2. GE Electrical.
3. Square D.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper, current carrying components. Furnish copper ground bus in each panelboard with full sized neutral; furnish insulated ground bus.

D. For non-linear load applications subject to harmonics furnish 200 percent rated, plated copper, solid neutral.

E. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes min, rms symmetrical for 480 volt panelboards. Panelboards shall be fully rated; series rated equipment is not acceptable. The short circuit rating of the equipment shall exceed 130% of the available short circuit current at the equipment.

F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers. Do not use tandem circuit breakers.

G. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards. Surface mounted.

H. Cabinet Front: Flush or Surface cabinet, concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel. No concealed trim clamps.

PART 3 – EXECUTION

3.1 INSTALLATION

A. To the extent possible, install all panelboards indoors due to the corrosive environment.

B. Install panelboards plumb.

C. Install recessed panelboards flush with wall finishes.

D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard. Refer to LAWA standard before revising directory to reflect circuiting changes to balance phase loads.

G. Install engraved nameplates per LAWA standards.

H. Ground and bond panelboard enclosure. Connect equipment ground bars of panels in accordance with NFPA 70.

END OF SECTION 26 24 16

SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motor control centers.

1.2 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers:

1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:

1. NEMA FU 1 - Low Voltage Cartridge Fuses.
2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2,000 Volts AC or 750 Volts DC.
3. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.
4. NEMA ICS 3 - Industrial Control and Systems: Factory Built Assemblies.
5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.
7. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
8. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. Underwriters Laboratories Inc.:

1. UL 198E - Class R Fuses.
2. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
3. UL 508 - Industrial Control Panels.
4. UL 845 - Motor Control Centers.

1.3 SUBMITTALS

A. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time and current curves of equipment and components.

C. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings without approved study will be returned and not reviewed.

D. AIC ratings shown on the single line diagrams are approximate values only. The AIC ratings of all submitted equipment must conform to 130% of the values shown on the approved Short Circuit and Overcurrent Protective Device Coordination Study.

E. The electrical contractor shall submit ¼”=1’0” scale drawings including interior elevations of all electrical rooms and areas including actual dimensions of all equipment in electrical rooms and indicate clearances per NEC, as well as door swings or other obstacles. These drawings shall be submitted along with or prior to shop drawing submittals. Shop drawing submittal without sketches will be returned and not reviewed. The equipment depicted on the plans and interior elevations shall match the equipment indicated on the shop drawings.

F. Test and Evaluation Reports: Indicate field test and inspection procedures and test results.

G. Source Quality Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality Control Submittals: Indicated results of Contractor furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit replacement parts list for controllers.

B. Project Record Documents: Record actual locations, configurations, and ratings of motor control centers and major components.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in 60 inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.7 AMBIENT CONDITIONS

A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

1.8 EXISTING CONDITIONS

A. Verify field measurements prior to fabrication. Indicate field measurements on shop drawings.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTER

A. Manufacturers:

1. Eaton.
2. General Electric.
3. Square D.
4. Substitutions: Not Permitted.

B. Description: NEMA ICS 3, Class I, Type B heavy duty, industrial grade motor control center.

1. Main Overcurrent Protection: Molded case circuit breaker.
2. Feeder Tap Units: Molded case thermal-magnetic circuit breakers.

C. Operation:

1. Service Conditions: NEMA ICS 2.
2. Voltage Rating: 480 or 120/208 volts, three phase, three or four wire, 60 Hertz.
3. Integrated Equipment Short Circuit Rating: Equal to at least 130% of the available fault current as determined by the Short Circuit and Overcurrent Protective Device Coordination Study.

D. Materials:

1. Horizontal Bus: Copper, with continuous current rating indicated on Drawings. Include copper ground bus entire length of control center.
2. Vertical Bus: Copper.

E. Fabrication

1. Configuration: Units front mounting only, accessible from front only.
2. Enclosure: NEMA ICS 6, Type 1 or 3R, non-walk-in for wet locations.
3. Install all control wiring in Panduit wiring ducts.
4. Control Wiring: Stranded copper.

F. Finishes

1. Manufacturer's standard gray enamel.

2.2 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Manufacturers:

1. Match manufacturer of Motor Control Center.

B. Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Operation:

1. Control Voltage: 120 volts, 60 Hertz.

D. Materials:

1. Overload Relay: NEMA ICS 2; bimetal or melting alloy.
2. Product Options and Features:
    a. Auxiliary Contacts: NEMA ICS 2, 2 2 each field convertible contacts in addition to seal-in contact.
    b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oil tight type.
    c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
    d. Pushbuttons: Unguarded type.
    e. Indicating Lights: LED type.
    f. Selector Switches: Rotary type.
    g. Relays: NEMA ICS 5.
    h. Control Power Transformers: 120 volt secondary, Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.3 TWO-SPEED CONTROLLERS

A. Manufacturers:

1. Match manufacturer of Motor Control Center.

B. Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower. Include integral time delay transition between FAST and SLOW speeds.

C. Operation:

1. Control Voltage: 120 volts, 60 Hertz.

D. Materials:

1. Overload Relay: NEMA ICS 2; bimetal or melting alloy.
2. Product Options and Features:
    a. Auxiliary Contacts: NEMA ICS 2, 2 2 each field convertible contacts in addition to seal-in contact.
    b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oil tight type.
    c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
    d. Pushbuttons: Unguarded type.
    e. Indicating Lights: LED type.
    f. Selector Switches: Rotary type.
    g. Relays: NEMA ICS 5.
    h. Control Power Transformers: 120 volt secondary, Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.4 FULL-VOLTAGE REVERSING CONTROLLERS

A. Manufacturers:

1. Match manufacturer of Motor Control Center.

B. Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower. Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

C. Operation:

1. Control Voltage: 120 volts, 60 Hertz.

D. Materials:

1. Overload Relay: NEMA ICS 2; bimetal or melting alloy.
2. Product Options and Features:
    a. Auxiliary Contacts: NEMA ICS 2, 2 2 each field convertible contacts in addition to seal-in contact.
    b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oil tight type.
    c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

d. Pushbuttons: Unguarded type.

e. Indicating Lights: LED type.

f. Selector Switches: Rotary type.

g. Relays: NEMA ICS 5.

h. Control Power Transformers: 120 volt secondary, Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.5 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:

1. Match manufacturer of Motor Control Center.

B. Description: NEMA AB-1, molded-case circuit breaker.

C. Operation:

1. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 250 amperes and larger have mechanism for adjusting long time and short time continuous current, short time and long time pickup current setting for automatic operation. Provide interchangeable trip unit.

2. Field-Changeable Ampere Rating Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger have changeable trip units.

2.6 SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller in accordance with manufacturer's standards.

B. Make completed motor control center available for inspection at manufacturer's factory prior to packaging for shipment. Notify LAWA at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify LAWA at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify surfaces are suitable for motor control center installation.

3.2 DEMOLITION

A. Disconnect and remove abandoned motor control centers.

B. Maintain access to existing motor control centers and other installations remaining active and requiring access.

3.3 INSTALLATION

A. Furnish concrete housekeeping pads.

B. Install in accordance with NEMA ICS 2.3.

C. Tighten accessible bus connections and mechanical fasteners after placing motor control center.

D. Select and install heater elements in motor controllers to match installed motor characteristics.

E. Install engraved plastic nameplates.

F. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage rating, and phase rating. Place label in clear plastic holder. Indicate method of identifying phase conductors.

G. Ground and bond motor control centers.

H. Provide wire markers or tags for all control wiring at all termination points. Provide side mounted, latched, pull-apart terminal blocks for all remote control wiring. Provide 25% spare terminals.

I. No interlock for A-B motor configuration.

J. Overload reset button shall be operable without wires blocking access.

K. Attach wire ties with screws or epoxy. Do not use adhesive tape.

L. Dual starters are not allowed. Provide one starter for only one motor.

3.4 REPAIR

A. Repair existing motor control centers to remain or are to be reinstalled.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS.

3.6 CLEANING

A. Clean existing motor control centers to remain or are to be reinstalled.

END OF SECTION 26 24 19

SECTION 26 25 00 – ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes busway and fittings including plug-in units.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:

1. NEMA BU 1 - Busways.
2. NEMA BU 1.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. Underwriters Laboratories Inc.:

1. UL 857 - Busways; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Shop Drawings: Provide dimensioned plan views and sections indicating proposed busway routing, required clearances, and locations and details of supports, fittings, equipment connections, and firestops and weatherseals at building element penetrations. Indicate voltage and current ratings, short circuit current ratings, configurations, and installed features and accessories. Include details of wall and floor penetrations. Where roof penetrations are required, provide certification that work does not void roof warranty. Provide all required seismic equipment anchorage details and calculations.

B. Product Data: Submit manufacturer's standard catalog pages and data sheets for busway system components and accessories. Include dimensions, weight, materials, fabrication details, finishes, and service condition requirements. Submit seismic certification of equipment.

1. Include busway resistance, reactance, and impedance data, voltage drop ratings and fault current data.
2. Include characteristic trip curves for each type and rating of circuit breaker plug-in device.

3. All instances when feeder busway ampacity exceeds rating of circuit breaker plug-in device(s) shall be coordinated with LAWA for approval prior to providing submittal for review & approval.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Coordination Drawings: Provide detailed floor plan views and layouts.

1. Indicate busway layout and support locations. Provide isometric drawing.
2. Coordinate the arrangement of busway with structural members, ductwork, piping, equipment and other potential conflicts.
3. Coordinate the work with other trades to avoid installation of obstructions within busway required clearances.
4. Coordinate arrangement of busway with the dimensions and clearance requirements of the actual equipment to be installed.
5. Coordinate the work with placement of supports, anchors, etc. required for mounting.
6. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
7. Where busway extends through roof, coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.

E. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of busway routing and location of plug-in units.

