

G&W Electric VIPER®-HV 72.5kV SOLID DIELECTRIC RECLOSERS

PART 1- GENERAL

1.1 DESCRIPTION

This specification covers the requirements for an electronically controlled, solid dielectric vacuum recloser with fault isolation and system restoration for use on sub-transmission systems up to 72.5kV. The Three Phase recloser shall consist of three single phases and be designated as G&W Viper-HV.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:

The chosen manufacturer shall have at least 10 years of experience in manufacturing solid dielectric reclosers. The manufacturer of the reclosers shall be completely and solely responsible for the performance of the reclosers as well as the complete integrated assembly as rated.

B. The manufacturer shall furnish certification of ratings of the reclosers upon request.

C. The recloser shall comply with requirements of the applicable industry standards that include the following minimum requirements:

| | |
|---------------------------------------|--|
| IEEE C37.60-2018 / IEC 62271-111:2019 | Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV |
| IEEE C37.04-2018 | IEEE Standard for Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V |
| 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 |
| IEEE C37.09-2018 | IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V |
| IEC 62217: 2012 | Polymeric HV insulators for indoor and outdoor use - General definitions, test methods and acceptance criteria |
| IEEE C37.90.1-2012 | IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus |
| IEEE C37.90.2-2004 | IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers |
| IEEE C37.90.3-2001 | IEEE Standard Electrostatic Discharge Tests for Protective Relays |

D. The recloser manufacturer shall be ISO 9001 and ISO 14001 certified.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Reclosers shall be packaged in crating that has been appropriately validated through vibration testing. The recloser shall be pre-assembled as much as possible to minimize field assembly.
- B. The contractor, if applicable, shall handle, transfer and move the reclosers in accordance with manufacturer's recommendations.
- C. Storage of the Recloser mechanism can be outdoor environment but the supplied control being placed under cover and/or in an environment free from excessive moisture in order to prevent damage since the control is shipped on its back and in non-outdoor or extended outdoor rated shipping container.

PART 2- PRODUCTS

2.1 RECLOSER CONFIGURATION

Recloser shall have orderable options for the following configurations:

- Phase-over-Phase mounting for vertical line construction
- Staggered Phase-over-Phase mounting for vertical line construction
- Cross arm style for horizontal line construction
- Mechanism capable of be mounted vertically, horizontally, and/or on a 45° angle

2.2 RECLOSER CONSTRUCTION

A. Mechanism Enclosure

The 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.

B. Operating Mechanism

The operating mechanism shall utilize a magnetic actuator for opening and closing of the vacuum interrupters, one per phase, with the following design provisions:

1. The magnetic actuator shall be powered by a capacitive discharge system located in the control enclosure.
2. The manual trip and lockout handle that contains the following features and capabilities:
 - a. The trip handle assembly shall be hotstick operable, yellow in color, made of stainless steel for maximum corrosion resistance and does not require any power to function.
 - b. A physical mechanical block device shall be part of the assembly to mechanically prohibit accidental closing when the manual trip handle is used.
 - c. The manual trip handle operation shall also block any electrical operation of the recloser.
 - d. An auxiliary contact (69 device) shall be provided down to the control to provide position indication of the manual trip handle.

3. 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.
4. Operating mechanism to have capability for both synchronized three phase open and close operation and single phase operation.

C. Vacuum Interrupters

Interruption of the fault or load current shall be accomplished through vacuum interrupters located inside the solid dielectric modules with the following operating time requirements:

1. Interrupting Time (Maximum): 40 msec
2. Closing Time: 76 msec

D. Solid Dielectric Modules

The solid dielectric modules shall utilize a time proven and essentially maintenance free EPOX solid dielectric insulation to fully encapsulate the vacuum interrupter with no SF6, oil, foam and/or porcelain insulating material utilized. Each module shall contain weather resistant molded silicone sheds on each module assembly with a 5,000 hour salt fog rating. Each module shall contain the following:

1. A 2000:5 multi-ratio current transformers encapsulated within the solid dielectric insulation for exclusive use with the recloser control. The CTs shall be designed with overvoltage protection so that excessive voltage cannot be produced if the CTs are opened under load. The 5 wires for each CT shall be brought into the control for clear and easy selection of desired ratio. Accuracy Class shall be 5P20 and per IEC 61869-2:2012 with accuracy to be +/- 4% at the rated current and composite error of +/- 5 % at 20 times the continuous current rating.
2. An integrated and internal 15,000:1 Low Energy Analog (LEA) voltage sensor shall be provided in the horizontal side bushing with +/- 4% accuracy across full temperature range of the recloser.

E. High Voltage Terminals

The 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.

F. Grounding Provisions

Grounding terminal pads shall be provided on both sides of the recloser frame.

G. Wildlife Protectors

A total of six (6) Wildlife protectors shall be provided and designed appropriated for the recloser. The wildlife protector's electrical ratings shall be validated per testing based upon IEEE 1656; modified for the 72.5kV operating voltage of the recloser.

