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1. Introduction

This is a general specification that covers the minimum requirements for pole mounted capacitor banks for controlled (switched) operation to be used in the distribution and transmission systems in Puerto Rico. Further information will be provided by LUMA Energy at the time of order placement and will provide information on site specific conditions, quantity, and other requirements. This document includes the general characteristics of the product.

2. Special Requirements

Samples shall be furnished as requested by LUMA Energy. Vendors that have supplied this product to LUMA on previous orders will not have to furnish samples at bid opening. The product will be received at LUMA's general warehouse (011) at Palo Seco, Puerto Rico. Shipping will include transportation and unloading at the indicated warehouse.

3. Literature

3.1. Descriptive and technical literature must be supplied by the vendor at time of bidding. This literature must include, but is not limited to, details of material, drawings, documented testing, and instructions for use and installation. **The literature must be an official document from and certified by the manufacturer.** Failure to submit documents on time and duly certified by the manufacturer will cause bidder disqualification.

3.2. If required by LUMA, final drawings and documentation shall be submitted by the vendor before the manufacturing and shipping process for approval.

4. Compatible with

For compatible manufacturer and model see Table 6. These models are examples of the product described in this document and do not represent a preference. LUMA will evaluate equally any model not listed here during any acquisition event.

5. Markings

5.1. Containers shall be marked outside with LUMA Energy's purchase order and item number.

5.2. Individual package(s) shall be clearly marked with manufacturer name and item information (part number, serial number, quantity, etc.).

5.3. Packaging labels and tags shall be waterproof.

6. Packaging

6.1. All products shall be packaged and marked in such a way as to facilitate handling and protection from damage and that the receiving warehouse can readily identify it and send it, in one complete unit, to a field location without opening crates or boxes to sort items and/or parts.

6.2. A list of all parts included in the container and/or package must be provided at delivery time so the receiving personnel can verify that everything requested is present, avoiding any delay in the receiving process.

6.3. All the electrical equipment shall be banded to the pallet or crate, using non-metallic banding, to prevent rust and shifting of the unit during transit, while allowing the unit to be handed by sling or fork truck without removing the banding.

6.4. LUMA Energy shall allow the use of metallic banding ONLY if the electrical equipment surface is protected from band contact.

7. Number Per Package (Logistics)

One (1) complete unit with all its accessories per wooden crate or as requested by LUMA.

8. Acceptance Criteria

8.1. Test required: certified by external qualified laboratories.

8.2. Product shall be manufactured in accordance with the latest issue below (section 8.3). When conflicts occur between purchaser's specifications and the latest issue below, the purchaser's specification shall prevail.

8.3. Latest applicable codes, standards, and other regulations:

a. IEEE 18: For shunt power capacitors.

b. IEC 60871-1: Shunt capacitors for A.C. power systems having a rated voltage above 1000V.

c. IEEE C37.66: Requirements for capacitor switches for AC systems (1kV to 38kV).

d. IEC/TS 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.

e. IEEE C57.12.00: General requirements for liquid-immersed distribution, power, and regulating transformers.

f. IEEE C57.12.20: Specifies the electrical, dimensional, and mechanical characteristics of single and three-phase, 60 Hz, liquid-immersed, self-cooled, overhead-type distribution transformers.

g. IEEE C57.91: Guide for loading mineral-oil-immersed transformers and step-voltage regulators.

h. ANSI/ASTM D3487: For mineral insulating oil used in electrical apparatus.

i. AWS D1.1: American Welding Society for structural steel welding procedures.

j. ANSI Z55.1: For gray finish for industrial apparatus and equipment.

k. NEMA B117: For salt spray test.

l. IEEE C62.11 and/or IEC 60099-4: Metal-oxide surge arresters for ac circuits (>1 kV).

m. UL 746C: Standard test for ultraviolet light and water exposure.

n. IEC 61000 4-2: Electrostatic discharge immunity test.

o. IEC 61000 4-3: Radiated, radiofrequency, electromagnetic field immunity test.

p. IEC 61000-4-4: Electrical fast transient/burst immunity test.

q. IEC 61000-4-5: Surge immunity test.

r. IEC 61000-4-11: Voltage dips, short interruptions, and voltage variations immunity tests for equipment with input currents up to 16 A per phase.

s. IEC 61000-4-12: Ring wave immunity test.

t. FCC 15 Part B Compliance.

8.4. If any other standards different from the ones indicated in this document are used, the supplier must provide information showing compatibility with the required ones.

8.5. The routine and design tests for control power transformers shall be made in accordance with ANSI C57.12.00. The routine test samples performed on the units shall be submitted at bid opening. The design test samples will be submitted only when the supplier requires approval of the product. The bidder shall submit a written certification stating that all tests shall be performed according to the latest codes, standards, and regulations to provide a product of quality.

9. Description

9.1. Pole mounted capacitor bank allows users to select features to meet their application needs. This product is used to improve the power factor in the system.

9.2. The pole mounted capacitor bank described in this specification is intended to be used for a grounded wye arrangement controlled (switched) operation. It must include all the necessary elements to connect and disconnect capacitor bank to the distribution system.

9.3. The capacitor banks must come completely pre-assembled and pre-wired from factory with all high voltage wiring accessories and terminal bushings provided with wildlife protection.