B. Provide seismic certification and equipment anchorage details.

C. Test Results: Provide field test results.

D. Operation and Maintenance Data:

1. Submit joint re-tightening schedule.
2. Include information on replacement parts and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.6 QUALITY CONTROL

A. Manufacture busway in an ISO 9001 certified facility.

B. Provide busway certified for Seismic Withstand Capability in accordance with Code for worst case levels.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle in accordance with NEMA BU 1.1 and manufacturer's written instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation including outdoor busway, which is not weatherproof until completely and properly installed. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not install indoor busway until building is closed in and suitable temperature conditions are controlled.

B. Conform to NEMA BU 1 service conditions during and after installation of busway.

1.9 UTILITY INTERCONNECTIONS

A. Coordinate with Utility Company to provide busway connections suitable for system requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. **Eaton.**
2. **Square D.**
3. **General Electric.**
4. **Substitutions: Not Permitted.**

B. Furnish busway system and all associated components and accessories from a single manufacturer and obtained from a single supplier.

C. Listing of an alternate acceptable manufacturer does not indicate or imply acceptance of their standard products. Manufacturers listed above are not relieved from complying with all specified ratings, features and functions. By using a product other than the basis of design the Contractor accepts responsibility for any and all costs associated with any necessary

modifications to related work including any design fees, inspection fees and construction management fees.

2.2 BUSWAY

A. Provide busway system consisting of all required components, fittings, devices, supports, accessories, etc. as necessary for a complete operating system.

B. Utility Interconnections: Provide utility company approved cable tap-boxes or other fittings required by utility company.

C. Description: Prefabricated sectionalized enclosed bus assemblies and associated fittings and devices; listed and labeled as complying with UL 857.

D. Busway General Requirements:

1. Busway Type: Feeder or Plug-in type as indicated, totally enclosed, low impedance, full neutral, internal ground bus, non-ventilated; suitable for installation in any mounting orientation the busway is designed for (horizontal flatwise, horizontal edgewise, vertical) without derating.
2. Enclosure: Sprinkler proof for indoor installations.
3. Temperature Rise: Not exceeding 55 degrees C, when operating at continuous rated current in an ambient temperature of 104 degrees F (40 degrees C).
4. Bus bars and stabs to be suitably plated at all electrical contact points.
5. Both feeder and plug-in busway rated 800 A and above to be of sandwich type construction, with no air gaps between bus bars except at plug-in openings.
6. Bus bar Insulation: NEMA Class B, rated 266 degrees F (130 degrees C).
7. Housing: Constructed with code gage steel or aluminum to reduce hysteresis and eddy current losses, with suitable protective finish of ANSI 49 gray polyester paint or ANSI 61 epoxy powder paint applied by an automated electrostatic process.
8. Conductors: Copper bars, fully insulated except at joints.
9. Joints: Single bolt type, with silver-plated contact surface for bus and splice plate., with high strength steel bolts and conical washers to maintain proper pressure over a large contact surface area:
    a. Use torque-indicating bolts with visual indication that proper torque has been applied; requires only a standard long handle wrench for proper activation.
    b. Bolts to be at ground potential to allow adjustment without requiring de-energizing of busway.
    c. Designed such that tightening of joints only requires access to one side of busway.
    d. Allows for length adjustment of plus/minus 0.125 inch (3.2 mm).
    e. For busway rated 800 A and above, joint connection assemblies to be removable to allow electrical isolation or physical removal of a busway length without disturbing adjacent busway lengths.

10. Voltage Drop:
    a. Voltage drop specified is based on the busway operating at full rated current and at stabilized operating temperature in 86 degrees F (30 degrees C) ambient.
    b. Do not exceed 3.1 volts per 100 feet (30.48 m) for three phase, line-to-line voltage drop at 40 percent power factor concentrated load.
    c. Do not exceed 4.0 volts per 100 feet (30.48 m) for line-to-line voltage drop at the load power factor that produces maximum voltage drop in the busway.
    d. Do not exceed a total busway voltage drop that causes the total feeder voltage drop to exceed 2 percent as required by California Title 24 Building Energy Efficiency Standards. The total feeder voltage drop includes the total feeder length from the service entrance equipment to the branch circuit panel with the largest calculated voltage drop.
    e. For purposes of voltage drop calculations assume a total load equal to 80% of the device rating serving the busway.

E. Short Circuit Current Rating:
    1. Provide busway system and associated components with listed short circuit current rating not less than 130% of the available fault current at the installed location as determined by short circuit study or as indicated on the drawings, whichever is higher. Where no available fault currents are indicated provide short circuit current rating equal to the short circuit current rating of the switchgear serving the busway. .
    2. Listed series ratings are not acceptable. Provide fully-rated busway.

2.3 SOURCE QUALITY CONTROL

A. Inspect and test according to NEMA BU1 and NETA ATS

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Remove exposed abandoned busways, including abandoned busways above accessible ceiling finishes. Patch surfaces.

B. Maintain access to existing busways and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Extend existing busway installations using materials and methods as specified.

D. Clean and repair existing busways to remain or to be reinstalled.

3.2 PREPARATION

A. Perform insulation resistance testing on individual current-carrying busway system components prior to installation in accordance with NECA 408 and NEMA BU1.1.

B. Verify that field measurements are as shown on drawings.

C. Verify that the ratings of busway system components are consistent with the indicated requirements.

D. Verify that mounting surfaces are ready to receive busway and associated supports.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.3 INSTALLATION

A. Install in accordance with NEMA BU1.1 and with manufacturer's instructions.

B. Arrange busway parallel and perpendicular to building lines.

C. Install busway plumb and level with sections aligned and with horizontal runs at the proper elevation.

D. Arrange busway to provide required clearances and maintenance access for busway and for other equipment adjacent to busway.

E. Unless otherwise indicated, orient horizontal plug-in busway with plug-in openings on sides to permit practical use of all plug-in openings.

F. Maintain proper phase sequence throughout busway system, accounting for phase transitions where applicable.

G. Tighten joints using torque wrench, to manufacturer's specified values.

H. Install busway length with expansion fitting at each location where busway run crosses building expansion joint or in long straight runs for temperature expansion/contraction in accordance with manufacturer's instructions.

I. Mount horizontal busway runs in flatwise position.

J. Provide end closures at unconnected ends of busway runs.

K. Busways in electrical rooms shall be plug in type with minimum of (2) plug provisions for future and clear space around each plug provision.

L. Each busway in electrical room shall be provided with a busway T stub for future connections and clear space around each T provision.

M. Support busway at intervals not exceeding 5 feet as required by the NEC. Support intervals for indoor busway may exceed 5 feet where designed and recommended by the manufacturer with a maximum spacing of 10 feet. Support vertical riser at each floor. Use suitable spring hangers for vertical riser applications where busway penetrates and is supported by building floors. Use manufacturer's recommended hangers and supports or provide required support and attachment components in accordance with Section 26 05 29.

N. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

O. Provide sway bracing as required to keep busway runs straight and prevent rotation and movement, accounting for unbalanced weight distribution of plug-in units where applicable.

P. Install busway with integral fire stops located where busway penetrates fire-rated walls and floors. Seal around opening to maintain fire-rating equal to wall or floor rating.

Q. Install 4 inch concrete curb around interior floor penetrations.

R. Install busway with integral weatherseal located where busway penetrates exterior wall or roof. Provide wall or roof flange and seal around opening to maintain weathertight installation. Seal roof penetrations as required to preserve integrity of roofing system and maintain roof warranty.

S. Outdoor Feeder Busway: Arrange busway to prevent water infiltration through drain holes from rain or snow. Seal joints in accordance with manufacturer's instructions and remove drain hole plugs.

T. Install plug-in units in accordance with manufacturer's instructions. Provide independent supports where recommended by manufacturer. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study.

U. Install fuses in fused switches.

V. Select and install heater elements in motor controllers to match installed motor characteristics.

W. Install permanent markings on busway as required in the Identification for Electrical Systems section 26 05 54.

X. Ground and bond busway in accordance with Section 26 05 27. Where integral housing ground is utilized, verify joint covers and other components required for continuity are properly installed.

Y. Clean dirt and debris from busway enclosure and components in accordance with manufacturer's instructions. Do not use compressed air or a blower in order to prevent debris infiltration. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

Z. Adjusting:

1. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
2. Adjust supports as required to minimize strain on busway and associated components.

3.4 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing.

B. Electrically isolate busway system before energizing and perform insulation resistance testing in accordance with NECA 408 and NEMA BU1.1.

   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Perform infrared scanning of energized busway system under maximum load conditions in accordance with NECA 408.

D. In addition to tests specified, inspect and test in accordance with NETA ATS, except Section 4. Perform inspections and tests listed in NETA ATS, Section 7.4.

E. Correct deficiencies and replace damaged or defective busway system components.

F. Include test reports with close-out submittals.

G. Training: Provide minimum of two hours of training for Owner's personnel on the operation, adjustment and maintenance of system. Use operation and maintenance manual as training reference supplemented with additional training materials as required. Provide training at project site.

END OF SECTION 26 25 00

SECTION 26 27 16 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hinged cover enclosures, cabinets, terminal blocks, and accessories.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.

1.3 EXTRA MATERIALS

A. Furnish two of each key.

PART 2 - PRODUCTS

2.1 Due to the corrosive exterior environment at the airport, all electrical cabinets and enclosure are to be located indoors, as much as possible. In the event that an exterior installation is the only option, these items are to be a NEMA Type 4, 3R Stainless Steel gasketed.

2.2 HINGED COVER ENCLOSURES

A. Manufacturers:

1. **Hoffman Electrical Products.**
2. **Square D.**
3. **General Electric.**

B. Construction: NEMA 250, Type 1 for indoors or **NEMA type 4,or 3R stainless steel** gasketed for outdoor installations.

