



## Equipment Specification

Document No.: 4350.001

Originating Department: Distribution Engineering

# Three Phase Solid Dielectric Vacuum Recloser



## 1. Introduction

This is a general specification for three phase solid dielectric vacuum reclosers, to be used on a 4.16 kV to 13.2 kV-LL, 60 Hz, electrical distribution system in Puerto Rico. Project information, on site specific conditions, quantity, type of recloser and electrical requirements will be provided by LUMA Energy at time of order placement.

- 1.1 Reclosers must include the appropriate components to be operated at the following line to line voltages:
  - a. 4.16 kV
  - b. 7.2 kV
  - c. 8.32 kV
  - d. 13.2 kV

## 2. General

- 2.1. Products shall be evaluated by LUMA Energy. Samples shall be furnished as requested by LUMA Energy.
- 2.2. Design tests must be conducted on each design of the recloser and on each significant design change in accordance with latest ANSI C37.60.
- 2.3. Certified design test reports must be provided as part of bidder's proposal.
- 2.4. The vendor must submit equipment outlines, complete schematic, and point-to-point wiring diagrams for LUMA Energy's approval via digital media (PDF or other agreed upon format). The vendor must provide digital and hardcopy of the operation and maintenance manuals (O&M Manuals), including diagrams and parts list. If offered product has not been approved previously by LUMA Energy, bidder must submit all these requirements to be evaluated with their offer.
- 2.5. Product evaluation will consist of point system where the supplier will be awarded points for complying with items in this specification. When an item on this specification is deemed as "preferred", it is going to be scored on a 0-3 scale, where "3" is awarded if the supplier meets the full requirement and "1" or "2" if the requirement is met with a less preferred option.

## 3. Environmental Conditions

- 3.1. **Temperature & Humidity:** Equipment supplied must be adequate for an operating temperature range of 0°C to 50°C (32°F to 122°F), with humidity up to 100%.

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- 3.2. **Wind Conditions:** All mounting equipment must be designed and constructed to withstand sustained hurricane-force wind velocities complying with the applicable construction codes, standards or LUMA Energy's design criteria for PR. LUMA will show preference to the bidders that shows evidence of this.
- 3.3. **Pollution:** The equipment shall be designed and constructed for the corrosive environment of a distribution system in a tropical zone close to sea or exposed to strong sea winds and it shall provide reliable performance in environments with high exposure to salt, minerals, chemicals, or wind-borne particulate. The insulator contamination levels for the equipment should be adequate to prevent flashover. All exposed material shall be stainless steel or other material with anti-corrosive capabilities. Any other material shall be submitted for evaluation and approval. LUMA reserve the right to require salt spray test to demonstrate corrosion resistance.

## 4. Standards

- 4.1. Each recloser must be built following the latest applicable ANSI/IEEE, NEMA, NEC, IEC, and ASTM standard and the herein included requirements.
- 4.2. The following standards shall form a part of this specification unless otherwise stated:
- ANSI/IEEE C37.60 - Standard Requirements for Overhead, Pad-Mounted, Dry Vault, and Subsurface Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38 kV
  - ANSI/IEEE C37.2 - Standard Electrical Power System Device Functions Numbers
  - IEEE 1247-2005 - Standard for Interrupter Switches for Alternating Current, Rated Above 1000 Volts
  - ANSI Z535 - Sign Standards for Utility Installations
  - NEMA-3R - Standard for Enclosure Construction Requirements
  - ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products (Evidence of this must be submitted for product's approval.)

## 5. Design and Functional Requirements

### 5.1. Electrical Requirements

- Maximum design voltage: 15.5 kV
- Nominal operating voltage: 13.2 kV, 8.32 kV, 7.2 kV, and 4.16 kV
- Basic insulation level (BIL): 110 kV
- 60 Hz withstand voltage:
  - Dry, one minute: 50 kV
  - Wet, ten seconds: 45 kV
- Continuous current rating: 800 A-RMS
- Interrupting rating: 16,000 A symmetrical RMS

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- g. All electrical ratings must comply with ANSI/IEEE C37.60. LUMA prefers the recloser and control powered by 1 phase 120 V AC.
- h. LUMA prefers that the recloser be capable of withstanding a 180° out-of-phase voltage across the terminals with the phase angle between the two voltages continuously varying. If the equipment complies, the bidder must submit evidence of this.
- i. The terminal pads must have flat, machined surfaces in accordance with NEMA standards.