9.4. The pole mounted capacitor banks will be connected to an electrical distribution system with the following characteristics:

a. System Voltages of 4.16kV to 13.2kV LL (2.4/4.16kV, 4.16/7.2kV, 4.8/8.32kV, & 7.62/13.2kV).

b. System Frequency: 60 Hz

c. System Connection: Grounded wye (4-wire)

d. Fault Current (minimum): 10,000 A

9.5. The assembly must include a pole capacitor bank frame, single phase capacitor units, capacitor switches, a control power transformer, surge arresters, junction box, capacitor bank control with zero voltage closing, multicore current and voltage sensors for three phase sensing, neutral current sensor, and wildlife protection.

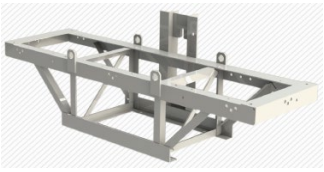
9.6. The capacitor bank assemblies and units shall be constructed with a minimum BIL rating of 95 kVBIL.

9.7. The capacitor bank (including equipment and accessories) must be designed to withstand outdoor operation in a humid tropical zone with altitude ranging from 15 to 3,000 ft above sea level, within an ambient temperature between 10° C and 40° C (10° F and 104° F) and subject to be installed close to seashore with a heavy corrosive environment.

9.8. The pole mounted capacitor bank (including any additional equipment/accessories) should be designed and constructed to withstand sustained hurricane-force wind velocities according to LUMA Energy's requirement.

9.9. The equipment reliability must meet an expected life of twenty-five (25) years with survival rate of at least ninety (90%) percent.

9.10. Capacitor Bank Frame:



a. The frame must be made of stainless steel or aluminum for protection against corrosion.

b. All mounting hardware for mounting capacitor units, and accessories shall be made of stainless steel or thermal diffusion galvanized steel.

c. The frame must accommodate at least three (3) single phase capacitor units from different kVA ratings (see Table 6).

d. The frame must be designed to support all necessary equipment for controlled (switched) capacitor bank installation.

e. Each capacitor bank frame must have a stainless-steel nameplate with the following information:

   1. Manufacturer's name
   2. Manufacture Year
   3. Voltage and kVAR Bank rating
   4. Basic Insulation Level (BIL)

f. The frame must include a ground connector that accommodates #10 AWG solid to #2 AWG stranded wire.

g. The capacitor bank frame shall be fitted with 4 lifting eyes which will provide level lifting when all accessories are mounted.

h. The frame for the pole-mounting bracket must have mounting holes or a combination of mounting holes and slots of 13/16" (20.64 mm) diameter that comply with the following spacing: 8" (20.23 cm), and 12" (30.48.cm), or 24" (60.96 cm). A spacing of 18" (45.72 cm) shall be accepted as an alternate option.

9.11. Capacitor Units:

a. Each capacitor bank must include three (3) double bushing capacitors units of 150 kVAR each for 450 kVAR bank or six (6) double bushing capacitors units of 150 kVAR each for 900 kVAR bank. Capacitor units shall come interconnected from factory in a grounded-wye pattern and grounded through the frame. Refer to Table 6 on Section 12 for capacitor bank ratings.

b. Capacitors must be suitable for switched or continuous operation at no more than 110% of rated rms voltage, 120% of rated peak voltage, 135% of rated kVAR, and 135% of nominal rms current based on rated voltage and kVAR.

c. Each capacitor unit tank must be made of stainless-steel type 409 with light gray finish for resistance to severely corrosive atmospheres. Tank rupture curve must be defined through 10 kA.

d. Single-phase capacitor units shall have two light gray porcelain bushings hermetically sealed to the capacitor tank. The bushings must be glazed for high strength and durability.

e. Must have stainless-steel mounting brackets with industry-standard 15.62" (39.67 cm) mounting center for unit interchangeability. The brackets must be solidly welded to the tank. The underside of brackets shall not be painted so that proper grounding connection to the frame or hook can be established.

f. Each capacitor unit must not have more than 0.10 Watt/kVAR of total losses, including dielectric losses.

g. The capacitor must be heavy duty (HD Type) designed and tested to conform with IEEE 18 latest revision. Tests shall be performed by the manufacturer on several capacitors to demonstrate design compliance with this standard. The design tests must include high voltage impulse withstand test, bushing test, thermal stability test, radio influence voltage (RIV) test, voltage decay test, and short circuit discharge test.

h. The basic insulation level (BIL) must be 95 kVBIL for all models in this specification document.

i. Capacitor bushing must conform to values in Section 9.11.q, Table 1: Capacitor Unit Electrical Characteristics of Bushings.

j. The bushing must include a clamp connector suitable for copper and aluminum conductors with a minimum size range from solid #8 AWG to stranded #2 AWG.

k. All capacitors shall have a stainless-steel nameplate permanently marked with all the information stated in the IEEE 18 standard, (e.g., Manufacturer's name, Manufacture date, Model, kVAR, kVBIL, V, Hz, µF, statement that the capacitor contains an internal discharge device, etc.).

l. The dielectric fluid contained in the capacitor must be non-PCB and the capacitor tank must have a blue decal or stick-on label to designate "Non-PCB".

m. The equipment reliability must meet an expected life of twenty-five (25) years with survival rate of at least ninety (90%) percent.

n. The manufacturer must state the failure capacitance (µF) range of the capacitor.

o. The capacitors must be equipped with an internal discharge device which reduces the residual voltage to 50V or less in five (5) minutes after disconnection from the rated voltage.

p. All capacitor units shall be designed to resist wildlife entry.

q. Table 1: Capacitor Unit Electrical Characteristics of Bushings

Electrical Characteristics of Bushings				
Basic Impulse Insulation Level BIL (kV)	**Minimum Insulation Creepage Distance**	**High Voltage Impulse Withstand Test**		
		60 Hz dry 1 min, (kV rms)	**60 Hz wet 10 s, (kV rms)**	**1.2/50µs Impulse (kV Crest)**
95	10" (25 cm)	35	30	95

