



# G&W Electric VIPER-HV 72kV Recloser

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## **Section 1 Scope**

This specification covers the minimum requirements for an electronically controlled, solid dielectric vacuum recloser with fault isolation and system restoration for use on mesh network sub-transmission system up to 72.5kV. The three phase recloser shall consist of three single phase units with a central recloser control and communication cabinet.

## **Section 2 General**

- 2.1 The recloser shall be three phase, outdoor, and shall be manufactured to meet all applicable requirements of the latest IEEE Standards in Section 3 and suitable for operation under the specified Environmental Conditions in Section 4.
- 2.2 The recloser shall be furnished with terminal lugs, channel bases, and provisions for mounting. All exposed bolts, nuts, washers, pins, etc. shall be stainless steel.
- 2.3 The recloser shall be suitable for mounting on composite, steel, and wooden poles, or substation steel structures (provided by others) with provisions for a 3/0 AWG grounding connector at the base and a top cover with line terminal connector. Grounding terminal pads shall be provided on both sides of the recloser frame.
- 2.4 The recloser shall utilize a time proven and essentially maintenance free solid dielectric modules EPOX solid dielectric insulation to fully encapsulate the vacuum interrupter with no SF6, oil, foam and/or porcelain insulating material utilized.
- 2.5 Each recloser shall contain weather resistant molded silicone sheds on each module assembly with a 5,000-hour salt fog rating.
- 2.6 Each recloser shall have sufficient cantilever strength to withstand sustained hurricane-force wind velocities as defined in Section 4 Environmental Conditions of this specification.
- 2.7 Each recloser solid dielectric module shall contain the following:
  - a. A 2000:5 multi-ratio current transformers encapsulated within the solid dielectric insulation for exclusive use with the recloser control.
  - b. The CTs shall be designed with overvoltage protection so that excessive voltage cannot be produced if the CTs are opened under load.
  - c. The five (5) wires for each CT shall be brought into the control cabinet for clear and easy selection of desired ratio.
  - d. Accuracy Class shall be 5P20 and per IEC 61869-2:2012 with accuracy to be  $\pm 4\%$  at the rated current and composite error of  $\pm 5\%$  at twenty (20) times the continuous current rating.
  - e. An integrated and internal 15,000:1 Low Energy Analog (LEA) voltage sensor shall be provided in the horizontal side bushing and vertical top bushing with  $\pm 4\%$  accuracy across full temperature range of the recloser.



- 2.8 The recloser shall have high voltage electrical terminals shall be equipped with four (4) NEMA pads with a total of six (6) terminal lugs provided for the three phase recloser.
- 2.9 The recloser shall have a total of six (6) Wildlife protectors that shall be provided and designed appropriated for the recloser with UV stable wildlife protectors for both source and load terminals The wildlife protector’s electrical ratings shall be validated per testing based upon IEEE Std 1656 and modified for the 72.5kV operating voltage of the recloser.
- 2.10 The recloser magnetic actuator and corresponding linkage assembly shall be housed within a high impact, UV stable, air insulated, poly-carbonate enclosure. A contact position indicator and housing designed with air vent. Lifting provisions shall be provided for each mechanism assembly.
- 2.11 The operating mechanism shall utilize a magnetic actuator for opening and closing of the vacuum interrupters, one per phase, with the following design provisions:
  - 2.11.1. The magnetic actuator shall be powered by a capacitive discharge system located in the control enclosure.
- 2.12 The manual trip and lockout handle that contains the following features and capabilities:
  - 2.12.1. The trip handle assembly shall be hot stick operable, yellow in color, made of stainless steel for maximum corrosion resistance and shall not require any power to function.
  - 2.12.2. A physical mechanical block device shall be part of the assembly to mechanically prohibit accidental closing when the manual trip handle is used.
  - 2.12.3. The manual trip handle operation shall also block any electrical operation of the recloser.
  - 2.12.4. An auxiliary contact (69 device) shall be provided down to the control to provide position indication of the manual trip handle.
  - 2.12.5. Vacuum interrupter contact position indication shall be accomplished using green (open) and red (closed) highly reflective indicators located on the bottom of each mechanism enclosure and provides 360° viewing for the ground. Position indication shall also be provided through LEDs located in the control.
  - 2.12.6. Operating mechanism to have capability for both synchronized three phase open and close operation and single-phase operation.
- 2.13 The recloser interruption of a fault or load current shall be accomplished through vacuum interrupters located inside the solid dielectric modules with the following operating time requirements:
  - 2.13.1. Interrupting Time (Maximum): 40 msec
  - 2.13.2. Closing Time: 76 msec



