



## Equipment Specification

Document No.: 4350.03

Originating Department: Distribution Engineering



# Three Phase Solid Dielectric Vacuum Recloser with Loop Restoration & Pulse Closing Capabilities

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## 1. Introduction

- 1.1. This is a general specification for three phase solid dielectric vacuum reclosers with loop restoration and pulse closing capabilities, 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.
- 1.2. Reclosers shall include the appropriate components to be operated at the following voltages:
  - A. 13.2 kV
  - B. 8.32 kV
  - C. 7.2 kV
  - D. 4.16 kV

## 2. General

- 2.1. Products shall be evaluated and approved by LUMA Energy. Samples shall be furnished as requested by LUMA Energy. Vendors will not have to furnish samples of materials previously approved by PREPA/LUMA.
- 2.2. Design tests shall 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 shall be provided as part of bidder's proposal.
- 2.4. The vendor shall submit equipment outlines, complete schematic, and point-to-point wiring diagrams for LUMA Energy's approval. The vendor shall provide hardcopy of the operation and maintenance manuals (O&M Manuals), including diagrams and parts list. If offered product has not been approved previously by PREPA/LUMA Energy, bidder must submit all these requirements to be evaluated with their offer.

## 3. Environmental Conditions

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

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- 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.
- 3.4. **Seismic:** Each recloser and control cabinet, shall maintain its structural integrity due to seismic events at LUMA Energy project specific site locations, which can be identified as either “Moderate” or “High” per the IEEE-693 standard’s definition.

### **4. Standards**

- 4.1. Each recloser shall 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:
- 4.2.1. 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
  - 4.2.2. ANSI/IEEE C37.2 - Standard Electrical Power System Device Functions Numbers
  - 4.2.3. IEEE 1247-2005 - Standard for Interrupter Switches for Alternating Current, Rated Above 1000 Volts
  - 4.2.4. ANSI Z535 - Sign Standards for Utility Installations
  - 4.2.5. NEMA-3R - Standard for Enclosure Construction Requirements
  - 4.2.6. ANSI/IEEE 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
  - 4.2.7. IEEE 693 - Standard for Seismic Qualifications.
  - 4.2.8. 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**

- A. Maximum design voltage: 15.5 kV
- B. Nominal operating voltage: 13.2 kV, 8.32 kV, 7.2 kV and 4.16 kV
- C. Basic insulation level (BIL): 110 kV
- D. 60 Hz withstand voltage:
  - Dry, one minute: 50 kV

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- Wet, ten seconds: 45 kV

E. Continuous current rating: 800 A-RMS

F. Interrupting rating: 16,000 A symmetrical RMS

5.1.1. All electrical ratings shall comply with ANSI/IEEE C37.60.

5.1.2. The recloser may be of a self-power design where external power sources are not necessary. The recloser shall have power sourced from both sides of the interrupters, each fed from a different phase. An external power source connection provisions shall be provided for cases where an optional external power source is required on system voltages lower than 13.2 kV. The control power shall be derived from an optional external power supply rated at 90 to 259 V-AC (primary source input) and 19 to 60 V-DC or 100 to 360 V-DC (secondary source output). Bidder shall provide any optional design/accessory requirements for recloser operation at operational voltages below 13.2 kV (phase to phase) such as specified in Section 1.2.

5.1.3. The recloser shall be capable of withstanding a 180° out-of-phase voltage across the terminals with the phase angle between the two voltages continuously varying. Evidence of this must be submitted for product's approval.

5.1.4. Ground connector provisions shall be provided on the unitized stainless-steel base.

### **5.2. Physical Requirements**

5.2.1. All mechanism and electrical housing shall be weatherproof. Appropriate venting shall be provided to prevent gas and moisture buildup within the unitized base. Vents and seals shall prevent insects, dust, wind-driven rain, and fluid from pressure-washing from entering the base, protection and control module and communication module.

