Switchgear
MN285005EN

Effective March 2018
Supersedes November 2015

COOPER POWER SERIES

RVAC Fluid-insulated Vacuum Switchgear; Installation, Operation, and Maintenance Instructions

Powering Business Worldwide

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

The information, recommendations, descriptions and safety notations in this document are based on Eaton Corporation's ("Eaton") experience and judgment and may not cover all contingencies. If further information is required, an Eaton sales office should be consulted. Sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between Eaton and the purchaser.

THERE ARE NO UNDERSTANDINGS, AGREEMENTS, WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OTHER THAN THOSE SPECIFICALLY SET OUT IN ANY EXISTING CONTRACT BETWEEN THE PARTIES. ANY SUCH CONTRACT STATES THE ENTIRE OBLIGATION OF EATON. THE CONTENTS OF THIS DOCUMENT SHALL NOT BECOME PART OF OR MODIFY ANY CONTRACT BETWEEN THE PARTIES.

In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or other-wise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and descriptions contained herein. The information contained in this manual is subject to change without notice.

Contents

This page is intentionally left blank.

Safety for life

Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally-approved safety procedures and safety instructions when working around high-voltage lines and equipment, and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally-approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling, or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally-approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install, or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.2

Product information

Introduction

Service Information MN285005EN provides installation instructions, operation information, maintenance procedures, and testing information for the RVAC pad-mounted vacuum switchgear. The information contained in this manual is organized into the following major categories: *Safety Information, Product Information, Installation Procedure, Operation, Maintenance Information, and Testing*. Refer to the table of contents for page numbers.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing, operating, or maintaining this equipment.

Additional information

These instructions do not claim to cover all details or variations in the equipment, procedures, or processes described nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your Eaton representative.

Acceptance and initial inspection

RVAC switchgear is completely assembled, tested, and inspected at the factory. The switchgear is filled to the correct level with insulating fluid. It is in good condition when accepted by the freight carrier for shipment.

1. Upon receipt, inspect the unit thoroughly for damage and loss of parts or fluid incurred during shipment. If damage or loss is discovered, file a claim with the carrier immediately.
2. Check for fluid leakage, and tighten any bolts that may have loosened during shipment.

Handling and storage

The switchgear should remain on its shipping pallet until it is installed. When handling the switchgear, always use a fork truck that has adequate lifting capacity and forks that extend the entire length of the pallet. Improper handling can cause damage to the switchgear. If the switchgear is to be stored for any appreciable length of time before installation, provide a clean, dry storage area. Be careful during handling and storage to minimize the possibility of mechanical damage. Do not stack other material on the switchgear cabinet.

Standards

RVAC switchgear is designed and tested in accordance with IEEE Std 386™-1995 standard, IEEE Std C37.74™-2003 standard, and IEEE Std C57.12.28™-2005 standard.

Quality standards

ISO 9001 Certified Quality Management System

Product description

The RVAC vacuum switchgear provides convenient load switching for 15-, 25-, and 35-kV underground systems. RVAC switchgear is designed for outdoor mounting on a concrete pad. Power is fed to and from the switch from underground through openings in the pad.

Deadfront construction minimizes the high-voltage safety hazards for both the operator and the general public.

Type RVAC switchgear employs mineral oil, Envirotemp™ FR3™, or Envirotemp™ E200™ as the insulating medium to provide a compact, low-profile installation.

NOTICE

The use of Envirotemp™ FR3™ dielectric fluid is limited to a minimum operating temperature of 32 °F (0 °C). Failure to comply can result in equipment misoperation.

T374.0

RVAC switchgear can be specified with a variety of fusing options to meet distribution system protection requirements.

Switch operation

The RVAC switchgear utilizes vacuum loadmake/loadbreak switches. Clampstick operable switch operating handles are located on the front plates of the unit.

Current-limiting fuse protection

Fault protection is provided by full-range current limiting fuses that provide protective characteristics over a wide range of applications.

Vacuum interrupters

Loadbreak switching takes place within sealed vacuum interrupters (**Figure 1**). Vacuum interrupters provide fast, low-energy arc interruption and produce no arcing by-products to contaminate the insulating fluid.