9.12. Capacitor Switch:

a. The capacitor bank must include three (3) single-phase, solid dielectric, vacuum interrupter type switches designed for applications in pole-mounted, substation, and metal-enclosed capacitor banks.

b. Vacuum under oil switches will not be allowed.

c. The capacitor switch shall be compatible, as a reference, with:

   1. EATON-CPS: Model (ECS15-95), Catalog Number: ECSA111BD1 00 RB0B

   2. Hubbell: P/N (33247102)

d. Shall be a single-phase, electrically operated vacuum switch with close and latch capability. The vacuum capacitor switch is intended for application on capacitors banks for 15 kV system voltage ungrounded or solidly grounded WYE.

e. Must be designed and tested as per standard IEEE Standard C37.66-2005.

f. The switch must be rated 15 kV, 60 Hz, 95 kV BIL, and must be capable of withstanding 200 Amps of continuous current, and 200 Amps of capacitive switching current.

g. Bushing must be constructed of low viscosity cycloaliphatic epoxy resin and must be designed with a minimum specific creepage distance of 31 mm/kV L-L.

h. The switch must be maintenance free with no routine maintenance required.

i. The switch must be operable in any mounting orientation.

j. The switch must be capable of being operated with a voltage control signal through a solenoid or manually operated by using a hot-stick and must have a switch position indicator.

k. The switch must withstand a minimum of 50,000 mechanical operations (one operation equals one open operation plus one close operation).

l. Must be capable of operating under extreme undervoltage application across the entire temperature range.

m. The switch must have Class C2 restrike as described under Section 6.5.3.3 of IEEE Std. C37.66.

n. Must have a 304 stainless-steel bracket with pre-drilled holes that allows for ground connection point and must include a ground connection connector assembled to the bracket.

o. The tank shall be constructed of a non-conductive, corrosion resistance material coated with an ultraviolet resistant paint and must not bear any structural loading.

p. Must be resistant to ozone, moisture, contamination, and ultraviolet light.

q. Must have tin-plated terminals for line and load conductor. These terminal connectors must accept cable range from #8 AWG solid to 2/0 AWG stranded.

r. Must have one normally open and one normally closed auxiliary contacts.

s. Must have a factory wired 6-pin receptacle to allow control cable connection.

t. Capacitor switch must include the 6 conductors control cable with the 6-pin mating plug, with at least 10 ft (3.05 m) of length.

u. Solenoid control voltage must be 110/120Vac nominal.

v. The capacitor switch must have a latching mechanism that requires a momentary rated voltage control signal to operate (open/close).

w. Each capacitor switch unit must have a stainless-steel nameplate with the following information:

1. Manufacturer's name
2. Manufacture type or identification number.
3. Month and year of manufacture designation.
4. Serial number
5. Maximum system voltage with ungrounded capacitor neutral.
6. Maximum system voltage with grounded system and grounded capacitor neutral.
7. Rated continuous current, A (RMS)
8. Rated AC capacitive switching current (RMS)
9. Rated Frequency

10. BIL Rating terminal to terminal
11. Creepage terminal to terminal
12. Creepage terminal to ground
13. Rated control voltage
14. Nominal close/open time
15. Rated short time (symmetrical) current.
16. Rated high-frequency transient-making current.
17. Probability of restrike classification.

9.13. Control Power Transformer:

a. The pole mounted capacitor bank must include one (1) control power transformer to supply power to the capacitor bank control system and the capacitor switches operating mechanism. Shall be a small pole type, single-phase, fixed load, oil immerse transformer.

b. The control power transformer shall be compatible, as a reference, with:

1. ABB, Inc.: Micro-Pole Overhead Transformers

2. Mid-Central Electric, Inc.: Control Power Transformer (CPT)

c. The transformer shall consist of a tank, cover, core, windings, bushings, insulating oil, etc.

d. Must have an internal weak link fuse.

e. Must have the following electrical characteristics:

1. Transformer capacity: 1 kVA
2. System frequency: 60 Hertz

3. Table 2: Primary, Secondary Voltage, Basic Impulse Insulation Level

System Voltage L-L (kV)	CPT Primary Voltage L-G (kV)	Secondary Voltage (V)	kVBIL (Primary/Secondary)
4.16	2.4	120	60 / 30
7.2	4.16	120	75 / 30
8.32	4.8	120	75 / 30
13.2	7.62	120	95 / 30

f. Control power transformers must have high power factor and low core and winding losses.

g. Cores shall be made from high quality grain-oriented silicon steel with flat, rolled, low loss permeability laminations free of buckles, and wave surface defects.

h. Winding shall be non-telescoping with high and lower tension windings assembly forming and integral unit with polarization index (PI) not less than 1.0.

i. Insulation shall be made with, at least, Class 105 insulation system with insulation power factor as per ANSI C57.12.10 (60 Hz).

j. Bushings must be high and low tension insulated in accordance with NEMA standards.

k. Shall be either cover type or sidewall type, according to voltage class as per ANSI C57.

l. High and low voltage bushings must be porcelain in accordance with Table 6 of ANSI C57.12.20.

m. The color of bushings shall be light gray no. 70, Munsell Notation 5 BG 7.0/ 0.4 as specified in ANSI Z55.1.

n. Number of bushings, primary and secondary, must be as specified in ANSI C57.

o. The high voltage bushing terminals provided shall be tin-plated to accommodate both aluminum and copper conductors. The size of these terminals shall be in accordance with Table 8 of ANSI C57.12.20.