C. Covers: Continuous hinge, held closed by flush latch operable by key.

D. Furnish interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.

E. Enclosure Finish: Manufacturer's standard enamel.

2.3 CABINETS

A. Manufacturers:

1. **Hoffman Electrical Products.**
2. **Square D.**
3. **General Electric.**

B. Boxes: Galvanized steel with removable end walls.

C. Backboard: Furnish 3/4 inch thick plywood backboard for mounting terminal blocks. Paint matte white.

D. Fronts: Steel, flush or surface type with screw cover front, door with concealed hinge. Finish with gray baked enamel.

E. Knockouts: as required for conduit entry.

F. Furnish metal barriers to form separate compartments wiring of different systems and voltages.

G. Furnish accessory feet for free-standing equipment.

2.4 TERMINAL BLOCKS

A. Terminal Blocks: NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

D. Furnish ground bus terminal block, with each connector bonded to enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

B. Install cabinet fronts plumb.

C. To the extent possible, install all enclosures indoors due to the corrosive environment.

END OF SECTION 26 27 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multi-outlet assembly; and device plates and decorative box covers.

B. The colors for all new wiring devices shall be compatible with the interior design aesthetic established for the public areas of the terminal. All devices on emergency power shall be red.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

1.3 DESIGN REQUIREMENTS

A. All wiring devices for emergency circuits shall be red**.**

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:

1. Leviton.
2. Hubbell.
3. Pass & Seymour.

B. Product Description: NEMA WD 1 Industrial, Heavy-Duty, AC only general-use snap switch, Leviton Decora, or similar.

C. Indicator Light: Lighted handle type switch.

D. Locator Light: Lighted handle type switch; clear color handle.

E. Ratings:

1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

2.2 WALL DIMMERS

A. Manufacturers:

1. Hubbell.

2. **Leviton.**
3. **Lutron.**

B. Product Description: NEMA WD 1, Type I semiconductor dimmer for incandescent lamps and for fluorescent lamps. Coordinate ballast type with dimmable fluorescent lamps.

C. Voltage: 120V or as required for application.

D. Power Rating: As required for application.

E. Accessory Wall Switch: Match dimmer appearance.

2.3 RECEPTACLES

A. Manufacturers:

1. **Hubbell.**
2. **Leviton.**
3. **Pass & Seymour.**

B. Product Description: NEMA WD 1, industrial, Heavy-duty and general-duty general-use receptacle, Leviton Decora or similar.

C. Configuration: NEMA WD 6, type as required.

D. Convenience Receptacle: Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.4 WALL PLATES

A. Manufacturers:

1. **Hubbell.**
2. **Pass & Seymour.**
3. **Leviton.**

B. Indoor Cover Plate: Stainless Steel engraved plate, for indoor switches, dimmers and receptacles.

C. Weatherproof Cover Plate: Gasketed cast metal plate with hinged and gasketed device cover for outdoor wiring devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install receptacles with grounding pole on top.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

E. Install cover plates on switch, dimmer, receptacle, and blank outlets in all areas.

F. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

1. Use jumbo size plates for outlets installed in masonry walls.

G. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuses.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 FUSE PERFORMANCE REQUIREMENTS

A. Motor Load Feeder Switches: Class RK1 (time delay).

B. General Purpose Branch Circuits: Class RK1 (time delay).

C. Motor Branch Circuits: Class RK1 (time delay).

1.4 SUBMITTALS

A. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. **Bussman.**
2. **Gould Shawmut.**
3. **Littelfuse.**

2.2 DESIGN REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.

B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

2.3 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Remove fuses from abandoned circuits.

B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

END OF SECTION 26 28 13

SECTION 26 28 19 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fusible and non-fusible switches.

1.2 SUBMITTALS

A. Product Data: Submit switch ratings and enclosure dimensions.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:

1. **General Electric.**
2. **Cutler Hammer.**
3. **Square D.**

B. Product Description: NEMA KS 1, Type HD, quick-make/quick break with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 4, Type 3R Stainless Steel, or better.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:

1. **General Electric.**
2. **Cutler Hammer.**
3. **Square D.**

B. Product Description: NEMA KS 1, Type HD, quick-make/quick break with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Locations: Type 1.

2. Exterior Locations: Type 4, Type 3R Stainless Steel, or better.

D. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

A. Switch Rating: Number of poles, voltage, current and horsepower rating as required for particular installation.

B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes.)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed switches plumb. Provide supports.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible disconnect switches.

D. Install engraved nameplates.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION 26 28 19

SECTION 26 28 23 - ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes molded-case and insulated-case circuit breakers in individual enclosures.

1.2 REFERENCES

A. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. Underwriters Laboratories Inc.:

1. NEMA AB-1 - Molded-Case Circuit Breakers, Molded-Case Switches.

1.3 SUBMITTALS

A. Product Data: Submit catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

B. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings without approved study will be returned and not reviewed.

C. AIC ratings shown on the single line diagrams are approximate values only. The AIC ratings of all submitted equipment shall not be less than 130 % of the available fault current as determined in the approved Short Circuit and Overcurrent Protective Device Coordination Study.

D. The electrical contractor shall submit ¼”=1’0” scale drawings including interior elevations of all electrical rooms and areas including actual dimensions of all equipment in electrical rooms and indicate clearances per NEC, as well as door swings or other obstacles. These drawings shall be submitted along with or prior to shop drawing submittals. Shop drawing submittal without sketches will be returned and not reviewed. The equipment depicted on the plans and interior elevations shall match the equipment indicated on the shop drawings.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and continuous current ratings of enclosed circuit breakers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:

1. **Eaton.**
2. **General Electric.**
3. **Square D.**
4. **Substitutions: Not Permitted.**

B. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1.

1. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 250 amperes and larger have mechanism for adjusting long time and short time continuous current, short time and long time pickup current setting for automatic operation. Provide interchangeable trip unit.
2. Circuit breakers with frame sizes 225 amperes and smaller are thermal-magnetic, non-adjustable type.
3. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip; and adjustable short time trip. Listed for 100 percent continuous duty. Provide for circuit breakers rated 400A and above.
4. Accessories: As required by system design. Conform to UL 489.
    a. Shunt Trip Device: 120 volts, AC.
    b. Undervoltage Trip Device: 120 volts, AC.
    c. Auxiliary Switch: 120 volts, AC.
    d. Alarm Switch: 120 volts, AC.
    e. Electrical Operator: 120 volts, AC.
    f. Handle Lock: Provisions for padlocking.
    g. Insulated Grounding Lug: In each enclosure.
5. Enclosure: NEMA AB 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
    a. Interior Dry Locations: Type 1.
    b. Exterior Locations: Type 3R Stainless Steel or Type 4.
6. Series Rating: Not allowed. Provide fully-rated breaker with a rating of not less than 130% of the available fault current as determined by the Short Circuit and Overcurrent Protective Device Coordination Study.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned enclosed circuit breakers.

B. Maintain access to existing enclosed circuit breakers and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing enclosed circuit breakers to remain or to be reinstalled.

3.2 INSTALLATION

A. Install enclosed circuit breakers plumb. Provide supports.

B. Height: 5 feet to operating handle.

C. Install grounding and bonding.

D. Locate and install engraved plastic nameplates.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS.

3.4 ADJUSTING

A. Adjust trip settings to coordinate circuit breakers with other overcurrent protective devices in circuit.

B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

C. Adjust all settings based on the Short Circuit and Overcurrent Protective Device Coordination Study.

END OF SECTION 26 28 23

SECTION 26 28 26 – ENCLOSED TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes transfer switches in individual enclosures.

B. National Electrical Manufacturers Association:

1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. Underwriters Laboratories Inc.:

1. UL 1008 - Transfer Switch Equipment.

1.2 SUBMITTALS

A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

B. Submit shop drawings after Short Circuit and Overcurrent Protective Device Coordination Study is approved. Shop drawings submitted without approved Study will be returned and not reviewed.

C. Provide AIC rating of equipment that conforms to the approved Short Circuit and Overcurrent Protective Device Coordination Study.

D. Provide 1/4"=1'-0" detailed and dimensioned floor plans and interior elevations of each area, room or enclosure where equipment is to be installed. Indicate actual dimensions of all equipment, location of all equipment within the area, room or enclosure, whether new or existing, and include all required code clearances and access requirements, door swings or other obstacles. Equipment on plans must be the actual equipment submitted for use on the Project. Shop drawing submittal without sketches will be returned without review.

E. Provide equipment anchorage calculations and details for each section of each piece of equipment stamped and signed by a Structural Engineer retained by the Contractor. All details and calculations are subject to the review and approval of the project Structural Engineer of Record. Provide field review to determine all existing conditions required to perform the calculations.

F. Provide data and information demonstrating the communications protocols necessary for integration into the LAWA building/energy management system.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of enclosed transfer switches.

B. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.5 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switches for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCH

A. Manufacturers:

1. **Russelectric Inc.**
2. **ASCO.**
3. **Cummins.**
4. **Eaton.**

Manufacturer must have nationwide factory-direct field service organization available on a 24-hour per day / 365 days per year call basis.

B. Product Description: NEMA ICS 10, automatic transfer switch with load break type bypass isolation switch.

C. Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, AND DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch in both NORMAL and EMERGENCY positions. Provide rollers or casters to allow transfer switch to be removed from the enclosure.

D. Rating: Voltage and current rating and number of poles as indicated on Drawings. Provide true 4-pole switch with all four poles mounted on a common shaft. Provide identical ratings for fourth pole.

E. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings and poles.

F. Interrupting Capacity and Withstand Current Rating: Comply with Short Circuit and Overcurrent Protective Device Coordination Study.