- 2.14 The recloser shall be supplied with a set of three (3) cables with the following requirements:
  - 2.14.1. Weather tight environmental connectors on both ends that mate with the corresponding recloser mechanism and the control to allow easy and quick connection of the cables.
  - 2.14.2. Cable length options shall have increments up to a maximum of 100 feet (30.5 meters) and contain a protective armor jacket.
- 2.15 The recloser manufacturer shall have at least ten (10) years of experience in manufacturing solid dielectric reclosers.
- 2.16 The recloser manufacturer of the recloser shall be completely and solely responsible for the performance of the recloser as well as the complete integrated assembly as rated.
- 2.17 The recloser manufacturer shall furnish certification of ratings of the reclosers upon request.
- 2.18 The recloser shall have appropriate hazard signs shall be applied to each unit, frame, or enclosure.
- 2.19 A Danger sign shall be placed on the recloser warning personnel of hazardous voltage and the need for qualified operating personnel.
- 2.20 Warning signs shall be placed on the recloser to warn against product misapplication more than fault ratings and the hazards when accessing moving components inside the mechanism housing.
- 2.21 Caution signs on the recloser shall warn of harmful X-ray potential during hi-potential voltage testing.
- 2.22 Each recloser shall be provided with a nameplate label. Ratings and information listed on nameplate shall indicate the following:
  - a) Rated Voltage (Maximum)
  - b) Impulse Level (BIL)
  - c) Continuous Current RMS
  - d) Interrupting current RMS
  - e) Duration of Short Circuit Current
  - f) Catalog Number
  - g) Serial Number
  - h) Manufacturing Date
  - i) Weight per Phase



### **Section 3 Standards**

- 3.1 The recloser shall comply with requirements of the applicable industry standards that include the following minimum requirements:
  - 3.1.1. IEEE C37.60-2018 / IEC 62271-111:2019 Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV
  - 3.1.2. IEEE C37.04-2018 IEEE Standard for Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V
  - 3.1.3. IEEE C37.06-2009 IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V
  - 3.1.4. IEEE C37.09-2018 IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V
  - 3.1.5. IEC 62217: 2012 Polymeric HV insulators for indoor and outdoor use - General definitions, test methods and acceptance criteria
  - 3.1.6. IEEE C37.90.1-2012 IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
  - 3.1.7. IEEE C37.90.2-2004 IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
  - 3.1.8. IEEE C37.90.3-2001 IEEE Standard Electrostatic Discharge Tests for Protective Relays
  - 3.1.9. IEEE Std 1656-2010, IEEE Guide for Testing the Electrical, Mechanical, and Durability Performance of Wildlife Protective Devices on Overhead Power Distribution Systems Rated up to 38 kV
  - 3.1.10. IEEE Std 693-2018, IEEE Recommended Practice for Seismic Design of Substations
  - 3.1.11. The recloser manufacturer shall be ISO 9001 and ISO 14001 certified.

### **Section 4 Environmental Conditions**

- 4.1 Temperature and Humidity: Recloser supplied shall be adequate for an operating temperature range of 5°C to 40°C (41°F to 104°F), with humidity up to 100%.
- 4.2 Wind conditions: The recloser shall be designed and constructed to withstand sustained hurricane-force wind velocities up to 160 mph (257.5 km/h) with an overload factor of 1.1.
- 4.3 Pollution: The recloser shall be designed and constructed for the corrosive environment of an outdoor substation in a tropical zone close to sea or exposed strong sea winds and



shall provide reliable performance in environments with high exposure to salt, minerals, chemicals, or wind-borne particulate.

- 4.4 Seismic: Recloser, including its support structure shall maintain its structural integrity due to seismic events at LUMA Energy project specific site locations, identified as “High” per the IEEE Std 693 standard definition. The vendor shall provide test certificates showing that a recloser of equal, or similar, type and rating has been shake-table tested in accordance with IEEE Std 693.

**Section 5 Recloser and Controller Electrical Ratings**

- 5.1 The recloser shall contain the following electrical ratings and characteristics as listed in Table 1.