### **5.2. Physical Requirements**

- a. Must include mounting crossarm frame type for pole installations and comply with section 5.2 b.
- b. Mounting bracket must have two holes of 11/16" or 13/16" diameter with 24" vertical spacing mounting between them (center to center). Alternatively, it must include a base with three vertical holes of 11/16" or 13/16" diameter, one at the top of the base, another at 12" from the top hole and the third at 16" from the top hole (center to center). This bracket must be made in stainless steel grade 304, minimum.
- c. The recloser unit must comply with one of the following options:
  - 1. Option A:
    - i. If required, mounting frame provisions for two 1.5 kVA, single hanger bracket, liquid filled distribution transformers with an approximate weight of 130 lbs. each. Provisions shall allow the transformers to be electrically connected to the outer phase positions (typically AØ and CØ) of the recloser. The mounting hardware needed to attach the transformers must be included in the package with the recloser unit. LUMA prefers if this mounting hardware is pre-installed.
    - ii. Auxiliary power transformers (PT) shall be rated to the existing phase-to-ground voltage, each with a current limiting fuse. LUMA prefers that each secondary PT shall be wired to a junction box. The output of the junction box will have a connector on both ends to connect the two 120 V-AC auxiliary secondary connections to the control cabinet.
    - iii. Lifting provisions to allow the transformers to be attached prior to hanging the recloser.
  - 2. Option B:
    - i. The recloser may be self-powered designed where external 1.5 kVA transformers are not necessary.

### **5.3. Mechanical Requirements**

- a. The unit must be designed for a minimum of 10,000 complete open/close operations. Each unit must be equipped with an operation counter. LUMA prefers a counter independent of those in the recloser relay/control. An operation is defined as an open and close operation, returning the mechanism contacts to the original state.

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- b. A contact position semaphore, that indicates green for open and red for closed, shall be visible from underneath the recloser at a distance of no less than 40 feet.
- c. The operating mechanism must provide single-phase and three-phase open/close operation of the vacuum interrupters. The recloser must be configurable to allow single-phase or three-phase operation.
- d. An external mechanism must be provided for manual opening of the recloser. When this mechanism is operated, the device shall be unable to close (electronically or otherwise) until the external mechanism is returned to its normal operating position.
- e. Operating ambient temperature range shall be 0°C to +50°C (32°F to 122°F).

### **5.4. Additional Requirements and Features**

- a. The followings items must be packaged as a single unit included with the recloser. LUMA prefers that the recloser shall have these items pre-installed prior to shipment:
  - 1. Only LUMA approved six 10 kV distribution class MOV arresters with integral isolators. Each shall be factory-installed and wired on both sides of the recloser. No additional grounding connections shall be required for the arresters, other than connecting to the system grounding lead.
  - 2. Frame support members near the arrester brackets shall not contribute to wildlife contacts. If necessary, these members shall be made of non-conductive, UV stable materials.
  - 3. Internal voltage sensors (+/- 2.0% accuracy maximum) for monitoring both the source and load side primary voltages. CT sensors shall have a +/- 1.0% accuracy maximum.
  - 4. If the recloser does not provide internal voltage sensing on the load side bushings, mounting provisions shall be provided for external voltage sensors (+/- 2.0% accuracy maximum) next to each of the load-side arresters (i.e., 3 mounting holes, one next to each arrester). Voltage sensors shall be provided by the vendor as part of the recloser unit.
  - 5. A junction box to connect the 120 V auxiliary power. The pre-wired box shall include two 10 ft. 2/c #8-gauge cables for 1 kVA auxiliary transformer, rated to the existing voltage to ground, each with a current limiting fuse. Each secondary PT shall be wired to the junction box. The output of the junction box will be a 40 ft. cable with connectors on both ends to 120 V-AC auxiliary power transformer to the recloser control cabinet.

***The following items shall not be pre-installed, but must be shipped with the unit as a complete package:***

- 6. 40 ft. control cable(s) that connect between the recloser and the controller, with their connectors.
- 7. Wildlife protection required on all connection terminals.

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8. Recloser controller as described in Section 6.