Figure 1. Vacuum interrupter mechanism assembly

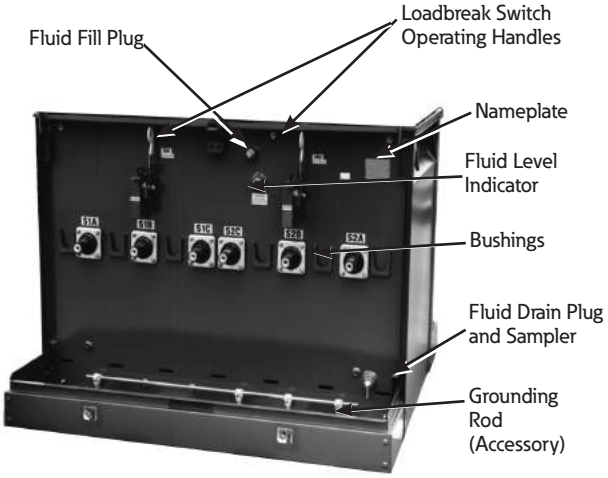

Figure 2. Source-side switchgear components

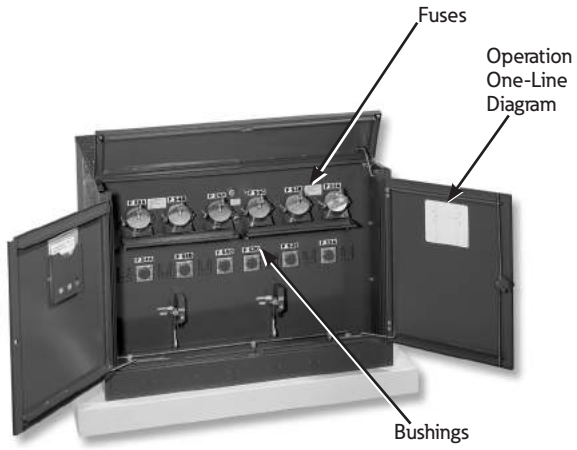

Figure 3. Tap-side switchgear components

Bushings

If 600 A deadbreak aluminum type bushings are furnished, they conform to IEEE Std 386™-1995 standard.

200 A interfaces are provided as either 200 A bushing wells or 200 A one-piece 35 kV bushings; both conform to IEEE Std 386™-1995 standard.

Bushings are mounted in-line and located a minimum of 24 inches (610 mm) above the pad.

Cabinet construction

RVAC switchgear features deadfront, low-profile tamper resistant construction. It is suitable for operation in areas subject to excessive moisture, occasional flooding, and blowing snow. Cabinets meet the enclosure security requirements of IEEE Std C57.12.28™-2005 standard.

Note: Occasional flooding applies only to the RVAC unit and not any controls or motors attached to the unit. Per IEEE Std 37.74™-2003 standard, submersible units are able to operate at their standard ratings provided the water head does not exceed 3 m above the top of the switchgear during occasional submersion.

Side-swing doors are provided with door stays and fitted with stainless steel hinges. On units wider than 46 inches (1168 mm), split doors are provided to allow easy operation by one person. Top-swing doors can be provided as an option. Both source and tap doors can be fully open at the same time. Each door has a floating lock pocket with padlock provisions and penta-head silicon bronze door bolt.

Tank construction is of 7- or 10-gauge steel, and cabinets are made of 12- or 13-gauge steel. Recessed lifting provisions are provided at each corner of the tank for a balanced lift.

⚠ WARNING

Hazardous voltage. Switchgear doors must be closed and padlocked at all times when unattended. Failure to comply can result in death, severe personal injury, and equipment damage. G168.1

Padlocking provisions

Standard features

Standard features (**Figure 2** and **Figure 3**) include a fluid level indicator on each front plate, automatic pressure-relief valve, operation one-line diagrams on the doors, fluid fill plug, fluid drain and sampler, and a standoff bracket for each bushing. Standard grounding provisions include a 1/2-13 UNC stainless steel ground nut for each bushing.

Finish

RVAC switchgear is finished in a green color which conforms to Munsell 7GY 3.29/1.5 Green.

The coating conforms to the following specifications: IEEE Std C57.12.28™-2005 standard, ASTM B1117 1000-hour 5% salt spray corrosion test, ASTM D2247 1000-hour humidity test, ASTM G53 500-hour ultraviolet accelerated weathering test, and ASTM D2794 impact test.

Nameplate

Prior to installation, be sure to check the switchgear nameplate (shown in **Figure 2**) to verify that the voltage and current ratings are correct for the system on which the switchgear is to be installed.

Weight

The weight of the switchgear is shown on the nameplate. Make sure to use lifting equipment with adequate capacity to safely handle the switchgear.

Switch operating handles

RVAC switchgear is equipped with clampstick operable loadbreak switch handles that can be mounted on the source- and tap-side front plates of the unit. The switch operating handle (shown in **Figure 4**) provides convenient push-to-close and pull-to-open operation. The handle can be padlocked in either the open or closed position.