p. The low voltage terminals provided should be tin-plated to accommodate both aluminum and copper conductors. The size of the terminals shall be in accordance with Table 9 of ANSI C57.12.20.

q. The transformer shall be provided with the appropriate wildlife protection covers to protect bushing connection terminals from animal and vegetation interactions.

r. Transformer's tank must be a cylindrical shape made of stainless-steel type 304 gage 14 for severe corrosive environments suitable for outdoor use and for mounting on flat surfaces, capacitor bank frames, or poles. It must be constructed in accordance with the latest revisions of ANSI C57.12.20 and ANSI C57.12.30 (integrity for coastal environments).

s. The tank bottom must be recessed, which offers protection when sliding over rough surfaces.

t. The tank shall have an internal mark, which indicates the proper oil level per Section 7.2.3 of ANSI C57.12.20.

u. Tank must be fitted with lifting lugs, NEMA mounting brackets, and ground provisions permanently affixed.

v. The transformer's tank cover must be dome-type, insulated, made of the same material as the tank, and coated with a dielectric finish.

w. The cover must be of bolted clamp, center bolted or bolted fastening ring type. The cover mounting bolts shall be stainless steel. Nuts and washers shall be stainless steel or bronze to minimize corrosion.

x. Welds to be made shall be in accordance with the material that will be welded and as per American Welding Society (AWS) 1.1 or latest revision. All welds at the exterior of the tank shall be continuous. It shall include the welding on all sides of lifting lugs, mounting brackets, grounding provisions, etc. to prevent accumulation of humidity.

y. The transformers shall have "special paint finishes" suitable for tropical climate conditions and to be used near the seashore and industrial plants. The coating shall meet all requirements of ANSI C57.12.30. The paint shall be light gray no. 70, Munsell Notation, 5BG 7.0/0.4 as specified in ANSI Z55.1.

z. Each transformer shall be furnished with its tank filled with oil with a Polychlorinated Biphenyl (PCB) concentration of less than 1 PPM (NO PCB). Less than 2 PPM could be accepted. The nameplate shall indicate this compliance. Also, a label shall be affixed to the transformer in a visible place indicating that the unit is a NO PCB transformer. The label shall have the same duration as the transformer under normal operating conditions.

aa. The awarded bidder shall submit a certificate stating that, at all moments, the transformers supplied to LUMA shall have a concentration of less than 1 PPM of PCB, and Safety Data Sheet (SDS) of the oil.

bb. The insulating oil shall comply with ANSI/ASTM D3487 and IEEE C57.91.

cc. The transformer's tank must be equipped with a pressure relief valve. The body of the pressure relief valve shall be an internal fault detector type compatible with IFD Corporation and in accordance with ANSI C57.12.20. The relief valve shall allow the pressure inside the tank to be released but no air is admitted when the unit is cool or lightly loaded.

dd. The transformer must include a nameplate mounted on one side of the mounting brackets in such a manner that there are no sharp edges exposed. The information shown on the nameplate must include: The windings material (aluminum or copper), date of manufacture, total weight, serial number, among all the other information as per ANSI C57.12.00. The nameplate shall be made of stainless steel or aluminum. The information on the nameplate shall be engraved or stamped to ensure legibility for the life of the transformer.

ee. The transformer must include a label indicating the kVA rating. This label shall be placed, whenever possible, below the secondary voltage bushings. The label shall have a minimum dimension of three (3) inches width by three (3) inches height and a maximum dimension of four (4) inches width by four (4) inches height. Also, the transformer must include a label with the words "STAINLESS STEEL", made from the same material as the kVA rating label. This label shall be placed directly under the kVA rating label. This label shall have the same width as the kVA rating label. These labels must be made of polyester resistant to abrasion, acids, chemicals, corrosion, solvent, moisture, cold, tearing, and UV light. The characters will be black over a white base. The labels shall last a minimum of 20 years on the transformer under normal operating conditions.

9.14. Surge Arresters:

a. Pole mounted capacitor rack must include three (3) outdoor, heavy-duty (riser pole), distribution-class, metal-oxide varistor (MOV), single-piece silicone polymer housing arresters mounted on capacitor frame.

b. Riser pole arrester must be capable of withstanding the following symmetrical RMS current:

   1. High Current Symmetrical RMS (Amps) and Duration (Seconds): 20 KA / 0.2 sec.

   2. Low Current Symmetrical RMS (Amps) and Duration (Seconds): 600 A / 1 sec.

c. All exposed metal parts of the arrester must be stainless steel 316 or bronze.

d. Leakage distance as per Section 9.14, Table 3: Rating and Insulation.

e. Overall height must not exceed 12” (30.48 cm).

f. The arrester must include an insulated hanger/bracket according to the MOV arrester rating indicated on Table 3 (3 kV to 10 kV).

g. The line terminal and ground terminal must be a 3/8" (9.53 mm) stainless-steel stud with a stainless-steel wire clamp and nut. Silicone bronze nuts could be accepted.

h. Those clamps shall be solderless clamp type capable of securely clamping aluminum or copper stranded conductors of sizes #6 to #2 AWG.

i. The arrester shall include an isolator to remove the ground from the circuit in the event of a short or fault.

j. The arrester must be free of radio influence voltage which may cause communication interference.

k. The following minimum information must be permanently attached to or stamped as part of the arrester:

1. Name of the device
2. Manufacturer's name and trademark
3. Manufacturer's type and identification number
4. Manufacture date
5. Ratings

l. The arrester must have approximately the following characteristics:

1. Table 3: Rating and Insulation

System Voltage	Arrester Rating		Approximate Housing Leakage	Approximate Hanger Leakage	Total Leakage (Minimum)
	MOV	MCOV			
4.16kV	3kV	2.55kV	7.2" (18.3 cm)	5.9" (15.0 cm)	12" (30.5 cm)
7.2/8.32kV	6kV	5.1kV	10.1" (25.6 cm)	5.9" (15.0 cm)	16" (40.6 cm)
13.2kV	10kV	8.4kV	13" (33.0 cm)	5.9" (15.0 cm)	19" (48.3 cm)

Arrester Insulation Withstand Voltages				
Arrester Rating		1.2/50µs Impulse (kV Crest)	1 min. Dry (kV rms)	10 sec. Wet (kV rms)
MOV	MCOV			
3kV	2.55kV	78	47	24
6kV	5.1kV	91	56	36
10kV	8.4kV	104	64	45

2. Table 4: Protective Characteristics

Voltage kV (L-L)	Arrester Rating (kV)		0.5 µs Discharge Voltage (kV)	Max Switching Surge Protective Level (kV Crest)
	MOV	MCOV		
4.16	3	2.55	15	10.4
7.2/8.32	6	5.1	20	14
13.2	10	8.4	37	24

Max Discharge Voltages Using 10 kA, 8X20µs Current Wave (kV Crest)							
Arrester Rating (kV)		1,500A	3,000A	5,000A	10,000A	20,000A	40,000A
MOV	MCOV						
3	2.55	7.8	8.1	8.4	9.1	10.1	11.6
6	5.1	15.6	16.3	17.0	18.3	20.2	23.4
10	8.4	23.1	24.1	25.1	27.0	29.8	34.6

3. Table 5: Compatible Manufacturers and Models as a reference.

Voltage kV (L-L)	Arrester Rating (kV)		Compatible Manufacturer	Compatible Model
	MOV	MCOV		
4.16	3	2.55	CPS UltraSIL polymer housed VarisSTAR	URS0303-0A1A-1A1A
			Hubbell PVR Optima	221603-7314
			TE Connectivity	DOV-03A-E0D0B0-I
7.2/8.32	6	5.1	CPS UltraSIL polymer housed VarisSTAR	URS0604-0A1A-1A1A
			Hubbell PVR Optima	221605-7314
			TE Connectivity	DOV-06A-E0D0B0-I
13.2	10	8.4	CPS UltraSIL polymer housed VarisSTAR	URS1005-0A1A-1A1A
			Hubbell PVR Optima	221609-7314
			TE Connectivity	DOV-10A-E0D0B0-I

9.15. Junction Box:

a. This junction box is intended to be mounted on capacitor frame for the interconnection of all assembly's control elements. It facilitates wiring between the control and capacitor bank switches and sensors. It receives control wires and provides organized connections for control power, capacitor switches, capacitor bank controller, and voltage/current & neutral sensors.

b. The junction box housing must be weatherproof, made of stainless steel, aluminum, or high strength UV resistant polymer with extreme resistance to high corrosive environment, NEMA 4X (IP65) as minimum.

c. Shall have enough poles in terminal block to accept connections and manage at least the following input and output:

1. Input connection for 3 current sensors.
2. Input for 3 voltage sensors.
3. Input for neutral current sensor.
4. Input for control power from control power transformer.
5. Output for 3 capacitor switches control signals.
6. Output/Input for capacitor bank controller cable (a 40' (12.19 m) wire harness with mating connector shall be included for this purpose).

d. The junction box shall be compatible, as a reference, with Eaton (CCR100K5).

9.16. Capacitor Bank Control:

a. The Capacitor Bank Control (called CBC hereafter) is a device designed to control utility distribution capacitor banks by operating capacitors switches. It is a three-phase digital control with advanced capabilities for local and remote capacitor automation, monitoring, and protection with communication interfaces.

b. The CBC shall have zero voltage closing capabilities, wiring harness (14 pin, 40' long (12.9 m)), and all current and voltage sensors for three (3) phase sensing including neutral current sensor.

c. The CBC shall have the ability to operate independently using site measurement values or remotely by wireless communications. In addition, if communication is lost the CBC must be capable of providing a backup failsafe operational mode using the site measurement values.

d. All equipment supplied under this document shall be designed for continuous operation.

e. The CBC must have a readable LCD display and LED lights indicators to show the state of the capacitor bank.

f. The CBC must have a keypad for programming, entering settings, and viewing metering data.

g. Communication and Data Transfer:

1. The CBC must have a USB port for local programming and data transfer.
2. Inside the CBC cabinet, the equipment must provide provisions for the mounting and power of an internally installed communication device.
3. The CBC must include communication options for wired and wireless networks, including ethernet and fiber connections.
4. Wi-Fi connection must have at least 128-bit encryption for security purposes and must comply with IEEE 802.11 standard. The unit must not transmit a Wi-Fi signal until an encrypted wake-up message is sent by the securely recognized laptop or SCADA control to enable/disable.
5. Must support DNP3 Level 2 and should be capable of operating and interface with SCADA and advanced distribution management system applications such as Load & Voltage Management systems for Conservation Voltage Reduction (CVR) & Volt/VAR Optimization (VVO).
6. The unit must include a 12-volt, 3-amp power supply to power cellular modem or a radio.
7. Any other communication technology proposed must comply with the security and communication requirements specified above. Technical information must be submitted to the Distribution Materials Section for evaluation and approval.

h. When the CBC loses communication, it shall have the ability to revert to a stand-alone operational mode utilizing site measurement values.