G. Product Features:

1. LED Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION, NORMAL BYPASS, and ALTERNATE SOURCE BYPASS.
2. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
3. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
4. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed.
5. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 80 percent or frequency varies more than 10 percent from rated nominal value.
6. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
7. In-Phase Monitor: Inhibit transfer until source and load are within acceptable limits.
8. Switched Neutral: Non-Overlapping contacts.
9. Provide LCD digital meter with 1% accuracy. Provide readout for voltage and frequency for all three phases for both normal and emergency source.
10. Provide block-transfer and load-shed functions.
11. Equip transfer switch with microprocessor based control system with real time clock and battery backup.
    a. Equip with self-diagnostics.
    b. Utilize industry standard open architecture communication protocol.
    c. Serial communication port to allow interface with LAWA energy management system network. Provide MODBUS RTU and TCP/IP, BacNet Web Services and SNMP communications protocols to support integration into the LAWA building/energy management system.
    d. Provide record storage and monitoring, logging and trending power data. Store in nonvolatile memory the following records: number of hours in emergency position; number of hours emergency available; total transfer in either direction; data, time, and description of the last four source failures; date of the last exercise period; and date of record reset.
    e. Communicate by the controller via local display and serial communication the following meter readings: Current per phase RMS and neutral; Current Unbalance %; Voltage P-P and P-N; Voltage Unbalance %; Real Power (KW) Apparent Power (KVA) Reactive Power (KVAR) per phase and 3-phase; Frequency; Accumulated Energy (KWH, KVAH, KVARH).

f. Control and monitoring system shall communicate fully with paralleling switchgear.

H. Automatic Sequence of Operation:

1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
2. Time Delay To Start Alternate Source Engine Generator: 0 to 120 seconds, adjustable.
3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay Before Transfer to Alternate Power Source: 0 to 1800 seconds, adjustable.
5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
6. Time Delay Before Transfer to Normal Power: 0 to 1800 seconds, adjustable; bypass time delay in event of alternate source failure.
7. Time Delay Before Engine Shut Down: 0 to 1800 minutes, adjustable, of unloaded operation.
8. Engine Exerciser: Start engine every 7 days; run for 0-600 minutes adjustable before shutting down. Bypass exerciser control when normal source fails during exercising period.
9. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

I. Enclosure:

1. Enclosure: ICS 10, Type 1.
2. Finish: Manufacturer's standard gray enamel.

2.2 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing of each transfer switch.

B. Make completed transfer switch available for inspection at manufacturer’s factory prior to packaging for shipment. Notify LAWA at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer’s test facility. Notify LAWA at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install 4 inch concrete housekeeping pads extending 4 inches beyond enclosure in all directions.

B. Install engraved plastic nameplates.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS.

3.3 MANUFACTURER'S FIELD SERVICES

A. Check out transfer switch connections and operations and place in service.

3.4 ADJUSTING

A. Adjust control and sensing devices to achieve specified sequence of operation.

3.5 DEMONSTRATION AND TRAINING

A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes to LAWA’s staff. Provide 8-hour training sessions for each of 3 shifts for groups of up to 10 LAWA personnel each.

END OF SECTION 26 28 26

SECTION 26 29 13 – ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manual motor controller, fractional horsepower controller, motor starting switch, and full voltage and reduced voltage non-reversing controllers.

1.2 SUBMITTALS

A. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, control schematics, dimensions, and enclosure details.

B. Test Report: Indicate field test and inspection procedures and test results.

PART 2 - PRODUCTS

2.1 ENCLOSED CONTROLLERS

A. Manufacturers

1. Cutler-Hammer.

2. GE Electric.

3. Square D.

2.2 MANUAL MOTOR CONTROLLER

A. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, one NO and one NC auxiliary contact, and toggle operator.

B. Enclosure: NEMA ICS 6, Type 1 or to meet conditions of installation. NEMA Type 4 or Type 3R Stainless Steel, or better for outdoor installations.

2.3 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

A. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light and toggle operator.

B. Enclosure: NEMA ICS 6, Type 1 or to meet conditions of installation. NEMA Type 4 or Type 3R Stainless Steel, or better for outdoor installations.

2.4 MOTOR STARTING SWITCH

A. Product Description: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and toggle operator.

B. Enclosure: NEMA ICS 6, Type 1 or to meet conditions of installation. NEMA Type 4 or Type 3R Stainless Steel, or better for outdoor installations.

2.5 FULL-VOLTAGE AND REDUCED VOLTAGE NON-REVERSING CONTROLLERS

A. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Control Voltage: as required.

C. Overload Relay: NEMA ICS 2; melting alloy.

D. Product Features:

1. Auxiliary Contacts: NEMA ICS 2, with 4 each normally closed field convertible contacts in addition to seal-in contact.
2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.
3. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
4. Pushbuttons: Shielded, Covered and Lockable type.
5. Indicating Lights: LED type.
6. Selector Switches: Rotary type.
7. Relays: NEMA ICS 2.
8. Control Power Transformers: 120 volt secondary. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
9. Reduced-Voltage starters to have delta/wye wiring arrangement.

E. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using thermal magnetic circuit breaker conforming to NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.

F. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 4 or Type 3R Stainless Steel, or better.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed controllers plumb. Provide supports.

B. Height: 5 feet to operating handle.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Install engraved nameplates.

E. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

END OF SECTION 26 29 13

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes engine generator set, emission control devices, fuel fittings and sub base tank, remote control panel, battery, and charger.

B. Locate all generators outdoors. Underground fuel tanks are NOT allowed at the airport.

1.2 SYSTEM DESCRIPTION

A. Description: Engine generator assembly and accessories to provide source of power for Level 1 and 2 applications in accordance with NFPA 110.

B. Capacity: As required with standby rating using specified engine cooling scheme.

C. Diesel generator muffler, flex and mounting hardware.

D. Main fuel supply shall be an aboveground tank with secondary containment capable of holding 110% of that main tank's capacity, also known as double wall tanks and/or sub-base tanks for emergency generators. A corrosion protection mechanism such a sacrificial anode shall be included. The main tank compartment shall be equipped with the proper level gage and vents. The secondary compartment shall be equipped with a leak detection sensor and vents. All sensors shall be continuously monitored to detect and report leaks or malfunctions. Please see Section 2.7 below for further details.

E. Provide engine generators approved by SCAQMD and CARB for use as emergency backup and meeting current emission standards at the time of installation.

1.3 SUBMITTALS

A. Shop Drawings: Indicate electrical characteristics and connection requirements. Include plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

B. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, transfer switch, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, and remote radiator.

C. Test Reports: Indicate results of performance testing.

D. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

1.4 FACTORY PROTOTYPE TESTING

A. The system manufacturer must certify that engine, generator and controls have been tested as a complete system of representative engineering models (not on equipment sold). The manufacturer shall supply equipment that is a current factory standard production model.

B. Prototype testing shall include:

1. Fuel consumption at 1/4, 1/2, 3/4 and full load.

2. Exhaust emissions.

3. Mechanical and exhaust noise.
4. Governor speed regulation at 1/4, 1/2, 3/4 and full load; and during transients
5. Motor starting kVA.
6. Generator temperature rise in accordance with NEMA MG1-22.40 and 16.40
7. Harmonic analysis, voltage waveform deviation and telephone influence factor.
8. Generator short circuit capability.
9. Cooling system performance.
10. 3 phase short circuit tests.
11. Maximum power (kW)
12. Generator revolving field assembly for 2 hours at 2700 rpm (150% overspeed) and 70 degrees C and each production unit tested at 2250 rpm (125% overspeed) at room temperature.

1.5 WARRANTY

A. Five Year Manufacturer Warranty: The manufacturer's standard warranty shall in no event be for a period of less than five years form date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall not be a limiting factor for the system warranty by either the manufacturer or servicing distributor. An extended warranty for an additional five years shall be offered as an option. Submittals received without written warranties as specified will be rejected in their entirety.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of engine generators for five years from Date of Substantial Completion, inclusive of after-market emission devices (if any).

1.7 MAINTENANCE MATERIALS FOR EACH ENGINE GENERATOR

A. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.

B. Furnish two of each fuel, oil and air filter element.

PART 2 - PRODUCTS

2.1 ENGINE

A. Manufacturers:

1. Caterpillar.
2. Kohler.
3. Cummins.

B. Product Description: Air-cooled in-line or V-type, four-stroke cycle, compression ignition Diesel internal combustion engine.

C. Rating: Standby rating in accordance with ISO-8528 and ISO-3046.

D. Fuel System: No. 2 fuel oil, low sulfur content compliant with CARB diesel regulation.

E. Engine speed: 1800 rpm.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed and engine overcrank. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit, with MANUALOFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 or 208 volts AC.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.

J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Furnish fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.

K. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.

2.2 GENERATOR

A. Manufacturers:

1. As provided by engine generator manufacturer.

B. Product Description: NEMA MG1, three phase, four pole, reconnectable brushless synchronous generator with brushless exciter. Voltage, ampere and power factor ratings are as indicated on Drawings.

C. Insulation: The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA class F. The excitation system shall be of brushless construction.

D. Temperature Rise: 80 degrees C Standby, maximum as measured by resistance and based on 40 degrees C ambient temperature.

E. Enclosure: NEMA MG1, open drip proof

F. Total Harmonic Distortion (THD): Not to exceed three percent.

G. Telephone Influence: Below 50.

H. Exciter (Self-Excited): The self-excited, brushless exciter shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes.

I. Automatic Voltage Regulator: The digital automatic voltage regulator (DVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design, which includes electronic voltage buildup,

volts per Hertz regulation, three-phase sensing, over excitation protection, loss of sensing protection, temperature compensation, shall limit voltage overshoot on startup, and shall be environmentally sealed.

2.3 GOVERNOR

A. Manufacturers:

1. As provided by engine generator manufacturer.

B. Product Description: Isochronous governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

2.4 CIRCUIT BREAKER

A. Circuit Breaker Specifications: Provide a generator mounted circuit breaker, molded case or insulated case construction, rating as indicated. Breaker shall utilize a thermal magnetic trip unit and 24VDC shunt trip. The breaker shall be UL listed with shunt trip device connected to engine/generator safety shutdowns. Breaker shall be set to protect the generator from short circuit damage. Breaker shall be housed in an extension terminal box mounted on the side of the generator. Mechanical type lugs, sized for the circuit breaker feeders, shall be supplied on the load side of breaker.