⚠ WARNING

Hazardous voltage. Never rely on the open position of the operating handle or the contact position indicator; it does not ensure that the line is de-energized. Follow all locally approved safety practices. Failure to comply can result in contact with high voltage, which will cause death or severe personal injury. G123.1

Side-mounted switch operating handles and a motor operator can also be provided as accessories.

The ratings for the RVAC switchgear are shown in **Table 1**.

Figure 4. Switch operating handle shown padlocked in the open position

Special certifications

Non-fused units can be provided with a UL® listing and labeling depending on the features specified. Please ensure appropriate labeling is provided prior to installation for instances where a UL® listing is required.

Ratings

Table 1. Electrical ratings

Nominal Voltage	5 kV	15 kV	25 kV	35 kV
Maximum Design Voltage, kV	15.5	15.5	27	38
BIL, kV	95	95	125	150
1-Minute Withstand (60 Hz) Switch* and Terminators, kV	35	35	60	70
Continuous Current (max), A	600	600	600	600
Load Switching, A	600	600	600	600
Momentary Current 10 cycles (sym.), kA	12	12	12	12
3 Shot Fault Making (sym./asym.), kA	12/20	12/20	12/20	12/20
* The withstand rating of the switch is higher than that of the connectors (IEEE Std C37.74™-2003 standard).				

Installation procedure

⚠ WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage. G102.1

1. Check the fluid level. Make sure the fluid in the switchgear tank is at the proper level by checking the fluid level indicator on the front plate. Two-sided units have fluid level indicators on both source-side and tap-side front plates. Make sure both are at the proper level.
2. Test the fluid dielectric strength and moisture content. If the switchgear has been stored for some time or is being relocated, perform these tests on the fluid in accordance with ASTM-approved testing procedures.

⚠ WARNING

This equipment relies on dielectric fluid to provide electrical insulation between components. The dielectric strength and moisture content of the fluid must be checked on a regular basis, as part of the routine maintenance inspection, to ensure that it is at or above minimum dielectric requirements and below the maximum moisture content. Use of this equipment with dielectric fluid that does not meet requirements can result in internal flashovers that will damage the equipment and can result in death or serious injury. G107.3

NOTICE

The use of Envirotemp™ FR3™ dielectric fluid is limited to a minimum operating temperature of 32 °F (0 °C). Failure to comply can result in equipment misoperation. T374.0

   a. On new equipment, the fluid must have a minimum dielectric strength of 26 kV.
   b. If the dielectric strength of the fluid is less than 26 kV, process or replace the fluid to restore its dielectric strength to an acceptable minimum level.
   c. Refer to the **Fluid testing** section of this manual for service recommendations based on the moisture content of the fluid.
   d. For additional information on fluid specifications and tests, refer to Reference Data TD280022EN and to the **Fluid testing** section of this manual.

3. Check the nameplate ratings. Make sure the ratings on the switchgear nameplate are correct for the planned installation.

NOTICE

Equipment damage. Never place jacks, tackle or other attachments under the unit for the purpose of lifting. Failure to comply will result in damage to the equipment. T240.0

NOTICE

Follow all locally approved safety practices when lifting and mounting the equipment. Use the lifting lugs provided. Lift the unit smoothly and do not allow the unit to shift. Improper lifting can result in equipment damage. G106.2

4. Mount the switchgear on the concrete pad.
   a. The switchgear must be installed on a level concrete pad or structure that has been designed to support the size and weight of the unit.
   b. The switchgear must be hoisted only by the recessed lifting provisions provided at the four corners of the tank. Suitable lifting straps must be used to prevent damage to the switchgear housing.
   c. The switchgear must be anchored to the concrete pad. Anchor the pad using the mounting cleats provided or using other suitable mounting hardware.

⚠ WARNING

Hazardous voltage. Solidly ground all equipment. Failure to comply can result in death, severe personal injury, and equipment damage. T223.2

5. Ground the switchgear. Switchgear must be adequately grounded. Install a permanent, low resistance ground connection to the switchgear tank. Grounding provisions are provided near the bottom of the tank.

⚠ CAUTION

Equipment misoperation. Always use compatible fuses. Follow all locally approved operating practices whenever changing fuses. Wet-well fuse assemblies must be re-fused and operated in accordance with the instructions provided by the fuse manufacturer. Failure to install the proper fuse can result in switchgear misoperation, equipment damage, and personal injury. G260.0

6. Assemble and install fuses. If the switchgear is equipped with fuses, be sure that the fuses are rated correctly for the installation and that they are properly installed. Further verify that the fuses are compatible with the wetwell fuse holder(s) supplied with the switchgear. Refer to **Figure 5** to ascertain fuse/wetwell fuse holder compatibility.