i. The CBC must be capable of three-phase gang capacitor switch operation with optional independent phase switching.

j. The CBC must have the ability for three-phase monitoring and must be capable of reporting each individual phase voltage, VARs, current, and power factor.

k. The CBC must perform data logging, sequence of events, and digital fault recording.

l. The CBC must have manual, remote, and automatic options for operation mode.

m. The CBC must be compatible with various voltage sensors and sources.

n. The vendor shall also provide the service software necessary for the CBC to operate properly.

o. The CBC cabinet must be able to contain both the CBC and the communication device along with their respective wiring and connections. This also may include wiring and connections for an external mounted antenna on either the pole or controller cabinet.

p. The CBC cabinet must be weatherproof, rated NEMA 4X, and IP65, with extreme resistance to high corrosive and prolong UV exposure environment.

q. The equipment should be capable of operating within an ambient temperature range of -4°F (-20°C) to 149°F (65°C) and a relative humidity from 0% to 95%, noncondensing.

r. The CBC must come with a pole mounting base and a 14-pin DIN connector.

s. The enclosure shall have a locking clasp and padlock provision.

t. The CBC shall include a ground lug.

u. The bidder must include a software application tool. The tool shall be able to remotely “over the air” or locally:

    1. Allow the user to program the control.

2. Trip & close the control.
3. View status, alarms, and states.
4. Download the Sequence of Events (SOE), the Data Profiler and Communications debug logs.
5. Upgrade the control firmware.

v. Power Analysis:

1. The CBC must support seven sensor inputs which can be used to monitor all three phase voltages, currents, VARs, and power factors plus the neutral current sensor.
2. Six (6) of them for three-phase analysis and to detect and report voltage and current, including THD and harmonics up to the 13th.
3. The seventh sensor input is required for Neutral Current Sensing.

w. The CBC shall have a bi-directional mode for standard operation and must be compatible with Photo Voltaic (PV), renewable energy, and Micro Grid system deployments.

x. The CBC must have the ability to detect neutral current imbalance. Suppliers must provide a split core current sensor for detection of neutral current.

y. The CBC must have the ability to detect and report voltage phase unbalance as defined in ANSI standard C84.1-2011 and must include unbalance voltage percentage and Phase A-B, B-C, and C-A voltages and phase angle.

z. The CBC shall include a temperature sensor for automatic operation and that can be used as a backup operation mode in the event of missing communication.

aa. The CBC must have the ability to confirm and validate the successful operation of each of the three capacitor banks when three-phase voltage and current sensors are present. The CBC must log and report on the status of each of the three phases of the capacitors, as successful or failed operation, upon the completion of the control operation.

bb. The VAR operation must detect and report reverse power flow.

cc. The CBC shall have a real-time clock to maintain time stamps and accurate time if power is lost.

dd. The CBC must have an input voltage range from 85 to 265 Vac with line fuse protection.

ee. The CBC must include a 14-pin DIN connector and a 40 ft (12.19 m) wiring harness with 14-pin mating connector.

ff. The CBC must include a low voltage distribution-class, 40 kA, single phase, 3 wires, secondary MOV surge arrester for 120V ac system. It should protect surges in both line and neutral conductors. Must comply with standard IEEE C62.11 current revision.

gg. The CBC shall be compatible, as a reference, with: EATON (CBC-8000) with the following additional parts:

1. 14 pins, 40' (12.19 m) wire harness with mating connector: EATON (CBC-CTRLSEN14P-40).
2. Secondary MOV surge arrester: EATON (ASZH175C100)

9.17. Line Post Sensors:

a. The line post sensors are for accurately measuring current and voltage in feeders to be used in smart grid applications.

b. Electrical Requirements:

1. Voltage Class:	15 kV or 27 kV
2. Frequency:	60 Hz
3. Basic Insulator Level:	110 kV
4. Leakage Distance, minimum:	19.9" (50.5 cm)
5. Dry arc distance, minimum:	8.8" (22.4 cm)

6. Partial discharge test voltages: 11 kV
7. Current output: 600 A:10 V
8. Voltage Divider Ratio: 1400:1
9. Voltage signal output accuracy and Phase shift: ± 1%, 0° ± 1°
10. Current signal output accuracy and Phase shift: ± 1%, 0° ± 1.5°

c. Construction:

1. Material: hydrophobic cycloaliphatic epoxy
2. Approximate height to conductor: 9.4" (23.9 cm)
3. Operating temperature range: -45°C to +55°C
4. Conductor minimum range: 0.19 to 1.18" (4.8 to 30 mm)
5. Cantilever Strength: 2,800 lbf (12.5 kN)
6. Approximate weight: 18 lbs. (8.2 kg)

d. Shall be furnished with a ground stud.

e. The sensor shall have at bottom of the device threaded hole compatible with a 3/4"-10 UNC bolt, used for installing the device on a crossarm or equivalent structure.

f. Shall have a "H1" or equivalent sign molded in at the top of the device that appropriately marks the polarity of the sensor.

g. Conductor Keepers:

1. The device shall be furnished with aluminum keepers or clamps (2 per device) used for establishing the connection of the device to the conductor.
2. Each keeper shall have a reversible construction so that the same keeper accommodates the entire range of conductors' sizes.