**Table 1. Recloser Electrical Ratings**

Description	Rating
Nominal Voltage Class (kV)	40 to 69
Maximum Rated Voltage (kV)	72.5
Power Frequency (Hz)	50/60
Lighting Impulse Withstand Voltage - BIL (kV)	350
Power-Frequency Withstand Voltage – 60 Seconds (kV)	160
Continuous Current (A)	1,200
Peak Withstand Current (kA <sub>peak</sub> )	82
Short time Withstand Current (kA)	31.5
Short-circuit Making Current (kA <sub>peak</sub> )	82
Short-circuit Breaking Current (kA)	31.5
Duration of Short-Circuit (s)	3.0
First Pole-to-Clear Factor	1.5 and 1.3
Line-Charging Breaking Current (A)	20
Cable-Charging Breaking Current (A)	250
Top Terminal (Z-Side) to Ground Creepage Distance - Inches (mm)	160.0 (4,064)
Side Terminal (Y-Side) to Ground Creepage Distance - Inches (mm)	139.9 (3,553)
Terminal to Terminal Creepage Distance - Inches (mm)	135.5 (3,442)
Mechanical Endurance (Operations)	10,000
Ambient Temperature	-40°C to +65°C -40°F to 149°F
Relative Humidity (RH)	0% to 95%
Ingress Protection	IPX6



- 5.2 The recloser electrical ratings and design type testing shall be verified through direct three phase high power testing. No synthetic circuit testing and/or single-phase validation testing shall be allowed.
- 5.3 The recloser shall be paired and validated under the requirements of IEEE C37.60-2018 / IEC 62271-111:2019.
- 5.4 The recloser control and relay shall be available as integral tested solutions under the IEEE C37.60-2018 / IEC 62271-111:2019 standard.
- 5.5 The recloser control package shall include a SEL 651R2 relay module.
- 5.6 The recloser control package shall include the following features listed in Table 2 and Table 3.

**Table 2. Recloser Control Package**

Category	Description
Relay	SEL 0651R2AH1GA8AD13X3XXXX (MOT breakdown shown in Table 3)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV Various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation	ABB FT-19 switches
Communication Mounting	Standard mounting and powering provisions for future communication equipment

- 5.6.1. SEL Rack Mount Relay (MOT 0651R2AH1GA8AD13X3XXXX) features are listed in Table 3.

**Table 3. SEL 651R Features**

Category	Description
Firmware	Standard
Control Cable Interface	Part of G&W's Package shown in Table 2
Enclosure	Part of G&W's Package shown in Table 2
Conformal Coat	Conformal Coated Circuit Boards
Secondary Input Voltage	(6) 8 Vac Max LEA inputs
Secondary Input Current	1A Phase, 0.2 A Neutral
Extra Inputs/Outputs	(7) 12 Vdc Inputs / (8) Standard Outputs
Communication Port	3 EIA-232, USB
Communication Interface	(1) 100BASE-FX, EIA-485
Communication Protocol	Standard
Power Supply	125 Vdc
User Interface	Configurable Labels and Tri-Colored LEDs



5.6.2. SEL-651R2 Relay Functionality:

- 50 (P, N, G, Q) – Overcurrent (Phase, Neutral, Ground, Negative Sequence)
- 51 (P, N, G, Q) – Time Overcurrent (Phase, Neutral, Ground, Negative Sequence)
- 79 – Auto reclosing
- 21– Phase and Ground Distance
- 25 – Synchronization Check
- 27 – Undervoltage
- 32 – Directional Power
- 59 (P, G, Q) – Overvoltage (Phase, Ground, Negative Sequence)
- 67 (P, G, Q) – Directional Overcurrent (Phase, Ground, Negative Sequence)
- 78 -Vector Shift
- 81 (O, U, R) – Frequency (Over, Under, Rate of Change)

5.6.3. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

- 5.7 The recloser shall have provisions for an optional control package for substation applications utilizing a SEL 421 relay module.
- 5.8 The recloser substation control package shall include the following features listed in Table 4 and Table 5.