   Note: Fuses should be applied on solidly grounded wye systems only. Consult factory for fuse application on delta systems.

7. Make the high-voltage line connections.
   a. Prior to making connections, make sure that the source-side and tap-side cable elbows are correctly identified and that the switchgear unit is oriented correctly for the installation. The source leads must connect to the source bushings of the unit, and the tap leads must connect to tap bushings of the unit.

b. Refer to the operation one-line diagrams located inside the doors of the switchgear, and make only those elbow connections shown. The voltage and current ratings shown on the nameplate must be correct for the planned installation.

c. All cables not in use must be properly isolated from all other leads. Unused leads must be parked on standoff insulators or properly grounded using an elbow grounding kit.

d. All bushings not in use must be insulated with properly rated isolating caps. It is also recommended that bushing elbow studs be pre-installed for future use. The studs must be torqued into place, and this is best done before the equipment is energized.

⚠ WARNING

Hazardous voltage. Switchgear doors must be closed and padlocked at all times when unattended. Failure to comply can result in death, severe personal injury, and equipment damage. G168.1

IMPORTANT

Do not use the red shipping covers on unused bushings. They are not designed for permanent use on energized equipment.

8. Close the door and apply a padlock to secure the switchgear from unauthorized access.

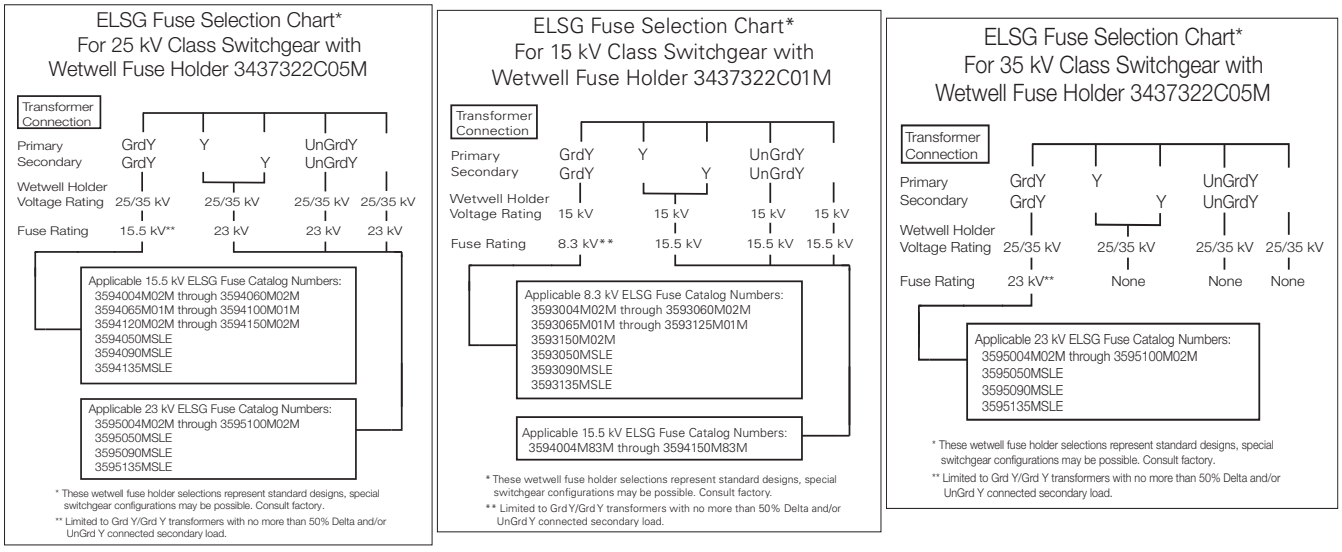

Figure 5. Fuse/wetwell fuse holder compatibility charts

Table 2. Fuse/Wetwell Fuse Holder Compatibility

Fuse Rating	Nominal Fuse Length (in.)	Standard Wetwell Holder Assembly
15 kV	19	3437322C01M
25 kV	21	3437322C05M*
35 kV	21	3437322C05M*

Operation

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Hazardous voltage. Never rely on the open position of the operating handle or the contact position indicator; it does not ensure that the line is de-energized. Follow all locally approved safety practices. Failure to comply can result in contact with high voltage, which will cause death or severe personal injury. G123.1

WARNING

Do not operate this equipment out of insulating fluid. Operation out of insulating fluid will result in internal flashovers that will damage the equipment and can cause death or severe personal injury. G104.2

Application

This switchgear must only be applied within its specified ratings. At no time should the continuous total load exceed the ratings shown on the nameplate.

The switchgear must always be filled to the correct level with insulating fluid.