3. Each keeper shall be able to secure the device using two bolts and lock washers to be supplied with the sensor.

h. Shall be furnished with aluminum grounding plate and all necessary hardware.

i. The device shall be furnished with a sensor output receptacle compatible with a 4-wire signal cable plug. This receptacle is to be located at the bottom part of the sensor.

j. The device shall be supplied with a compatible output cable. This cable shall have a compatible connector on one end that connects to the sensor and pigtail termination on the opposite end. The cable length shall be at least 20' (6.1 m) long.

k. The line post sensor shall be compatible, as a reference, with:

1. Lindsey (9E650/E1106/G with cable 9620/20.

9.18. Neutral Current Sensor:

a. Used to sense neutral current in capacitor banks.

b. The sensor shall be furnished with a tilt-top opening that suits conductors up to 1.25 in.

c. The sensor shall be furnished with a 35 ft. minimum length output cable. This cable shall be bare conductor at its end.

d. Sensor shall be watertight.

e. Electrical Ratings:

1. Insulation Voltage Class: 600 V

2. Output Ratio: 50 A = 5 VAC

3. Required Load Impedance: 200 kΩ, minimum.

4. Accuracy: 1%

f. The neutral current sensor shall be compatible, as a reference, with Lindsey (R-22981).

10. Inspection

10.1. Upon inspection of incoming products, the purchaser reserves the right to refuse their shipments and to determine the acceptability or rejection of the product received. The supplier shall be liable for all costs incurred for a product that is rejected.

10.2. The acceptance of any product shall in no way relieve the vendor from his responsibility to meet all the requirements of this specification, and it would not prevent subsequent rejection if such products were found later to be defective or out of compliance.

11. Proposal Information

11.1. Submitted proposals must include:

a. Technical information, drawings, and tests.

b. Table of Compliance completed by the bidder with reference (see Appendix 1).

12. Table 6: Warehouse and Asset Suite Identification Number

Pole Mounted Capacitor Banks for Controlled (Switched) Operation (95 kVBIL ea.)							
Capacitor Bank Ratings and Compatible Manufacturer							
Warehouse Catalog #	**Asset Suite #**	**Voltage (kV) L - G**	**Voltage (kV) L - L**	**Units kVAR ea.**	**Units/ Frame**	**Bank kVAR**	**Compatible Manufacturer as a reference**
032-87876	87876	2.4	4.16	50	3	150	Eaton Hubbell
032-87877	87877	4.16	7.2	50	3	150	Eaton Hubbell
032-87878	87878	4.8	8.32	50	3	150	Eaton Hubbell
032-87879	87879	7.62	13.2	50	3	150	Eaton Hubbell
032-87880	87880	2.4	4.16	100	3	300	Eaton Hubbell
032-87881	87881	4.16	7.2	100	3	300	Eaton Hubbell
032-87882	87882	4.8	8.32	100	3	300	Eaton Hubbell
032-87883	87883	7.62	13.2	100	3	300	Eaton Hubbell
032-83893	83893	2.4	4.16	150	3	450	Eaton Hubbell
032-83894	83894	4.16	7.2	150	3	450	Eaton Hubbell
032-83895	83895	4.8	8.32	150	3	450	Eaton Hubbell
032-83896	83896	7.62	13.2	150	3	450	Eaton Hubbell
032-83897	83897	7.62	13.2	300	3	900	Eaton Hubbell

- End of Specification -

Appendix

Appendix 1: Table of Compliance

Criteria	Description	Pass/Fail (P / F)	Comments
Specification	Compliance with the document 4350.185.		
Industry Standards	ANSI/ASTM, IEEE, IEC, NEMA & UL as per Section 8.		
Type	Pole Mounted Single-Phase Heavy-Duty Controlled Capacitors Banks		
Product Requirements	Three or six capacitors per bank connected to each other in a grounded-wye pattern and grounded through the frame.		
	Factory assembled including all necessary hardware, wiring, and wildlife protection on all high voltage sides.		
	Hardware for installation in stainless-steel.		
	14-pins, 40' long wiring harness included.		
Capacitor Bank Frame (As per Section 9.10)	Material: Stainless-Steel or Aluminum		
	Pole type for 3 or 6 single phase capacitor units.		
	Mounting provision for Switches, CPT, Arresters, and Junction Box.		
	Ground connector for #10 AWG solid to #2 AWG stranded wire.		
	Pole Mounting Bracket with hole pattern of 8" and 12" apart or 24" apart (18" shall be accepted as an alternate option).		
	Holes diameter: 13/16"		
	Fitted with 4 lifting eyes.		
Capacitor Units (As per Section 9.11)	IEEE 18-2012 and/or IEC 60871-1 compliance.		
	409 stainless-steel tank, Heavy-Duty type.		
	Light Gray Porcelain Bushings with Nickel Plated Terminals.		
	Two Bushings ea. with parallel groove connectors for #8 to 2 AWG.		
	Electrical Characteristics as per Section 12, Table 6, and in compliance with IEEE 18.		
	Tank Rupture Curves defined through 10kA.		
	Discharge Resistors to 50V within 5 minutes.		
	Dielectric Fluid: Non-PCB		
	Mounting brackets with industry-standard 15.62" mounting center.		
	Nameplate as per Section 9.11.k.		