**Table 4. Substation Recloser Control Package**

Category	Description
<b>Relay</b>	04215411XB0X4H744442X (MOT breakdown shown in Table 5)
<b>Control Cable Interface</b>	35 Pin Harting Connector Interface
<b>Control Voltage</b>	120 and 240Vac, auto-ranging, 50/60Hz
<b>Enclosure</b>	Single Door (Rear Mount), Painted Stainless Steel
<b>Power Module</b>	Viper-HV Various power supply voltages (125Vdc for relay and 24Vdc for
<b>Aux Operating Panel</b>	Panel for Open/Close Pushbuttons, LEDs, Hot Line Switch with LED,
<b>Battery Backup</b>	(2) 12Vdc, 68Ahr Battery
<b>Test &amp; Isolation Switches</b>	ABB FT-19 switches (SEL 421 Relay and provision for Future SEL T401L)
<b>Communications Equipment</b>	Included and wired in the control on communication panels are the following accessories: 1 - SEL-2401 Satellite Clock (Part No. 20410X1X2) 1 - SEL-3622 Security Gateway (Part No. 3622XDE111X1) Mounting and powering provisions for customer future communication equipment



5.8.1. SEL Rack Mount Relay (MOT 04215411XB0X4H744442X) features are listed in Table 5.

**Table 5. SEL 421 Features**

Category	Selection
<b>Firmware</b>	Plus, Sub-Cycle Elements, Series Compensation Logic, and Full Automation
<b>Power Supply</b>	48-125 Vdc or 110-120Vac
<b>Connector Type</b>	Screw-Terminal Block
<b>Secondary Inputs</b>	300 V Phase-Neutral Maximum (Wye), 1 A Phase
<b>Ethernet Communication Protocols</b>	FTP, Telnet, Synchrophasors, and DNP
<b>Ethernet Connection Options</b>	Ports 5C, 5D: Ethernet Card with Two 10/100Base-T Connectors
<b>Mainboard Input Voltage</b>	125 Vdc
<b>Mounting</b>	Horizontal Rack Mount
<b>Chassis</b>	5U, Front Panel With 24 Target LEDs 12 Operator Control Pushbuttons, and Tri-Color LEDs
<b>I/O Board Position B For 4U or 5U Chassis</b>	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
<b>I/O Board Position B Input Voltage</b>	125 Vdc
<b>I/O Board Position C For 5U Chassis Only</b>	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
<b>I/O Board Position C Input Voltage</b>	125 Vdc
<b>Conformal Coat</b>	Conformal Coated Circuit Boards

5.8.2. SEL-421 Relay Functionality:

- 50 (P, N, G, Q) – Overcurrent (Phase, Neutral, Ground, Negative Sequence)
- 51 (P, N, G, Q) – Time Overcurrent (Phase, Neutral, Ground, Negative Sequence)
- 79 – Auto reclosing
- 21– Phase and Ground Distance
- 25 – Synchronization Check
- 27 – Undervoltage
- 32 – Directional Power
- 50BF – Breaker Failure Overcurrent
- 59 (P, G, Q) – Overvoltage (Phase, Ground, Negative Sequence)
- 67 (P, G, Q) – Directional Overcurrent (Phase, Ground, Negative Sequence)
- 68 – Out-of-Step Block/Trip
- 81 (O, U, R) – Frequency (Over, Under, Rate of Change)



5.8.3. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

## **Section 6 Testing Requirements**

- 6.1 Each individual recloser shall undergo a mechanical operation check verifying contact:
  - 6.1.1. Trip/close velocity
  - 6.1.2. Travel profile
  - 6.1.3. Timing and phase synchronicity
- 6.2 The recloser shall be AC hi-pot tested one minute in the closed position and across the open contacts.
- 6.3 Circuit resistance shall be checked on all phases.
- 6.4 Timing tests shall be conducted to verify time curve characteristic (TCC) performance.
- 6.5 Voltage sensors shall be calibrated and accuracy for each shall be confirmed.

## **Section 7 Packing, Shipping, and Storage**

- 7.1 All parts and material shall be protected with wooden crate, properly sized, and fabricated to protect the unit from damage during sea freight transportation and subsequent storage.
- 7.2 Each recloser shall be shipped in its own single wooden crate, which shall be prepared for long-term storage in upright position. Desiccant bags shall be provided to assist in keeping the interior of the wooden crate moisture-free.
- 7.3 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.
- 7.4 All materials, elements, parts, and hardware wooden crates shall be shipped in Conex boxes for transference from shore-to-ship and ship-to-shore for transportation on truck 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.
- 7.5 A copy of each detailed packing list must be sent to LUMA Energy personnel in charge of the requisition, prior to the delivery.

**– End of Specification –**

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