5.2.2. The terminal pads shall have flat, machined surfaces in accordance with NEMA standards.

5.2.3. A control group, consisting of a protection and control module and a communication module, with battery backup, shall be located in the base of the fault interrupting system. Each module shall be removable, while the recloser unit is energized, with a module-handling fitting attached to a standard 8 ft. hot-stick.

5.2.4. Mounting bracket shall have two holes of 11/16" or 13/16" diameter with 24" vertical spacing mounting between them. Alternatively, it shall 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.

5.2.5. Could include mounting frame options suitable for crossarm pole installations if it is necessary.

5.2.6. Provisions for optional heaters shall be installed wherever it is necessary to eliminate condensation. Thermostats shall be provided where heaters should not be energized continuously.

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### **5.3. Mechanical Requirements**

- 5.3.1. The unit shall be designed for a minimum of 10,000 complete open/close operations. Each unit shall be equipped with an operation 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.
- 5.3.2. The fault-interrupting system shall be capable of being opened without control power from any source.
- 5.3.3. A contact position semaphore for each phase interrupter, 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. Shall be also available through Wi-Fi.
- 5.3.4. An external lever shall be provided to allow the manual application of a hot-line tag to mechanically prevent reclosing functions and allow quick-trip operation while hot-line work is be performed.
- 5.3.5. The unit shall incorporate a ground-defeat mechanism, mechanically and electronically, to allow defeat of the ground relay during paralleling operation.
- 5.3.6. The operating mechanism shall provide single-phase and three-phase open/close operation of the vacuum interrupters. The recloser shall be configurable to allow single-phase or three-phase operation.
- 5.3.7. An external mechanism shall 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.
- 5.3.8. Operating ambient temperature range shall be 0°C to 50°C (32°F to 122°F).

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

- 5.4.1. The recloser shall have the following items pre-installed prior to shipment:
  - A. Only LUMA Energy 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.
  - B. 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.
  - C. Internal voltage sensors (+/- 0.5% accuracy maximum) for monitoring both the source and load side primary voltages. CT sensors shall have a +/- 0.5% accuracy for metering up to 900 A and +/- 2.0% across the full fault-detection range up to 28.4 kA asymmetrical interrupting. These ratings shall be across the tested temperature range of 0°C to 50°C (32°F to 122°F).

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

- D. Wildlife protection required on all connection terminals.
- E. Site ready option at the purchaser's discretion.

### 6. Communication and Protection & Control Requirements

- 6.1. The recloser shall use an interconnected control group, with the ability to perform pulse closing along with the capabilities to integrate with multiple other reclosers to form a team-based restoration scheme fed from multiple sources.
- 6.2. The control group monitors real-time load and uses peer-to-peer communication to determine fault location and alternate source-restoration capability. After protection operations isolate the fault, the control group automatically restores service to as many un-faulted line segments as the alternate source has reserve capacity to supply.
- 6.3. The control group shall include a battery backup that can operate for a minimum of four hours after loss of AC-line voltage on both sides of the fault interrupter to provide extended dead-line switching.
- 6.4. Approved controller(s):  
S&C IntelliRupter protection and control and communication modules
- 6.5. 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.
- 6.6. The communication module shall provide power provisions and ability to mount a radial/serial Ethernet-based radio as well as have a fiberoptic interface, to provide flexibility between radio-base and fiber-based communication.
- 6.7. The recloser controller shall have integral transceiver allowing communication directly between the recloser and a laptop using a communication configuration by at least one of the following:
  - A. 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.
  - B. Latest Wi-Fi communication capabilities (IEEE 802.11) – This Wi-Fi connection shall have at least 128-bit encryption for security purposes. The unit shall 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 shall be adequately encrypted with user definable encryption keys and be password-protected for security purposes.
  - C. In case that the proposed equipment cannot provide for item 6.7.B., the bidder shall submit quotation for optional accessories to comply with this item for evaluation and approval.