### **5.5. Site Ready Option**

LUMA may request the vendor to furnish a “site ready” recloser as a preferred option. In this design, the recloser is to be shipped with all the following accessories pre-installed, so the complete unit is ready to hang on a pole and connect the leads. The items listed below are to be furnished, installed, and pre-wired by the vendor:

- a. Pre-wiring shall include the following:
  1. Power
  2. Antenna (antenna not included)
  3. DB9 serial cable or Ethernet.
- b. Six 10 ft. leads of 250 Kcmil compressed copper wire with insulation rated at 600 volts or higher. Leads to be terminated and attached to the recloser’s source and load bushings.
- c. LUMA prefers that the two external 1.5 kVA transformers for the existing primary voltage and 120 V AC secondary for auxiliary power, one connected to a source side lead and the other connected to a load side lead, be pre-installed. Transformers must include internal over-current protection. Transformer secondary leads shall be pre-wired to the junction box. (This requirement may be omitted if other power provisions have already been incorporated into the vendor’s design and approved by LUMA’s Distribution Materials Section).
- d. External partial range current limiting fuses must be furnished and pre-installed by the vendor if the internal over-current protection used on the transformer is not rated for interrupting a 7100 A-RMS symmetrical fault. These fuses must be mounted on the primary bushing of the transformer and wired to the 10 ft. 250 kcmil copper leads described in item 5.5.b.
- e. The six arresters described in item 5.4.a.1 shall be installed and wired to recloser’s primary bushings. The bottom of the arresters shall be wired to a bare #4 copper ground lead that also is connected to the recloser frame.
- f. External voltage sensors (equivalent to Lindsey SVM1 part # 9315), if required, shall be installed on source and load bushings where the recloser does not already have voltage-sensing inputs for the controller. This is typically the two load-side phases where the auxiliary power transformer is not connected. Sensors shall be wired to the recloser’s primary bushings.
- g. Cables and connectors to wire the voltage sensor outputs and auxiliary power to the junction box. LUMA prefers that the junction box itself shall be pre-attached to the recloser frame.

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- h. Recloser frame must be designed so bracing assembly is not required at the job site. The recloser assembly must be ready to lift and hang on the pole without attaching additional bracing or structural supports, according to item 5.2.b mounting brackets.

### **6. Controller (Relay) Requirements**

- 6.1. The recloser could use a separate controller. If required, an interconnected control cable with a multi-pin (threaded) connector shall be utilized between the recloser and control cabinet. Approved controllers are:
  - a. Schweitzer Engineering Laboratories (SEL) 651R2
  - b. S&C IntelliRupter control and communication modules
- 6.2. Controller models not listed above shall be submitted to the Distribution Materials Section for evaluation, testing, and approval. This includes modified or custom versions of the controllers.
- 6.3. Controller features shall include:
  - a. All mechanism and electrical housing must be weatherproof.
  - b. As a minimum, one 10/100 Base-T copper Ethernet port and two EIA-232 serial ports for SCADA communication, one Ethernet port or USB port for programming.
  - c. Six voltage sensor inputs.
  - d. Loop-Scheme control logic capability.
  - e. The recloser controller must have integral transceiver allowing communication directly between the recloser and a laptop using a communication configuration by at least one of the following:
    - 1. LUMA prefers the latest Wi-Fi communication capabilities (IEEE 802.11) – This Wi-Fi connection must have at least 128-bit encryption for security purposes. 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. All wireless communication must be adequately encrypted with user definable encryption keys and be password-protected for security purposes. If the proposed equipment cannot provide for this, the bidder could submit a quotation for optional accessories that would allow the equipment to offer this type of communication and requirement.

Any other communication technology proposed must comply with the security and communication requirement specified above. Technical information must be submitted to the Distribution Materials Section for evaluation and approval.
    - 2. Local port – This port will allow LUMA Energy to access the controller locally with a laptop using the controller software to operate and interrogate (upload/download) the recloser.
  - f. SCADA capable with DNP 3.0 protocol must include, as a minimum, the following:
    - 1. Three-phase status and control