B. Provide an additional circuit breaker for the radiator mounted load bank.

2.5 CONTROL PANEL

A. Generator Mounted Control Panel: Provide a generator mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation; adjustable cycle cranking, digital AC metering (0.5% true rms accuracy) with phase selector switch, digital engine monitoring, shutdown sensors and alarms with horn and reset, adjustable cool down timer and emergency stop push-button. Panel shall incorporate self-diagnostics capabilities and fault logging. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged lid.

B. Digital Readouts: Provide the following digital readouts:

1. Engine oil pressure
2. Coolant temperature
3. Engine RPM
4. System DC Volts
5. Non-resettable engine running hours
6. Generator AC volts
7. Generator AC amps
8. Generator frequency
9. KW meter
10. Percentage of rated Power

11. KVA meter
12. KVAr meter
13. Power Factor meter
14. KWHR meter

C. Alarm NFPA 110: Provide the following indications for protection and diagnostics according to NFPA 110 level 1:

1. Low oil pressure
2. High water temperature
3. Low coolant level
4. Overspeed
5. Overcrank
6. Emergency stop depressed
7. Approaching high coolant temperature
8. Approaching low oil pressure
9. Low coolant temperature
10. Low voltage in battery
11. Control switch not in auto position
12. Low fuel main tank
13. Battery charger ac failure
14. High battery voltage
15. EPS supplying load
16. Base-mounted tank low fuel level
17. Base-mounted tank high fuel level
18. Spare

D. Remote Annunciator NFPA 110: Provide one remote annunciator to meet the requirements of NFPA 110, Level 1. Remote annunciator panel shall reside in BAS room. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn. Additionally, provide communication of generator points with Building Automation System (BAS), Power Monitoring Communications System (PMCS), & Facility Monitoring & Control System (FMC). Location shall be clearly identified on the electrical and architectural drawings.

E. Programmable Control Panel: Provide programmable protective relay functions inside the control panel to include the following:

1. Undervoltage
2. Overvoltage

3. Over frequency
4. Under frequency
5. Reverse power
6. Overcurrent (phase and total)
7. KW level (overload)
8. Three spare LED's
9. Four spare inputs

2.6 FUEL SYSTEM

A. Fuel Filter: Filter/Separator - In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine.

B. Fuel Piping: All supply and return fuel piping shall be double-shell rated for diesel fuel service. Steel piping, including vent piping, (except stainless) shall be epoxy-coated (primer plus epoxy or equivalent).

C. Fuel Line Rating: Flexible fuel lines rated 300 degrees F and 100 PSI.

2.7 SUB-BASE FUEL TANK

A. Manufacturers:

1. IBI.
2. International Supply Co.
3. Tramont.

B. Provide a sub-base steel dual wall fuel tank for the generator set, sized to allow 8 hours of operation.

1. All Protected Base Tanks are UL Secondary Containment list and labeled. It is comprised of a UL142 steel tank, enclosed by a UL142 steel containment basin. All steel tanks are tightness tested at the manufacturer's facility, in accordance with testing procedures specified by UL142 for AST's, and meet UL requirements for standard and emergency venting. The interior of the primary tank has been cleaned and free of any loose material, mill scale, or debris. Sub base tanks are UL 2085 listed for the UL 2 hour fire burn test. Tanks must be ballistic and impact rated per UL 2085 specification.
2. The base tank shall be furnished as a complete, factory assembled and tested assembly and listed as an assembly by Underwriters Laboratories, to UL 142 and UL 2085 factory installed.
3. Primary tanks shall be of minimum thickness per UL 142. Inner tanks will be of rectangular configuration per UL standard 142. All welds must comply with AWS, and ASME IX and ASME B31.1.
4. Secondary containment consists of UL 142 primary tank, completely enclosed by a UL 142 secondary containment tank, which is 110% of the primary. Primary and secondary tank will be Rectangular in configuration. Both tanks are pressure tested to between 3 PSI and 5 PSI per UL requirements. The exterior of the tank will be steel.

5. All tank systems and sub-assemblies shall be installed in strict accordance with the manufacturer's recommendations and applicable fire and environmental codes.
6. All tanks are primed with a Rust-Oleum Shop Coat Enamel. Top coat is Alkyd High Gloss Enamel paint (Sherwin WilliamsSW6004 Mink.)
7. All tanks to be installed on reinforced engineered concrete slab. Protective barriers shall be installed as required by state and local codes.
8. Tanks shall be marked on a visible side with "Flammable", "Combustible", and "No Smoking", product identification, and other signs as required by state and local codes.
9. The system installation (end user) shall be inspected and approved by the system installer or its certified contractor. The system installer shall submit a comprehensive checklist of quality and safety items associated with the installation of the system and its sub-assemblies to verify that the installation is in compliance with applicable local fire and environmental codes.

C. Features

1. Emergency tank and basin vents.
2. Mechanical level gauge.
3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA requirements.
4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level.
6. Basin drain.
7. Integral lifting provisions

2.8 EMISSION CONTROL DEVICES

A. Provide and install as per manufacturer recommendations.

B. Diesel Particulate Filter - The engine shall be equipped with an active diesel particulate filter compliant with current SCAQMD and CARB emissions standards for a major source facility.

C. Install emission control devices that meet SCAQMD, CARB and EPA emission tier standards for the engine at the time of installation.

2.9 STARTING SYSTEM

A. Starting Motor: The engine shall be started by two 24 V DC electric starting motors. Crank termination switch and 24 V DC fuel solenoid valve shall be provided for remote automatic start/stop capability.

B. Jacket Water Heater: A unit mounted forced circulation type water heater. The heater Watt rating shall be sized by the manufacturer to maintain jacket water temperature at 90 degrees F, and shall be a 480 volt, three phase, 60 hertz.

C. Batteries: Lead acid batteries of sufficient capacity for four 15 second crank periods with 10 second rest intervals shall be furnished. Battery voltage of 24 V DC shall be derived from four 12 V DC, 205 amp hour high performance batteries, dry charged. Two battery interconnection cables and four battery-to-starter cables.

1. Battery Trays: A battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall be treated to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over battery electrolyte shall be contained within the tray to prevent a direct path to ground.

2. Battery Charger: A current limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. Ac input voltage shall be 120 volts, single phase. Charger shall have LED annunciation for low DC volts, rectifier failure, loss of AC power, high DC volts. Amperage output shall be no less than ten (10) amperes. Charger shall be wall-mounting type in NEMA 1 enclosure.

2.10 RADIATOR MOUNTED LOAD BANK

A. Furnish a continuous duty load bank, complying with UL 508A, mounted directly on the skid base, on the exhaust side of the radiator, complete with all necessary pilot and power control, wiring and devices to furnish a functional system for the intended use. Load bank shall comply with all applicable NEMA, NEC and ANSI Standards. Load bus configuration and load terminations shall be clearly identified.

B. The load bank shall have the capability of maintaining a constraint load for the Emergency Power Supply Source (EPSS), during both exercising and actual use condition. Rating shall be a minimum of 50% of the generator output rating and matched to the EPSS voltage. Load steps at a minimum of three (3) incremental loads, manually controlled.

C. Enclosure shall be suitable for installation on the exhaust side of the engine radiator. It shall match dimensionally the radiator's duct flange height and width without adaptive duct work. The control section shall have a hinged and gasketed access door(s).

D. Manufacturer shall be Avtron load bank K-711 Series, or equal.

E. Construction shall be aluminum or galvanized steel. All fasteners shall be stainless steel. Load elements shall be helically wound and rated to operate at 50% of the maximum continuous wire rating. Each 50 kW element shall have current limiting fuses. (Furnish three (3) sets of three (3) fuses as spares.)

2.11 VIBRATION ISOLATORS FOR EACH ENGINE GENERATOR

A. For unit to base provide spring type with neoprene acoustical pads, leveling devices and vertical limit stops. Minimum static deflection shall be 1 inch.

B. For base to concrete pad spring mountings, provide adjustable type to provide minimum clearance of 4 inches between structural base and floor, with alignment and lift off restraints.

C. Provide for engine-generator set base, engine-generator set base and remote radiator and silencer and exhaust pipe.

2.12 ENCLOSURE

A. Weatherproof Enclosure: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Provide fixed louvers, battery rack and silencer. Provide sound attenuated enclosure and critical area silencer for noise attenuation.

2.13 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Make completed engine-generator assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify LAWA at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify LAWA at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engraved plastic nameplates.

B. Ground and bond generator and other electrical system components.

3.2 START-UP AND TESTING

A. Coordinate all start-up and testing activities with LAWA.

B. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:

1. Verify that the equipment is installed properly.
2. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
3. Test all alarms and safety shutdown devices for proper operation and annunciation.
4. Check all fluid levels.
5. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
6. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
7. Perform a 4-hour load bank test at 0.80 power factor at full nameplate load using a reactive load bank and cables supplied with the generator. Observe and record the following data at 15-minute intervals:
    a. Service meter hours
    b. Volts AC - All phases
    c. Amps AC - All phases
    d. Frequency
    e. Power factor or VARs
    f. Jacket water temperature
    g. Oil Pressure
    h. Fuel pressure

i. Ambient temperature

8. Connect the generator to building load and verify that the generator will start and run all designated loads in the building.

3.3 TRAINING

A. Furnish eight hours of instruction to be conducted at project site with manufacturer's representative to LAWA choice of staff to be trained. Provide training session for each of 3 shifts.

B. Describe loads connected to emergency and standby system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and standby power.