Switch operating handles

WARNING

Hazardous voltage. Never rely on the open position of the operating handle or the contact position indicator; it does not ensure that the line is de-energized. Follow all locally approved safety practices. Failure to comply can result in contact with high voltage, which will cause death or severe personal injury. G123.1

WARNING

Hazardous voltage. Always use a clampstick when working with this equipment. Failure to do so could result in contact with high voltage which will cause death or severe personal injury. G108.1

The push/pull loadbreak switch operating handles (shown in **Figure 4**) are typically located on the front plates of the unit and can be operated by a clampstick. Always follow locally approved operating practice when working with this equipment.

Fuses

CAUTION

Equipment misoperation. Always use compatible fuses. Follow all locally approved operating practices whenever changing fuses. Wet-well fuse assemblies must be re-fused and operated in accordance with the instructions provided by the fuse manufacturer. Failure to install the proper fuse can result in switchgear misoperation, equipment damage, and personal injury. T260.0

Follow locally approved operating practice whenever changing fuses. Verify that the replacement fuses are compatible with the fuse holder(s) supplied with the switchgear. Refer to **Figure 5** to ascertain fuse/wetwell fuse holder compatibility.

Note: Fuses should be applied on solidly grounded wye systems only. Consult factory for fuse application on delta systems.

WARNING

Hazardous voltage. This equipment must be de-energized and grounded prior to conducting any maintenance, dielectric fluid sampling, or dielectric fluid filling procedures. Failure to comply can result in death or severe personal injury. T239.2

Fuse changeout procedure

1. Remove the loadbreak elbow and park the elbow on the parking stand.
2. Cap the bushing with an insulated bushing cap. If the unit is not equipped with drip shields, cover the bushings and elbows to prevent fluid from dripping on them.
3. Follow the instructions provided with the replacement fuses. Remove the expended fuse, and install the replacement fuse.
4. Remove the insulating cap from the bushing. Remove the loadbreak elbow from the parking stand, and re-install the elbow on the bushing.

Maintenance information

⚠ WARNING

This equipment relies on dielectric fluid to provide electrical insulation between components. The dielectric strength and moisture content of the fluid must be checked on a regular basis, as part of the routine maintenance inspection, to ensure that it is at or above minimum dielectric requirements and below the maximum moisture content. Use of this equipment with dielectric fluid that does not meet requirements can result in internal flashovers that will damage the equipment and can result in death or serious injury. G107.3

⚠ CAUTION

This equipment requires routine inspection and maintenance to ensure proper operation. If it is not maintained, it can fail to operate properly. Improper operation can cause equipment damage and possible personal injury. G105.1

The RVAC switchgear is a deadfront design. All live parts are contained within the sealed tank enclosure. A routine maintenance inspection program is required to ensure proper operation.

It is necessary to establish and maintain a regular schedule for sampling and testing the insulating fluid to ensure proper dielectric strength, moisture content, and fluid levels in the switchgear.

Maintenance inspection procedure

The RVAC switchgear must be de-energized, grounded, and removed from service before conducting any maintenance, fluid sampling, or fluid-filling procedures.

⚠ WARNING

Hazardous voltage. This equipment must be de-energized and grounded prior to conducting any maintenance, dielectric fluid processing, or dielectric fluid filling procedures. Failure to comply can result in death or severe personal injury. T239.2

1. De-energize and ground the switchgear.
2. Reduce the internal tank pressure to 0 PSIG. The switch is equipped with a pressure relief valve that opens at 5 PSIG and closes at 3 PSIG. To relieve internal tank pressure, pull the ring on the pressure relief valve to reduce the pressure to 0 PSIG.
3. Perform the following inspections:
   - **Check fluid level** – refer to the **Fluid filling procedure** in this manual if fluid levels are low.

     Note: When the switchgear is installed on a level surface, the ball float in the fluid level indicator sight gauge on the front plate will be at the top of the site glass when fluid temperature is at 68 °F (20 °C) or higher. Colder temperatures and/or an uneven pad will result in the gauge indicating less than maximum fluid levels.
   - **Inspect tank cover** – the tank cover shoudl be free of chipped paint and corrosion. If a crack or hole is found, obtain a fluid sample and check moisture content and dielectric strength immediately. If a replacement cover or cover gasket is needed, refer to the **Replacement parts** section of this manual.
   - **Inspect tank exterior for fluid leaks** – there should be no fluid staining on or near the tank seals at the bushings, visible break windows, and other gasketed seals on the front plates. If fluid stains are present, check the fluid level, and see the **Fluid filling procedure** if more fluid is required. Bushing leaks may be sealed by re-applying torque to the bushing clamp hardware (5 to 6 ft-lbs). Do NOT tighten visible break window hardware. First check for cracks in the window. If found order replacement window kit. If no cracks, tighten hardware (95 to 105 in-lbs).
   - **Check bushing and elbow conditions** – elbow connections should be secure and free from unusual wear. Record abnormalities and contact the manufacturer with any concerns.
   - **Inspect tank and cabinets for corrosion or unusual signs of wear** – contact the manufacturer with any concerns.
   - **Functionality check** – verify that cabinet doors close and lock properly. Verify manual operation of each switch and VFI. Contact the manufacturer with any concerns.
   - **Record any other unusual wear/abnormalities** – contact the manufacturer with any concerns.