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2. Single-phase status and control
  3. Local/remote status
  4. Profile 1 (three-phase control) status and control
  5. Profile 2 (single-phase control) status and control
  6. Recloser function – status and control
  7. Hot-line tag status and control
  8. Primary voltage (both sides)
  9. Primary phase current
  10. Battery test and status
  11. AC control power present
  12. Shutdown due to control power loss
  13. Fault indication, type, and direction
  14. All events must be timestamped with local time
  15. Per phase under voltage (UV) indication, for both sides
- g. Inside the control cabinet, the equipment must provide provisions for the mounting and power of an internally installed communication device. The communication module shall accept radial/serial Ethernet-based radios as well as have a fiberoptic interface on the faceplate, to provide flexibility between radio-based and fiber-based communication.
- h. When applicable, a polyphaser surge arrester with a N connector extending through the bottom of the controller. The inside portion of the surge protection must include a coaxial cable of sufficient length to connect the communication device to an antenna.
- i. Battery with sufficient reserve capacity for a minimum of 4 hours of communication operation upon loss of auxiliary power source(s).
- j. Equipment supplied must be adequate for an operating temperature range of 0°C to 50°C (32°F to 122°F), with humidity up to 100%.
- k. All control and auxiliary devices on the recloser must be labeled per ANSI C37.2 with device numbers and/or function, including heaters.
- l. The recloser relay/control settings must be shipped as specified or as requested by the purchaser.
- m. USB drive or other agreed-upon medium that includes the software installed on the controller.

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- n. The controller must have the ability to monitor the voltage on all six bushings. If a voltage monitor transducer (VMT) is required, the supplier must provide detail on how it will be configured and powered.
- o. Recloser units that uses the SEL 651R2, or similar, controller must comply with the following requirements:
  - 1. All mechanism and electrical housing must be weatherproof. Supports must be provided for anchoring incoming cables and grounding. Door and locking devices must be provided with a clasp for padlocking.
  - 2. Control cabinet must be stainless steel with a single door and rear pole mounting bracket compatible with concrete or steel pole. Must be sized to sufficiently contain all other power supply, communication, and battery equipment.
  - 3. Tri-Color LEDs and configurable labels, if applicable.
  - 4. Internal transfer relay to power the controller from either one of two 120 V-AC auxiliary power sources. AC transfer switches to be 4PDT, or similar.
  - 5. Connectors for two 120 V-AC auxiliary power secondary connections shall be wired to AC transfer switch.
  - 6. Front panel user interface with digital display.
  - 7. Front panel accessible port or USB for connecting an IBM compatible computer running Windows 10 operating system.
  - 8. Front panel GFCI convenience receptacle with front panel replaceable fuse.
  - 9. When equipped with a battery, control provides deadline operation, which allows the control to open and close the interrupters when AC power is not present.
  - 10. I/O option with two 120 V-AC/125 V-DC inputs wired to monitor the two 120 V-AC PT secondary connections. Will include 5 12V-DC inputs.
  - 11. LUMA prefers that the supplier provides 2 spare fuse  $\frac{1}{4}$ " x  $1\frac{1}{4}$ " each within the control (GFCI, relay AC input battery, and auxiliary power) shipped within the control.
  - 12. 2 Position fuse block to provide fused protection for the 120 V-AC line connections of the secondary PT supplied with 30 A fuses.
  - 13. An Ethernet to connect the controller to accept either radio-based or fiber-based communication device.

### **7. Qualification and Testing Requirements**

- 7.1. Production tests must be performed in accordance with ANSI/IEEE C37.60 on each furnished recloser.

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- a. The test report must be provided containing the measurements made during routine testing.
  - b. Test measurements must include upper and lower control limits.
  - c. All units must be hi-potted after final assembly, prior to shipment. Minimum hi-pot test must be 60 Hz, 50 kV, for one minute.
  - d. A complete tabulation of all weights, electrical ratings, and capacities must be provided.
  - e. The supplier must furnish 3 sets of drawings for the first shipment release to the Distribution Materials Section. The drawing must include a view displaying overall dimensions, cable and ground connections, and mounting provisions. This information must be submitted this information during the bidding process.
  - f. The supplier must furnish one copy of each of the following:
    1. Instruction book with complete instructions for installation and operation of the equipment and all information necessary for the adjustment, maintenance, and repair of the equipment. (Printed format, not an electronic file)
    2. USB drive or other agreed-upon medium that includes the software installed on the controller
    3. Copies of nameplates, operating mechanism, and potential transformers information, if used.
    4. Outline drawing
    5. Control schematic diagram
    6. Wiring diagram showing physical placement of components
  - g. Purchaser may elect to have his representative present when tests are conducted.
- 7.2. LUMA may require the bidder to provide proof of tests demonstrating equipment can withstand harsh conditions from salt (sea) spray and prolonged ultraviolet exposure.

