# 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