Criteria	Description	Pass/Fail (P / F)	Comments
Capacitor Switches (As per Section 9.12)	IEEE C37.66 and IEC/TS 60815-1 compliance.		
	Corrosion Resistant Coating Tank		
	Cycloaliphatic Epoxy Bushings with Tin Plated Terminals.		
	1Ø, solid dielectric, vacuum interrupter type.		
	15kV, 95kVBIL, 60Hz, 200A		
	Creepage Distance: 31 mm/kV L-L.		
	Voltage Control Signal (solenoid) and Hot Stick Manual Operation		
	Class 2 restrike rating as per IEEE C37.66		
	NO and NC Auxiliary Contacts included.		
	6-pin receptacle included.		
	10' - 6 conductors' cable with mating plug included.		
	Solenoid Control Voltage: 120Vac		
	Operable in any mounting orientation.		
	Nameplate as per Section 9.12.w.		
Control Power Transformer (As per Section 9.13)	IEEE C57. (12.00, 12.20, .91), ASTM D3487, ANSI Z55.1, AWS D1.1, and B117 compliance.		
	304 Stainless-Steel Cylindrical Shape Tank		
	Constructed as per IEEE C57.12.20.		
	Copper or Aluminum Windings.		
	Pressure Relief Valve included.		
	Non-PCB oil		
	Color (light gray) and coating as per ANSI C57.12.31		
	Electrical characteristics as per Section 9.13.e.		
	Bushings on cover or side as per ANSI C57.		
	High and Low voltage bushings terminals shall be tin-plated for CU/AL conductors and sized as per Table 8 of ANSI C57.12.20.		
	Lifting lugs, NEMA mounting brackets, and ground provisions permanently affixed.		
	Labels as per Section 9.13.z and 9.13.ee.		
	Nameplate as per Section 9.13.dd.		
Surge Arresters (As per Section 9.14)	IEEE C62.11 and/or IEC 60099-4 compliance.		
	Type: Heavy-Duty (Riser Pole), Metal-Oxide Varistor.		
	MOV Rating: 3kV, 6kV, and 10kV		
	Silicone Rubber Housing.		
	Insulated Hanger included.		
	Ground terminal isolator included.		
	Line and Ground Terminals: 3/8" SS stud with SS wire clamp and nut. Bronze nut accepted.		
	Clamp Range: #6 to #2 AWG AL/CU conductors.		
	Total Minimum Leakage for 3kV, 6kV & 10kV: 12", 16" & 19" respectively.		
	Electrical characteristics as per Section 9.14.l, Tables 3 & 4.		
	Markings as per Section 9.14.k.		

Criteria	Description	Pass/Fail (P / F)	Comments
Junction Box (As per Section 9.15)	SS, Aluminum, or high strength UV resistant polymer with extreme resistance to high corrosive environment.		
	NEMA 4X (IP65) as minimum.		
	Terminal blocks with enough poles to accept at least:		
	• Input connection for 3 current sensors.		
	• Input for 3 voltage sensors.		
	• Input for neutral current sensor.		
	• Input for control power from control power transformer.		
	• Output for 3 capacitor switches control signals.		
	• Output/Input for capacitor bank controller cable (a 40' wire harness with mating connector shall be included for this purpose).		
Capacitor Bank Control (As per Section 9.16)	IEC 61000-4- (2, 3, 4, 5, 11 & 12), UL 746C, and FCC 15 Part B compliance.		
	Zero voltage closing capability.		
	Operation: Independently by site measurements values or remotely by wireless communications.		
	Operating Temp: -20°C to 65°C		
	LCD and LEDs indicators to show the capacitor bank state.		
	Keypad for programming and navigating menu.		
	USB for data transfer.		
	Communication Device included.		
	Wi-Fi connection (IEEE 802.11) with at least 128-bits encryption for security purposes.		
	DNP3 (Level 2) support.		
	12-volt, 3-amp power supply to power cellular modem or a radio.		
	Suitable for three-phase gang capacitor switch operation with optional independent phase switching.		
	Perform data logging, sequence of events, and digital fault recording.		
	Compatible with various voltage sensors and sources.		
	Software application included.		
	Seven sensors' inputs support as per section 9.16.v.		
	Bi-directional mode for standard operation, compatible with renewable energy, and Micro Grid system deployments.		
	Temperature sensor for automatic operation included and that can be used as a backup operation mode in the event of missing communications.		
	Real-time clock available.		
	Input voltage ranges from 85 to 265 Vac with line fuse protection.		
	Low voltage distribution-class, 40 kA, single phase, 3 wires, secondary MOV surge arrester for 120V included.		
	Enclosure:		
	• Weatherproof, rated NEMA 4X, and IP65.		
	• Pole mounting base and a 14-pin DIN connector.		
	• Locking clasp and padlock provision.		
	• Ground lug		

Criteria	Description	Pass/Fail (P / F)	Comments
Pole Line Sensors (As per Section 9.17)	Material: hydrophobic cycloaliphatic epoxy		
	Operating temp: -45°C to 55°C		
	Electrical requirements as per section 9.17.b.		
	Cantilever Strength: 2,800 lbf		
	Threaded hole for a 3/4"-10 UNC bolt at the bottom.		
	"H1" as molded-in polarity identification.		
	Two aluminum clamps with bolt and lock washers for conductor connection. Conductor diameter range: 4.8 to 30 mm		
	Sensor output receptacle for a 4-wire signal cable plug at the bottom.		
	20' long cable with compatible plug on one end and pigtails on the other end included.		
Neutral Line Sensor (As per Section 9.18)	Watertight		
	Tilt-top opening that suits conductors up to 1.25" diameter.		
	35' minimum length output cable included. Bare at its ends.		
	600V insulation		
	Output Ratio: 500A = 5VAC		
	Required Load Impedance: 200 kΩ, minimum		
	Accuracy: 1%		

NOTE: This table is only a checklist for reference. The compliance must be with the complete document. Filling out the table with "PASS" won't be accepted as a compliance without the technical information required to certify it.

4300.50.185 Pole Capacitor Bank for Controlled Operation (12-1-25)

Final Audit Report 2025-12-01

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