Internal inspection and bushing replacement

If internal damage is suspected or if the switch must be opened for inspection, the following procedure is recommended.

⚠ WARNING

Hazardous voltage. This equipment must be de-energized and grounded prior to conducting any maintenance, dielectric fluid processing, or dielectric fluid filling procedures. Failure to comply can result in death or severe personal injury. T239.2

1. De-energize and ground the switchgear.
2. Draw a fluid sample. Use the drain plug with sampler at the bottom of the tank. If moisture is found in the tank, refill with clean, dry insulating fluid after maintaining the unit.

3. Clean off the tank cover. Take appropriate precautions to keep dirt, moisture, and any other foreign matter from entering the tank and contaminating the insulating fluid.
4. Remove the tank cover.
5. Inspect for internal damage. Check inside the switchgear for broken leads and loose parts. If any bushings, switches, or fuse holders are damaged, repair as required.
6. Bushing repairs. The bushings can be changed through the tank cover.
   a. Lower the fluid level as needed to make repairs. Store the drained fluid according to locally approved procedures and in a sealed, clear, and dry container.
   b. Disconnect the internal cables and leads.
   c. Unbolt the external steel clamps from the front plate and replace any damaged bushings, bushing wells, fuse holders, or switches with new parts and a new gasket. Be sure to position the gasket so that it will seal properly.
7. Replace tank cover. New gaskets should be used when re-installing the cover. Refer to the **Replacement parts** section of this manual for further instructions.
8. Refill with insulating fluid. Refer to the **Fluid filling procedure** and **Fluid sampling procedure** sections in this manual, and make sure that the unit is properly filled to the 68 °F (20 °C) fluid fill level with clean, dry insulating fluid.
9. Close and lock the doors of the switch, after repairs are complete, in order to prevent unauthorized access and accidental contact with high-voltage lines.

Insulating fluid maintenance

⚠ WARNING

This equipment relies on dielectric fluid to provide electrical insulation between components. The dielectric strength and moisture content of the fluid must be checked on a regular basis, as part of the routine maintenance inspection, to ensure that it is at or above minimum dielectric requirements and below the maximum moisture content. Use of this equipment with dielectric fluid that does not meet requirements can result in internal flashovers that will damage the equipment and can result in death or serious injury. G107.3

To assure trouble-free operation of this equipment, a regular schedule of fluid testing and fluid maintenance is required. A routine fluid testing and maintenance schedule is necessary to monitor changes that occur in the fluid as a result of normal operation and to detect abnormal conditions that may occur.

Maintaining a record of this test data will help in assessing the condition of the fluid over time.

Frequency of maintenance

The insulating fluid should be initially tested within two years of the installation of the equipment. That test will yield information required to establish a baseline reference for observing trends in the unit's normal operation and to diagnose any fault conditions that may be present.

After the initial fluid testing and inspection, type RVAC switchgear should be maintained every two years. The scheduled maintenance should include a physical inspection of the unit, a fluid level check, and fluid testing as described in the **Fluid testing** section of this manual.

Types of fluid samples

The unit must be de-energized before withdrawing a fluid sample. Withdrawing a fluid sample from a unit that has a critically low fluid level could result in flashover and unit failure when the unit is re-energized. Never energize this equipment without ensuring that it is filled to the proper fluid level with clean, dry insulating fluid.

The fluid sampling procedure requires that two types of fluid samples be taken.

1. A bulk fluid sample, to be used for general fluid tests. Approximately one liter (one quart), taken in accordance with ASTM D923 (latest revision), is required.
2. A "gas-tight" fluid sample, taken in accordance with ASTM D3613 (latest revision), for diagnosis and fault gas analysis.