D. Provide manuals for attendees.

END OF SECTION 26 32 13

SECTION 26 33 00 - BATTERY EQUIPMENT (INVERTER)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes emergency power supplies and accessories.

1.2 SUBMITTALS

A. Product Data: Submit catalog and data sheets showing electrical characteristics and connection requirements. Include unit ratings, dimensions, and finishes. Include performance data for batteries.

1.2 WARRANTY

A. Furnish five year manufacturer warranty for batteries.

PART 2 - PRODUCTS

2.1 EMERGENCY POWER SUPPLY

A. Manufacturers:

1. Lithonia.

2. Chloride.

3. Dual Lite.

B. Product Description: NFPA 111 Type A, Class 1.5 stored emergency power supply system designed for Level 1 applications and consisting of rectifier/charger unit, storage battery, and solid state inverter with static transfer switch, in one or several enclosures, unit suitable for operating HID lamps without extinguishing lamp on transfer.

C. Input Voltage: As indicated on Drawings.

D. Output Power: As indicated on Drawings.

E. Output Voltage: As indicated on Drawings.

F. Inverter Output Frequency: 60 Hz plus 1 percent.

G. Efficiency: 90 percent minimum.

H. Maximum Recharge Time: 12 hours following 1.5 hour discharge.

I. Total Harmonic Distortion: Less than 10 percent at full resistive load.

J. Battery: Nickel cadmium sealed type battery.

K. Charger: Dual rate, designed to maintain battery in full-charge condition during normal conditions.

L. Furnish remote trouble monitor in enclosure with manufacturer's standard finish.

M. Accessories: Provisions for remote battery alarm.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units plumb and level.

3.2 DEMONSTRATION AND TRAINING

A. Engage a factory –authorized service representative to train LAWA maintenance personnel to adjust, operate and maintain the units.

END OF SECTION 26 33 00

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty three-phase, solid-state, uninterruptible power system (UPS). The UPS shall provide high-quality AC power for sensitive electronic equipment loads.

B. A static UPS is mandatory for all systems that require memory or control retention such as those found in baggage handling and building management systems.

1.2 SYSTEM DESCRIPTION

A. Design Requirements - UPS Module.

1. Voltage. Input/output voltage specifications of the UPS shall be:
    a. Rectifier Input: As required.
    b. Bypass Input (for dual-input modules): As required.
    c. Output: Three-phase, 4-wire-plus-ground, as required.
    d. Output Load Capacity: Specified output load capacity of the UPS shall be as required at 0.8 lagging power factor.

B. Design Requirements - Matching Battery Cabinet.

1. Battery Cells: Sealed, lead-acid, valve-regulated.
2. Reserve Time: 30 minutes at full load, 0.8 power factor, with ambient temperature between 20° and 30°C.
3. Recharge Time: to 95% capacity within ten (10) times discharge time.

C. Modes of Operation.

1. The UPS shall be designed to operate as an on-line, double-conversion, reverse- transfer system in the following modes:
    a. Normal - The AC equipment is to be continuously powered by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float- charging a power reserve battery.
    b. Emergency - Upon failure of utility AC power, AC equipment is to be powered by the inverter, which without any switching obtains its power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
    c. Recharge - Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charger shall automatically restart, walk-in, and gradually

resume providing power to the inverter and also recharge the battery system.

d. Bypass - If the UPS must be taken out of service for maintenance or repair, or should the inverter overload capacity be exceeded, the static bypass transfer switch shall perform a reverse transfer of the connected equipment from the inverter to the bypass source without interruption in power to the mission critical AC equipment.

D. Performance Requirements

1. AC Input to UPS DD.

a. Voltage Configuration for Standard Units: three-phase, 4-wire plus ground.

b. Voltage Range: +10%, -20% of nominal.

c. Frequency: Nominal frequency +/-5%.

d. Power Factor: Up to 0.96 lagging at nominal input voltage and full rated UPS output with input filter.

e. Inrush current: 800% of full load current maximum.

f. Current Limit: 115% of nominal AC input current maximum and 100% of nominal for optional generator operation.

g. Input Current Walk-In: 15 seconds to full rated input current maximum. Field selectable 5 or 20 seconds.

h. Current Distortion: 10% reflected input THD maximum at full load with the optional input filter; 30% reflected input THD maximum at full load without the optional input filter.

i. Surge Protection: The UPS shall be able to sustain input surges without damage per criteria listed in ANSI C62.41 Category A and B.

2. AC Output, UPS Inverter.

a. Voltage Configuration: three-phase, 4-wire plus ground.

b. Voltage Regulation:

1) +/- 0.5% three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.

2) +/- 1.0% three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.

c. Frequency: Nominal frequency +/-0.1%.

d. Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 0.1 to 5.0 Hz per second.

e. Phase Displacement:

1) +/- 0.5 degree for balanced load,

2) +/- 1.0 degrees for 100% unbalanced load.

f. Bypass Line Sync Range:

1) +/- 0.5 Hertz,
2) Field selectable +/- 0.5 to 5.0 Hz.

g. Voltage Distortion:
1) 1% total harmonic distortion (THD) for linear loads.
2) 2.5% THD for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating.

h. Load Power Factor Range: 1.0 to 0.7 lagging without derating.

i. Output Power Rating: Rated kVA at 0.8 lagging power factor.

j. Overload Capability:
1) 125% for ten minutes (without bypass source).
2) 150% for one minute (without bypass source).
3) 200% for 10 cycles, pulse paralleling with the static switch.

k. Inverter Output Voltage Adjustment: +/-5% manual adjustment.

l. Voltage Transient Response:
1) 100% load step +/- 5.0%.
2) Loss or return of AC input power +/- 1.0%.
3) Manual transfer of 100% load +/- 3.0%.

m. Transient Recovery Time: to within 1% of output voltage within one cycle.

n. Voltage Unbalance: 100% unbalanced load +/- 1%.

o. Fault Clearing: Sub-cycle current of at least 300%.

1.3 ENVIRONMENTAL CONDITIONS

A. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. Operating Ambient Temperature
UPS Module: 32°F to 104°F (0°C to 40°C).
Battery: 77 +/-9°F (25 +/-5°C).

2. Storage/Transport Ambient Temperature
UPS Module: -4°F to 158°F (-20°C to 70°C).
Battery: -4°F to 92°F (-20°C to 33°C)

3. Relative Humidity
0 to 95%, non-condensing.

4. Altitude (to 33°C)
Operating: to 6,600 ft. (2,000 meters) above Mean Sea Level. Derated for higher altitude applications.
Storage/Transport: to 40,000 ft. (12,200 meters) above Mean Sea Level.

5. Audible Noise
Noise generated by the UPS under any condition of normal operation shall not exceed 65 dBA measured 1 meter from surface of the UPS.

1.4 SUBMITTALS

A. Proposal Submittals

1. Submittals with the proposal shall include:

   a. System configuration with single-line diagrams.

   b. Functional relationship of equipment including weights, dimensions, and heat dissipation.

   c. Descriptions of equipment to be furnished, including deviations from these specifications.

   d. Size and weight of shipping units to be handled by installing contractor.

   e. Detailed layouts of customer power and control connections.

   f. Detailed installation drawings including all terminal locations.

B. UPS Delivery Submittals

1. Submittals upon UPS delivery shall include a complete set of submittal drawings and one (1) instruction manual that shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.5 WARRANTY

A. UPS Module

1. The UPS manufacturer shall warrant the UPS module against defects in materials and workmanship for 12 months after the installation is accepted by LAWA.

B. Battery

1. The battery manufacturer’s standard warranty shall be passed through to the end user.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. A minimum of twenty years’ experience in the design, manufacture, and testing of solid-state UPS systems is required. The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

B. Factory Testing

1. Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

PART 2 - PRODUCT

2.1 FABRICATION

A. Manufacturers:

1. **Liebert.**
2. **Eaton Corp.**
3. **Toshiba.**

B. Materials

1. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
2. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component sub-assembly shall not be greater than 75% of their ratings. Electrolytic capacitors shall be computer grade and be operated at no more than 95% of their voltage rating at the maximum rectifier charging voltage.

C. Wiring

1. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
2. Provision shall be made for power cables to enter or leave from the top or bottom of the UPS cabinet.

D. Construction and Mounting

1. The UPS unit, comprised of input transformer (if required), rectifier/charger with input filter, inverter, static transfer switch, output transformer and maintenance bypass switch, shall be housed in a single free-standing NEMA type 1 enclosure. Cabinet doors/covers shall require a tool for gaining access. Casters and stops shall be provided for ease of installation. Front access only shall be required for expedient servicing, adjustments, and installation. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.
2. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug connections. Like assemblies and like components shall be interchangeable.

E. Cooling

1. Cooling of the UPS shall be by forced air. Low-velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output.
2. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

F. Grounding

1. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

2.2 COMPONENTS

A. Input Transformer

1. When required, the input transformer shall be factory installed inside the UPS module cabinet without increasing the standard footprint.

B. Rectifier/Charger

1. General

   a. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a phase-controlled, solid-state SCR type with constant voltage/current limiting control circuitry.

2. AC Input Current Limiting

   a. The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 115% of the full input current rating. The rectifier/charger shall operate at a reduced current limit mode whenever the critical load is powered from the UPS static bypass circuit such that the maximum UPS input current will not exceed 115% of full load input current. In addition, the rectifier/charger shall have a separate battery current limit, adjustable from 0 to 15% of the full load input current. An optional second circuit shall limit the battery recharge current to zero when activated by a customer-supplied contact closure to signal a customer function such as generator operation.

3. Input Current Walk-In

   a. The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 15-second time interval after input voltage is applied. Walk-in time shall be field selectable for 5 or 20 seconds.

4. Fuse Failure Protection

   a. Power semiconductors in the rectifier/charger shall be fused with fast- acting fuses, so that loss of any one-power semiconductor shall not cause cascading failures.