### **8. Nameplate Information**

In addition to the applicable data required by ANSI C37.60, the nameplate must include the appropriate catalog number, total unit weight, manufacture date (month, year), product class (type), voltage class, current rating, operating voltage, and manufacturer's serial number for proper and complete identification of the recloser.

### **9. Signs**

Any signs placed on the equipment must comply with the latest issue of standard ANSI Z535 - Sign Standards for Utility Installations. Evidence must be submitted at proposal for evaluation.

### **10. Equipment Color**

The overhead reclosers must be finished with Light Gray Number ANSI 70 paint or stainless steel.

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### **11. Packing, Shipping and Storage**

- 11.1. Shipment must be FOB to destinations (DAP).
- 11.2. LUMA preferred all recloser to be shipped fully assembled with the external accessories as required in section 5.5. An exception shall be approved by purchaser.
- 11.3. Recloser assembly must be packaged to ensure that leads, cables, wildlife covers, transformers, fuses, controller, or other components are not disturbed or damaged during shipping. All parts and material shall be protected with wooden crate, properly sized, and fabricated to protect the unit during transportation (air, land, and sea) and subsequent storage.
- 11.4. For recloser assemblies to be stored outdoors and open to the elements, packaging must prevent equipment from being damaged by rain, snow, ice, wind, etc.
- 11.5. Warning label must be placed on the equipment for special handling and storage requirement.
- 11.6. Conducting parts, insulators and base must be supplied fully assembled inside wooden crates. Additional materials must be packed in weatherproof boxes and identified with weatherproof labels.
- 11.7. All materials, elements, parts, and hardware crates shall be shipped on flatbed trailers and stored in such a way so that they can be unloaded by finger lifts. Deliveries in containers or closed platforms where finger lifts cannot be used, will not be accepted.
- 11.8. A copy of each detailed packing list must be sent to LUMA Energy personnel in charge of the requisition, prior to the delivery.
- 11.9. All parts of the recloser unit must be shipped in the same package or bundle to avoid logistic problems when received.
- 11.10. Containers must be marked outside with LUMA Energy purchase order and item number.

### **12. Guarantee**

- 12.1. The supplier shall guarantee for a period of twenty (24) months after delivery or twelve (12) months from installation that the equipment supplied are free from defects in material and workmanship.
- 12.2. Replacement costs associated with recloser or control failure due to inadequate design, faulty manufacturing or software errors are responsibility of the manufacturer.
- 12.3. Non-conformance observed during sampling will require the supplier to bring the reclosers into compliance with the specification 14 days after notification. The units to be brought into compliance with the specification shall be shipped back to the supplier at the supplier's expense.

### **13. Proposal Information**

- 13.1. Submitted proposals must include:
  - a. Technical information

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- b. Drawings that show a view displaying overall dimensions, cable and ground connections, and mounting provisions.
- c. Table of Compliance completed by the bidder with reference (embedded spreadsheet under Appendix)
- d. Any exceptions to this specification
- e. Copies of sample nameplates
- f. List of optional requirements for accessories/equipment not included as part of the unit price of the recloser. (Such as external power supplies, external voltage sources, communication, etc.) Price for these accessories and equipment must be included.
- g. Lists of special and standard maintenance tools, if required.
- h. List of recommended spare parts

**Warehouse and Asset Suite Identification Number.**

Three – Phase Dielectric Vacuum Reclosers		
Voltage	Asset Suite Number	Warehouse Number
4.16 kV	82490	032-82490
7.2 kV	82491	032-82491
8.32 kV	82492	032-82492
13.2 kV	82382	032-82382

— End of Specification —

**Appendix**

Please open embedded spreadsheet (“Table of Compliance”) and provide responses indicating vendor’s compliance, exception, or alternative to each of the items listed. Indicate any references if applicable. Please return completed spreadsheet as part of the vendor’s proposal for approval of equipment as described in this specification.

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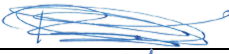
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