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- 6.8. When applicable, a polyphaser surge arrester shall have a connector extending through the bottom of the recloser unit to connect to an external mounted antenna. The inside portion of the surge protection shall include a coaxial cable of sufficient length to connect to the communication device.
- 6.9. The communication module shall include an integrated global positioning system clock for 1 millisecond accurate event timestamping of events.
- 6.10. Battery shall have sufficient reserve capacity for a minimum of 4 hours of communication operation upon loss of auxiliary power source(s).
- 6.11. Protection and control module features shall include:
  - A. The control application shall be included with each control unit and shall have a customer-programmed security code to limit access to control programming functions to authorized personnel.
  - B. Voltage sensor (six) inputs.
  - C. Current sensor inputs.
  - D. The control shall provide instantaneous and demand metering.
  - E. Loop-Scheme restoration control logic capability.
  - F. Selectable programming for a minimum of four cycles for recloser control (i.e., three openings) with separate and different programmable timing for each cycle.
  - G. A minimum of four protection-setting groups shall be provided, each capable of fully specifying the operation of the control in overcurrent protection.
  - H. Each setting group shall allow the configuration of time-current curves for phase overcurrent, ground overcurrent, hot-line Tag and cold load pickup.
  - I. Trip curves shall be permanently resident in control memory, even upon loss of all AC and DC power. Trip curves shall be selectable from a library of industry-standard recloser time-current characteristics curves.
  - J. The control shall include cold load pickup feature to prevent the control from tripping while energizing non-faulted system loads.
  - K. A lockout feature shall be included to automatically lockout the control when the current exceeds a programmable level.
  - L. A reclose feature shall be included that issues multiple reclose attempts in the event control power is lost.
  - M. The control shall include a sensitive ground fault trip feature that will provide tripping of the recloser after a programmable, definite time for ground currents below normal ground minimum trip levels.
  - N. The control module shall provide local indication of normal operation, Wi-Fi connection/disconnection and loss of control voltage.

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- O. A standard feature for hot-line tag to block all closing operations shall be included in the design of the control when performing live-line work.
- P. The protection and control module shall provide visible (light) indication of hot-line tag application or removal.
- Q. The control module shall have the capability to be controlled locally or remotely (SCADA) to allow single-phase and three-phase operation following control programming/setup.
- R. A coordination feature shall be included which allows the control to step through selected operation in the operating sequence without tripping.
- S. A non-volatile memory module shall backup configuration data and site-specific information.
- T. An event recorder shall be provided to record and store events in non-volatile memory.
- U. The control module shall provide the recording oscillograph in a standard COMTRADE (Common format for Transient Data Exchange for power systems) file or the control software shall provide means for the recorded conversion to COMTRADE.
- V. The control module shall include common industry protection and control elements.
- W. The protection and control elements shall enable sequence coordination, phase unbalance detection and synchronization check functions, and include a cold-load pickup modifier.
- X. SCADA capable with DNP3.0 protocol, that shall include, as minimum, the following:
  - a. Three-phase status and control
  - b. Single-phase status and control
  - c. Local/remote status
  - d. Profile 1 (three-phase control) status and control
  - e. Profile 2 (single-phase control) status and control
  - f. Recloser function – status and control
  - g. Hot-line tag status and control
  - h. Primary voltage (both sides)
  - i. Primary phase current
  - j. Battery test and status
  - k. AC control power present
  - l. Shutdown due to control power loss
  - m. Fault indication, type and direction
  - n. All events shall be timestamped with local time