Fluid sampling procedure

⚠ WARNING

Hazardous voltage. This equipment must be de-energized and grounded prior to conducting any maintenance, dielectric fluid processing or dielectric fluid filling procedures. Failure to comply can result in death or severe personal injury. T239.2

Use the following fluid sampling guidelines to prevent contamination and to safely extract fluid samples:

1. De-energize and ground the switchgear prior to sampling fluid.
2. Where local governing authorities allow access to energized equipment, the following precautions must be taken:

⚠ DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

⚠ WARNING

Hazardous voltage. Always use a shotgun stick when working with this equipment. Failure to do so could result in contact with high voltage, which will cause death or severe personal injury. G108.0

a. A hotstick tool capable of uncapping, opening and collecting fluid from the fluid sampling valve should be used to keep personnel away from the energized bushings.

⚠ WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage. G102.1

b. Personnel authorized to access energized equipment must be properly trained in locally approved safety procedures and utilize locally approved personal protection equipment.

⚠ WARNING

Do not operate this equippment if energized parts are not immersed in dielectric fluid. Operation when parts are not properly immersed in dielectric fluid may result in internal flashovers that will damage the equipment and can cause death or severe personal injury. G104.4

c. Check switchgear fluid level prior to extracting a fluid sample. If the fluid level is low, do not attempt to extract a sample.

d. A means to plug the fluid sampling valve should be available in the event the valve is unable to close and fluid continues to flow.

⚠ WARNING

The switchgear tank must have neutral or positive internal pressure prior to extracting a fluid sample. Negative internal pressure may cause air to enter the tank during sampling which can reduce the fluid's dielectric strength. This may result in internal flashovers that will damage the equipment and can cause death or severe personal injury.

e. Neutralize internal tank pressure by pulling on the pressure relief device ring prior to opening the sampling valve.

3. Fluid samples should only be extracted when fluid temperatures are 59 °F (15 °C) or higher. Moisture analysis results may not accurately reflect the amount of moisture inside the switchgear if samples are extracted when the fluid is below this temperature.

4. The container temperature must be equal or greater than the ambient air temperature to prevent condensation after opening the container.

5. Never sample fluid during inclement weather (rain, sleet, or snow). The fluid sample could be contaminated by moisture.

6. Always use the drain plug and sampler located near the bottom of the front plate of the tank to extract fluid samples.

7. Use only approved, new fluid-resistant tubing (nitrile or silicone rubber) for sampling the fluid. Use of previously used tubing or incompatible materials can result in contamination of the fluid sample. Tube ID required for the fluid sampling valve is 5/16 inch.

8. The fluid sampling valve and cap should be "finger tight". Use lineman's pliers or tongue and groove pliers to loosen the cap and/or valve if needed. Fluid should start to flow from the valve after 2 – 3 counterclockwise turns.

   Note: Do not attempt to turn the valve more than 5 full turns. The valve will completely uncouple after 8 turns and allow fluid to flow freely. If fluid does not flow from the valve after 5 turns and the tank has been de-pressurized, re-tighten the valve, and contact the manufacturer for further instructions.

9. Using a disposable container (not the container that will be sent to the lab), extract one quart of fluid from the sample valve and discard it as waste.

10. Use only glass or extruded metal (solderless) containers to store fluid for laboratory analysis. Plastic containers must not be used as water vapor can permeate through plastic and alter the results.

11. If dissolved gas analysis is required, the sample must be collected using a glass syringe designed for this purpose.

12. Label the sample container with the switchgear serial number, sample date, and temperature at the time of extraction.

13. Rinse sample container with fluid before extracting a sample. Fill sample container with fluid to 1/3 of the container volume, rinse, and discard rinse fluid.

14. Always fill sample containers to the top to prevent ambient air from altering the moisture content of the sample. Leave about one inch of air space in the container to account for thermal expansion.

15. Retighten sampling valve to "finger tight" plus a 1/4 turn. Reinstall cap, and leave it "finger tight".

16. Upon completion of sampling, recheck the switchgear fluid level, and add fluid if required.

Fluid filling procedure

The fluid level indicator sight gauge on the front plate of the switchgear provides a convenient method to check the fluid level. The indicator provides the correct level for fluid at 68 °F (20 °C).

If the fluid level is low, use the following procedure to add dry insulating fluid to fill the unit to the correct level:

1. De-energize and ground the switchgear prior to fluid filling.
2. Use only insulating fluid that complies with ASTM D3487 (latest revision). The fluid must have a minimum dielectric strength of 30 kV when tested per ASTM D877. Never use fluid that contains PCBs (Polychlorinated Biphenyls).
3. Use only transfer equipment with fluid resistant materials for hoses, seals, valves, pumps, etc. Failure to use proper transfer equipment can result in contamination of the fluid.
4. When adding fluid, use the fluid fill plug located on the front plate of the unit.
5. Avoid getting gas bubbles in the fluid during fluid filling. Gas bubbles in the fluid can reduce its dielectric strength.
6. When filling is complete, check the fluid level gauge to verify that the fluid is filled to the correct level. Allow at least one hour for gas bubbles to dissipate prior to energizing the unit.
7. Install fluid fill plug, and energize the unit.
8. Record the date and the amount of fluid needed to refill the unit, and retain the information with the permanent maintenance record of the unit.