2.3 Electrical Ratings

The recloser shall contain the following electrical ratings and characteristics:

| 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 _{peak}) | 82 |
| Short-time Withstand Current (kA) | 31.5 |
| Short-circuit Making Current (kA _{peak}) | 82 |
| Short-circuit Breaking Current (kA) | 31.5 |
| Duration of Short-Circuit (s) | 3 |
| 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 |
| Relative Humidity (RH) | 0 – 95% |
| Ingress Protection | IPX6 |

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.

2.4 CONTROL CABLES

The recloser shall be supplied with a set of three (3) cables with the following requirements:

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. Cable length options shall have increments up to a maximum of 100 feet (30.5 meters) and contain a protective armor jacket.

2.4 CONTROL CABINET CHARACTERISTICS AND FUNCTIONALITY

The recloser shall be paired and validated under the requirements of IEEE C37.60-2018 / IEC 62271-111:2019. The following control and relay options shall be available as integral tested solutions under the IEEE/IEC noted standard:

A. Custom Control Package featuring the SEL 651R2 relay module

1. Control Package to include the following features:

| Category | Description |
|---------------------------|--|
| Relay | 0651R2AH1GA8AD13X3XXXX (MOT breakdown shown below) |
| 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 Switches | ABB FT-19 switches |
| Communication Mounting | Standard mounting and powering provisions for future communication equipment |

2. SEL Rack Mount Relay (MOT 0651R2AH1GA8AD13X3XXXX) features are as follows:

| Category | Description |
|-------------------------|-----------------------------------|
| Firmware | Standard |
| Control Cable Interface | Part of G&W's Package shown above |
| Enclosure | Part of G&W's Package shown above |
| 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 LED's |

3. 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 – Autoreclosing
- 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)

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

B. Custom Control Package featuring the SEL 421 relay module

1. Control Package to include the following features:

| Category | Description |
|---------------------------|--|
| Relay | 04215411XB0X4H744442X (MOT breakdown shown below) |
| 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) |
| Aux Operating Panel | Panel for Open/Close Pushbuttons, LEDs, Hot Line Switch with LED, Local/Remote Switch |
| Battery Backup | (2) 12Vdc, 68Ahr Battery |
| Test & Isolation Switches | ABB FT-19 switches (SEL 421 Relay and provision for Future SEL T401L) |
| Communications Equipment | 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 |

2. SEL Rack Mount Relay (MOT 04215411XB0X4H744442X) features are as follows:

| Category | Selection |
|------------------------|--|
| Firmware | Plus, Sub-Cycle Elements, Series Compensation Logic, and Full Automation |
| Power Supply | 48-125 Vdc or 110-120Vac |
| Connector Type | Screw-Terminal Block |
| Secondary Inputs | 300 V Phase-Neutral Maximum (Wye), 1 A Phase |
| Ethernet Communication | FTP, Telnet, Synchrophasors, and DNP |

| | |
|---|--|
| Protocols | |
| Ethernet Connection Options | Ports 5C, 5D: Ethernet Card with Two 10/100Base-T Connectors |
| Mainboard Input Voltage | 125 Vdc |
| Mounting | Horizontal Rack Mount |
| Chassis | 5U, Front Panel With 24 Target LEDs, 12 Operator Control Pushbuttons, and Tri-Color LEDs |
| I/O Board Position B For 4U or 5U Chassis | 24 Opto-isolated Level-Sensitive Inputs, 8 Outputs |
| I/O Board Position B Input Voltage | 125 Vdc |
| I/O Board Position C For 5U Chassis Only | 24 Opto-isolated Level-Sensitive Inputs, 8 Outputs |
| I/O Board Position C Input Voltage | 125 Vdc |
| Conformal Coat | Conformal Coated Circuit Boards |

3. 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 – Autoreclosing
- 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. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

2.5 FACTORY PRODUCTION TESTS

Each individual recloser shall undergo a mechanical operation check verifying contact:

- trip/close velocity,
- travel profile,
- timing and phase synchronicity.

The recloser shall be AC hi-pot tested one minute in the closed position and across the open contacts. Circuit resistance shall be checked on all phases.

Timing tests shall be conducted to verify TCC performance.

Voltage sensor to be calibrated and accuracy confirmed.

2.6 STANDARD COMPONENTS

The following shall be included as standard:

- Galvanized mounting bracket
- Lifting provisions
- Grounding provisions
- UV stable wildlife protectors for both source and load terminals

2.7 LABELING

A. Hazard Alerting Signs

Appropriate hazard signs shall be applied to each unit, frame or enclosure (if applicable). A Danger sign shall warn of hazardous voltage and the need for qualified operating personnel. Warning signs shall warn against product misapplication in excess of fault ratings and the hazards when accessing moving components inside the mechanism housing. Caution signs shall warn of harmful X-ray potential during hi-potential voltage testing.

B. Nameplates, Ratings Labels, and Connection Diagrams

Each recloser shall be provided with a nameplate label. Ratings and information listed on nameplate shall indicate the following: Rated Voltage (Maximum), Impulse Level (BIL), Continuous Current RMS, Interrupting current RMS, Duration of Short Circuit, Catalog Number, Serial Number, Manufacturing Date and Weight per Phase.