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- o. Per phase under voltage (UV) indication, for both sides
- Y. The control shall include an alarm system. Data alarms shall be included that compare metered values to preset limits for a selectable time delay. Status alarms shall operate when user-selected functions change state.
- Z. The control module shall include a mode to operate the recloser as a remote switch only (disabling protection settings) which can be operated locally or remotely.
- AA. LUMA prefers equipment that provides harmonic comprehensive information for three-phase voltages and currents, plus neutral current.
- BB. LUMA prefers equipment that provides histogram data that displays statistical information, including time-tagged Min/Max values.
- CC. LUMA prefers equipment that provides a data-profiler feature, which enables data collection at user-selectable intervals.
- DD. 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.
- EE. Operating temperature range shall be 0°C to 50°C (32°F to 122°F). (Lower limit temperature is flexible because of Puerto Rico's nominal seasonal temperature range)
- FF. All control and auxiliary devices on the recloser shall be labeled per ANSI C37.2 with device numbers and/or function, including heaters.
- GG. The recloser protection and control settings, as shipped, shall be specified, or as requested by the purchaser.
- HH. CD-ROM or other agreed-upon medium that includes the software installed on the controller.
- II. The controller shall have the ability to monitor the voltage on all six bushings. If a voltage monitor transducer (VMT) is required; shall provide detail on how it will be configured and/or powered.

### 7. Qualification and Testing Requirements

- 7.1. Production tests shall be performed in accordance with ANSI/IEEE C37.60 on each furnished recloser.
  - 7.1.1. The test report shall be provided containing the measurements made during routine testing.
  - 7.1.2. Test measurements shall include upper and lower control limits.
  - 7.1.3. All units shall be hi-potted after final assembly, prior to shipment. Minimum hi-pot test shall be 60 Hz, 50 kV, for one minute.
  - 7.1.4. A complete tabulation of all weights, electrical ratings and capacities shall be provided.

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7.1.5. The supplier shall furnish 3 sets of drawings for the first shipment release to the Distribution Materials Section. The drawing shall include a view displaying overall dimensions, cable and ground connections, and mounting provisions.

7.1.6. The supplier shall furnish one copy of each of the following:

- A. Instruction book giving 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)
- B. CD-ROM or other agreed-upon medium that includes the software installed on the controller
- C. Copies of nameplates, operating mechanism, and potential transformers information, if used.
- D. Outline drawing
- E. Control schematic diagram
- F. Wiring diagram showing physical placement of components

7.1.7. Purchaser may elect to have their representative present when tests are conducted.

7.2. Provide proof of tests demonstrating equipment can withstand harsh conditions from salt (sea) spray and prolonged ultraviolet exposure.

### **8. Nameplate Information**

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

8.2. LUMA warehouse identification number may alternatively be stenciled on the side of the recloser.

### **9. Signs**

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

### **10. Equipment Color**

10.1. The overhead reclosers shall be finished with Light Gray Number ANSI 70 paint or stainless steel. The manual operation lever shall be painted yellow.

10.2. Pad mounted version shall be finished with Munsell Green No. 7GY 3.29G/1.5 paint. The manual operation lever shall be painted yellow.

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

- 11.1. Shipment shall be FOB to destinations.
- 11.2. All recloser shall be shipped fully assembled, unless approved by purchaser.
- 11.3. Recloser assembly shall be packaged to ensure the recloser unit, controllers 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, open to the elements, packaging shall prevent equipment from being damaged by rain, snow, ice, wind, etc.
- 11.5. Warning label shall 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 shall 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.

### **12. Guarantee**

- 12.1. Replacement costs associated with recloser or control failure due to inadequate design, faulty manufacturing or software errors are responsibility of the manufacturer.
- 12.2. 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 shall include:
  - A. Technical information
  - B. Any exceptions to this specification
  - C. Copies of sample nameplates
  - D. 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, arresters, wildlife protection, communication, etc.)
  - E. Lists of special and standard maintenance tools
  - F. List of recommended spare parts

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- G. List of software requirements
- H. List of license requirements
- I. Automatic restoration system requirements
- J. Peer-to-Peer communication requirements
- K. SCADA communication requirements
- L. Table of Compliance (embedded spreadsheet under Appendix)

— 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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### Catalog and Asset Suite Identification Number

Three – Phase Dielectric Vacuum Reclosers with Loop Restoration & Pulse Closing		
Voltage	Asset Suite	Catalog ID
4.16 kV	82291	032-82291
7.2 kV	82292	032-82292
8.32 kV	82293	032-82293
13.2 kV	82294	032-82294

### Document History

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