5. DC Filter

   a. The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure that the DC output of the rectifier/ charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

6. Automatic Rectifier Restart

    a. Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in, and gradually resume providing power to the inverter and also recharge the battery system.

7. Battery Recharge

    a. In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

8. DC Over Voltage Protection

    a. There shall be DC over-voltage protection so that if the DC voltage rises to the pre-set limit, the UPS is to shut down automatically and initiate an uninterrupted transfer of the connected equipment to the static bypass line.

C. Inverter

1. General

    a. The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.

2. Overload Capability

    a. The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 200% of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

3. Fault Clearing and Current Limit

    a. The inverter shall be capable of supplying an overload current of 150% of its full-load rating for one minute. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

4. Step Load Response

    a. The output voltage shall be maintained to within to-5.0% with a 0 to 100% step load change or a 100%-to-0 step load change. The output voltage shall recover to within 1% of nominal voltage within 1 cycle.

5. Voltage Distortion

    a. For linear loads, the output voltage total harmonic distortion (THD) shall not be

greater than 1%. For 100% rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 2.5%. The output rating is not to be derated in kVA or kW due to the 100% nonlinear load with 3:1 crest factor.

6. Output Power Transformer
    a. A dry-type power transformer shall be provided for the inverter AC output. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.
7. Phase Balance
    a. Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement. With 100% load on one phase and 0% load on the other 2 phases or 100% load on 2 phases and 0% load on the other phase, the voltage balance is to be within 1% and the phase displacement is to be 120 degrees within 1 degree.
8. Fuse Failure Protection
    a. Power semiconductors in the inverter shall be fused with fast-acting fuses, so that loss of any one-power semiconductor will not cause cascading failures.
9. Inverter Shutdown
    a. For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.
10. Inverter DC Protection
    a. The inverter shall be protected by the following disconnect levels:
        1) DC Over voltage Shutdown.
        2) DC Under voltage Warning (Low Battery Reserve), user adjustable from 1 to 99 minutes.
        3) DC Under voltage Shutdown (End of Discharge).
11. Over Discharge Protection
    a. To prevent battery damage from over discharging, the UPS control logic shall automatically raise the shutdown voltage set point as discharge time increases beyond fifteen (15) minutes.
12. Inverter Output Voltage Adjustment
    a. The inverter shall use a software control to adjust the output voltage from +/- 5% of the nominal value.
13. Output Frequency
    a. An oscillator shall control the output frequency of the inverter. The oscillator shall be temperature compensated and hold the inverter output frequency to +/- 0.1% for steady state and transient conditions. Frequency drift shall not

exceed 0.1% during a 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.

D. Display and Controls

1. Monitoring and Control

a. The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A graphical display shall be used to show a single-line diagram of the UPS, and shall be provided as part of the monitoring and controls sections of the UPS. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD display. Additional features of the monitoring system shall include:

1) Menu-driven display with pushbutton navigation.
2) Real time clock (time and date).
3) Alarm history with time and date stamp.
4) Battery backed-up memory.

2. Metering

a. The following parameters shall be displayed:

1) Input AC voltage line-to-line.
2) Input AC current for each phase.
3) Input frequency.
4) Battery voltage.
5) Battery charge/discharge current.
6) Output AC voltage line-to-line and line-to-neutral for each phase.
7) Output AC current for each phase.
8) Output frequency.
9) Percent of rated load being supplied by the UPS.
10) Battery time left during battery operation.

3. Alarm Messages

a. The following alarm messages shall be displayed:

1) Input Line Fault.
2) Input Phase Rotation Error.
3) Input Over/Under Frequency.
4) Input Current Limit.
5) Rectifier Fail.
6) Battery Test Failed.
7) Battery Low Warning (Adjustable 1 To 99 Minutes).
8) Battery Low Transfer.
9) DC Over Voltage Steady State.

10) Bypass Frequency Error.
11) Load On Bypass.
12) Excessive Auto Retransfers.
13) SBS SCR Shorted.
14) Bypass Sync Error.
15) Input Phase Loss.
16) I DC Peak.
17) Output Under Voltage Transfer.
18) Output Over Voltage Transfer.
19) Inverter Overload.
20) SBS Overload.
21) Inverter Overload Transfer.
22) Transfer Failed Shutdown.
23) Hardware Shutdown.
24) Output Power Supply Fail.
25) Inverter Control Fault Transfer.
26) EPO Latched (remote EPO activated).
27) System Fan Fail.
28) Ambient Over Temperature Limit.
29) Over Temperature Timeout Shutdown.

b. An audible alarm shall be provided and activated by any of the above alarm conditions.

4. Status Messages

a. The following UPS status messages shall be displayed:

1) Normal operation.
2) On SBS.
3) Load on UPS.
4) Load on bypass.
5) User Shutdown.
6) Battery Discharging.

5. Controls

a. UPS start-up, shutdown, and bypass operations shall be accomplished through the front-panel pushbutton controls. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic diagram screen shall be available on the LCD screen to depict a single-line diagram of the UPS and indicate switch positions and power flow.

6. On-Line Battery Test

a. The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode. If the battery fails the test, the system shall automatically do the following:

1) Maintain the load through the UPS.

2) Display a warning message.

3) Sound an audible alarm.

b. The battery test feature shall have the following user selectable options:

1) Interval between tests (2 to 9 weeks).

2) Date and time of initial test.

3) Enable/disable test.

E. Static Transfer Switch

1. General

a. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating of 110% rated load continuously, 200% rated load for five seconds. The static transfer switch shall also have fault-clearing capabilities of: 1100 amperes for 1 second; 3000 amperes for 10 cycles; and 6000 amperes peak for the first half cycle.

b. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

2. Uninterrupted Transfer

a. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

1) Inverter overload capacity exceeded.

2) AC output over voltage or under voltage.

3) Battery protection period expired.

4) UPS fault condition.

b. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:

1) Inverter/bypass voltage difference exceeding preset limits.

2) Bypass frequency out of limits.

3) Bypass out-of-synchronization range with inverter output.

3. Uninterrupted Retransfer

a. Retransfer of the mission critical AC equipment from the bypass source to the

inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

1) Bypass out of synchronization range with inverter output.
2) Inverter/bypass voltage difference exceeding preset limits.
3) Overload condition exists in excess of inverter full load rating.
4) UPS fault condition present.

F. Internal Maintenance Bypass Switch

1. General

a. A manually operated maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter, and static bypass transfer switch.

2. Isolation

a. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static bypass switch shall be provided when the UPS is in the maintenance bypass mode of operation.

3. Maintenance Capability

a. With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static bypass transfer switch.

4. Battery Cabinet System

a. The matching battery cabinet shall include sealed, lead-acid valve regulated battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system line-up. Battery cells shall be mounted on slide-out trays for ease of maintenance. A battery disconnect circuit breaker with under voltage release (UVR) shall be included for isolation of the battery system from the UPS module. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level. Casters and leveling feet shall also be provided with the battery cabinet for ease of installation. When the application calls for the battery cabinet to be bolted to the UPS cabinet, the interconnecting cables are to be provided, precut to the correct length and cable lugs installed, by the UPS manufacturer.

G. Accessories

1. Input Filter

a. The rectifier/charger shall include an input filter to reduce reflected input current distortion to 10% THD at full load with nominal input voltage. Another benefit of the input filter shall be to maintain the input power factor at 0.90-0.96 lagging minimum from full load to half load with nominal input voltage.

2. External Maintenance Bypass Cabinet

    a. A matching external maintenance bypass cabinet shall be provided to enable the UPS module to be completely isolated from the electrical system while the critical load is powered through the external maintenance bypass line. This optional cabinet shall provide make- before-break operation for transfers to and from the external maintenance bypass line with a single rotary switch. The following components shall be standard: single rotary switch with auxiliary contacts, inter-cabinet wiring, casters, and leveling feet. The following components shall be optional: input circuit breaker, shielded isolation transformer, and output circuit breaker. This matching cabinet shall bolt to the side of the UPS module with a barrier shield to separate the two cabinets. Only front access shall be required for installation and service.

3. Slim-Line Distribution Cabinet

    a. A matching distribution cabinet shall be provided for flexible cable distribution of power from the UPS output to the critical loads. The distribution cabinet shall include one or two 42-pole panel boards. Both plug-in and bolt-in style panel boards shall be available to accommodate specific site requirements. A main circuit breaker shall be provided with each panel board.

    b. The Slim-Line distribution cabinet shall be designed as a bolt-on section to the UPS module or Maintenance Bypass cabinet for field installation by the installing contractor. The Slim-Line distribution cabinet shall add no more than ten (10) inches to the width of the UPS system.

4. 1+1 Redundant Paralleling

    a. The UPS shall be available in a version capable of parallel-redundant operation. Two modules with the paralleling option board shall be connected to a simple parallel cabinet requiring no system-level controls or displays. The parallel cabinet shall include two module isolation circuit breakers and one system output breaker. All control and load- sharing logic shall be independent and contained within each module. The only control connection between the two modules shall be a single Category 5 Ethernet cable. The UPS modules shall load share within 1% when the Ethernet cable is attached. As a fail-safe operating mode, the UPS modules shall be capable of load sharing within 5% even if the Ethernet cable is removed or damaged after system start-up. In like manner, the system shall be capable of operating normally (including overload and fault handling, manual transfers and automatic transfers to bypass) for an indefinite period with no inter-module signals available.

5. Load Bus Synchronization

    a. The Load Bus Sync® circuit shall synchronize the output of two independent UPSs even if the UPSs are operating from asynchronous bypass sources (e.g. backup generator sets) or on battery power. The Load Bus Sync (LBS) circuit shall consist of a control enclosure and an option card inside each UPS module. The LBS control enclosure shall enable the operator to designate which bypass source will be the Designated Master source, and both UPS systems will synchronize their outputs to that source.

6. Programmable Relay Board

a. Eight sets of isolated Form C contacts shall be provided to indicate a change of status of any of the alarm conditions. Any of the UPS alarms can be programmed onto any channel of the programmable relay board.

7. Remote Status Panel

   a. A remote status panel shall be provided and shall include the following:

      1) Load on UPS LED.
      2) Load On Bypass LED.
      3) Battery Discharge LED.
      4) Low Battery Reserve LED.
      5) UPS Alarm Condition LED.
      6) New Alarm Condition LED (for a second UPS alarm condition).
      7) Audible Alarm with Reset pushbutton.
      8) Lamp Test/Reset pushbutton.

   b. The remote status panel shall be provided in a NEMA Type 1 enclosure for wall mounting.

8. Battery Circuit Breaker

   a. A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker shall have an under voltage release (UVR) and auxiliary contacts, and shall be in a separate wall mounted NEMA-1 enclosure. The battery breaker provides a manual disconnecting means, short circuit protection, and over current protection for the battery system. When opened, there shall be no battery voltage in the UPS enclosure. The UPS shall be automatically disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.

9. Internal Modem

   a. The UPS shall come with an internal modem capable of dialing out from the UPS to notify up to two remote computers, terminals, PC's, or pocket pagers when important events occur. The modem will also be capable of accepting incoming calls, with the appropriate security, and connecting to a remote terminal, computer or PC, to perform all those functions normally available on the front panel including viewing monitoring screens.

10. SNMP

    a. The UPS shall come equipped with an internal SNMP adapter, which will connect the UPS directly to any I.P. based network using Ethernet communications. The UPS will become a managed device on the network. From a network management station the system administrator shall be capable of monitoring important system measurements, alarm status and alarm history data. In the event of a utility failure the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low battery. On resumption of Utility power the SNMP shall resume full SNMP communication automatically.

11. IBM AS/400 UPS Signal
    a. The following isolated normally open contacts shall be provided for user connection to an IBM AS/400 UPS signal interface:
        1) UPS on (UPS is supplying power).
        2) Bypass active (bypass is supplying power).
        3) Utility failure (battery is discharging).
        4) Battery low (limited battery time remaining).
    b. A 50-foot shielded cable, compliant with NEMA Class 2 for plenum applications, with sub-miniature 9-pin D-type connector, shall be provided for connection to the signal interface.
12. IBM AS/400 Multi-Interface System
    a. An AS/400 Multi-Interface System shall be provided where a single UPS is powering multiple AS/400 units (up to 8). The MultiInterface Unit (MIU) shall provide the required UPS status information to each AS/400 so it can perform an automatic unattended orderly shutdown when necessary. Each AS/400 includes the software required to interface with the UPS. The following status messages are activated in the IBM system:
        1) UPS on (UPS is supplying power).
        2) Bypass active (bypass is supplying power).
        3) Utility failure (battery is discharging).
        4) Battery low (limited battery time remaining).
    b. Each AS/400 individually monitors the UPS status to determine when to initiate a quick power down to preserve data and protect hardware during a utility power outage. This system requires the optional remote contact board to provide isolated contacts. This system shall include a shielded primary cable with a 9-pin subminiature D-shell connector, the AS/400 Multi-Interface Unit (MIU), and shielded secondary cables with RJ11 and 9-pin subminiature D-shell connectors. Cables shall be available in selected lengths from 25 to 300 feet.
    c. IBM and AS/400 are trademarks of International Business Machines Corporation.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Factory-trained field service personnel shall perform the following inspections and test procedures during the UPS startup.
    1. Visual Inspection
        a. Inspect equipment for signs of damage.
        b. Verify installation is correct.
        c. Inspect cabinets for foreign objects.

d. Verify neutral and ground conductors are properly sized and configured.

e. Inspect battery cases.

f. Inspect battery for proper polarity.

g. Verify all printed circuit boards are configured properly.

2. Mechanical Inspection

a. Check all control wiring connections for tightness.

b. Check all power wiring connections for tightness.

c. Check all terminal screws, nuts, and/or spade lugs for tightness.

3. Electrical Inspection

a. Check all fuses for continuity.

b. Confirm input voltage and phase rotation is correct.

c. Verify control transformer connections are correct for voltages being used.

d. Assure connection and voltage of the battery string(s).

3.2 MANUFACTURER'S FIELD SERVICE

A. Service Personnel

1. The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory trained field service personnel dedicated to the start-up, maintenance, and repair of UPS and power equipment. The organization shall consist of regional and local offices.

2. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, and 365 days/year. If emergency service is required, response time shall be 20 minutes or less.

3. An automated procedure shall be in place to insure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.

B. Replacement Parts Stocking

1. Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country.

2. Recommended spare parts shall be fully stocked by local field service personnel with back-up available from national parts center and the manufacturing location. The national parts center Customer Support Parts Coordinators shall be on-call 24 hours/day, 7 days/week, and 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.

C. UPS Operator Training

1. Operator training courses for customer employees shall be available by the UPS manufacturer. The training course shall cover UPS theory, safety, battery considerations

and UPS operational procedures.

2. Training and materials shall be provided for LAWA personnel.

D. Maintenance Contracts

1. A complete offering of preventive and full service maintenance contracts for both the UPS system and battery system shall be available. An extended warranty and preventive maintenance package shall be available. Factory-trained service personnel shall perform warranty and preventive maintenance service.

END OF SECTION 26 33 53

SECTION 26 43 13 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transient voltage surge suppressors for low-voltage power, control, and communication equipment.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.3 SUBMITTALS

A. Product Data: For each type of product. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Product Certificates: For TVSS devices, from manufacturer.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors which fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers of a Broad Line of Suppressors:

1. **Cutler-Hammer, Inc.**
2. **Square D Co.**
3. **General Electric.**

C. Manufacturers of Category A and Telephone/Data Line Suppressors:

1. **MCG Electronics, Inc.**
2. **NTE Electronics, Inc.**
3. **Telebyte Technology, Inc.**

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Copper lugs.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. One set of dry contacts rated at 5 amps, 250-Vac, for remote monitoring of protection status.

B. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring Copper lugs.
3. Integral disconnect switch.
4. Arrangement with copper busbars and for bolted connections to phase buses, neutral bus, and ground bus.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. Red and green LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. One set of dry contacts rated at 5 amps and 250-Vac, for remote monitoring of protection status.
9. Surge-event operations counter.
10. Peak Single-Impulse Surge Current Rating: 240kA per phase.
11. Connection Means: Permanently wired.

C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120 .

2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

D. Protection modes and UL 1449 clamping voltage for 240/120 V, single-phase, 3-wire circuits, shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 clamping voltage for 240/120 V, 3-phase, 4-wire circuits, with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V and 1000 V for 240 V.
2. Line to Ground: 2000 V for 480 V and 1000 V for 240 V.

2.3 PROJECT CONDITIONS

A. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

2.4 PANELBOARD SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status Copper lugs.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 5 amps, 250-Vac, for remote monitoring of protection status.
4. Fuses, rated at 200-kA interrupting capacity.
5. Fabrication using bolted compression lugs for internal wiring.

6. Integral disconnect switch.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. Red and green LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 5 amps, 250-Vac, for remote monitoring of protection status.
11. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 120 kA per phase.

C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277 and400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and400 V for 208Y/120.

D. Protection modes and UL 1449 clamping voltage for 240/120 V, single-phase, 3-wire circuits, shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 clamping voltage for 240/120 V, 3-phase, 4-wire circuits, with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: 2000 V for 480 V and1000 V for 240 V.
2. Line to Ground: 1500 V for 480 V and800 V for 240 V.

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

C. Provide multipole, 15-A circuit breaker as a dedicated disconnect for the suppressor, unless otherwise indicated, or direct bus mounted, internal to electrical equipment.

3.2 CONNECTIONS

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

3.3 TRAINING

A. Engage a factory-authorized service representative to train LAWA maintenance personnel to adjust, operate, and maintain surge protective devices.

B. Train LAWA maintenance personnel on procedures and schedules for maintaining suppressors.

C. Review data in maintenance manuals.

D. Schedule training with LAWA with at least seven days' advance notice.

END OF SECTION 26 43 13

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

1.2 DEFINITIONS

A. LED: Light Emitting Diode.

B. Luminaire: Complete lighting fixture, including driver or ballast if included.

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

B. Product Data: Submit product catalog data showing specified features.

C. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.

2.2 LED LIGHTING FIXTURES AND COMPONENTS

A. Product Testing: Comply with U.L. 1598 and 8750. Test according to IES LM-79 and LM-80.

B. Drivers: Operation to be at standard rated voltage of driver, and not “over-driven.”

2.3 FLUORESCENT BALLASTS

A. Manufacturers:

1. **Philips.**
2. **Osram.**
3. **General Electric.**

B. Product Description: Electronic ballasts shall be instant start and designed for the type and quantity of lamps served. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated. Comply with ANSI C82.11.

2.4 FLUORESCENT DIMMING BALLASTS AND CONTROLS

A. Manufacturers:

1. **Philips.**
2. **General Electric.**
3. **Lutron.**

B. Product Description: Electrical assembly of control unit and ballast to furnish smooth dimming of fluorescent lamps.

C. Control Unit: Selected for energy efficiency and daylight harvesting capability.

D. Ballast: Selected by dimming system manufacturer as suitable for operation with control unit and suitable for lamp type and quantity specified for luminaire.

2.5 LED LAMPS

A. Manufacturers:

1. **Philips.**
2. **Osram.**
3. **General Electric.**

2.6 FLUORESCENT LAMPS

A. Manufacturers:

1. **Philips.**
2. **Osram.**
3. **General Electric.**

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned luminaires, lamps, and accessories.

B. Extend existing interior luminaire installations using materials and methods as specified.

3.2 INSTALLATION

A. Provide labor and materials to install and structurally support fixtures in accordance with all applicable codes and safety practices.

END OF SECTION 26 51 00