Fluid testing

The insulating fluid in this equipment has been tested to meet the requirements of ASTM D3487, and it has been processed to remove moisture and dissolved gases. It must be tested on a regular basis in order to ensure that it meets those requirements.

Two types of fluid tests are required to evaluate and maintain the quality of the insulating fluid. They are: general fluid tests and dissolved gas analysis.

General fluid tests

The general fluid test requirements are taken from those described in IEEE Std C57.106™-1991 standard, IEEE Guide for Acceptance and Maintenance of Insulating Oil in Equipment. The required fluid tests and acceptable limits for service-aged fluid are shown in **Table 3** and **Table 4**.

Fluid test results that do not meet the requirements may indicate a problem with either the fluid or the unit. Contact your Eaton representative for technical assistance.

Table 3. Test limits for service-aged fluid

Fluid Test	Method	Requirement
Dielectric Strength	D877	26 kV minimum
Acid Number*	D974	0.20 mg KOH/g maximum
Dissipation Factor*	D924	1.0% maximum
Interfacial Tension*	D971	24 mN/m minimum
Moisture Content	D1533	See **Table 4**
*Requirements shown are for mineral oil only. Service-aged limits for ester fluids have not been established at the time of this publishing.		

Table 4. Service recommendations for insulating fluid moisture contents

Fluid Type	Moisture Content (ppm)	Service Recommendation
Mineral Oil	< 25	Continue with Eaton recommended maintenance schedule (inspection and sampling every 2 years).
	25 – 35	Obtain another fluid sample for moisture analysis in 6 months to determine if moisture levels are rising. Refer to the **Fluid sampling procedure** section in this manual. If moisture levels increase, determine leak point and repair. Process or replace the fluid if water conent has exceeded 35 ppm.
	> 35	De-energize the equipment immediately. Take another sample and verify results. If verified, process or replace the fluid before returning to service.
FR3	< 400	Continue with Eaton recommended maintenance schedule (inspection and sampling every 2 years).
	400 – 600	Obtain another fluid sample for moisture analysis in 6 months to determine if moisture levels are rising. Refer to the **Fluid sampling procedure** section in this manual. If moisture levels increase, determine leak point and repair. Process or replace the fluid if water conent has exceeded 600 ppm.
	> 600	De-energize the equipment immediately. Take another sample and verify results. If verified, process or replace the fluid before returning to service.
E200	< 800	Continue with Eaton recommended maintenance schedule (inspection and sampling every 2 years).
	800 – 1200	Obtain another fluid sample for moisture analysis in 6 months to determine if moisture levels are rising. Refer to the **Fluid sampling procedure** section in this manual. If moisture levels increase, determine leak point and repair. Process or replace the fluid if water conent has exceeded 1200 ppm.
	> 1200	De-energize the equipment immediately. Take another sample and verify results. If verified, process or replace the fluid before returning to service.

Dissolved gas analysis

Dissolved gas analysis is a useful technique for diagnosing abnormal conditions and assessing the normal condition of fluid in fluid-filled equipment. The method employed is ASTM D3612 which is used in conjunction with IEEE Std C57.104™-2008 standard, IEEE Guide for the Detection and Determination of Generated Gases in Oil Immersed Transformers and their Relations to the Serviceability of the Equipment. **Table 5** provides recommendations on dissolved gas levels in fluid insulated switchgear.

Table 5. Dissolved gas levels in insulating fluid

Acetylene Level C_2H_2	Total Combustible Gas	Required Action
Less than 35 ppm	Less than 500 ppm	**Normal Level** Resample per routine maintenance schedule
35–50 ppm	500–1000 ppm	**Caution Level** Resample at 3–6 months to establish trend; maintain fluid if gas levels increase to hazardous level.
More than 50 ppm	More than 1000 ppm	**Hazardous Level** Remove unit from service and maintain the fluid.

Replacement parts

Eaton's replacement parts for pad-mounted switchgear units are available through the factory Service Department. To order replacement parts, refer to the nameplate and provide the product type, serial number, catalog number, voltage rating, and a description of the part. Contact your Eaton representative for additional information and ordering procedures. The following documents are also available for common field repairs and procedures:

- MN285009EN – Cover gasket replacement, cover installation, leak check procedures and fluid sampling procedures.
- MN285007EN – Visible break window replacement procedure.

Testing

All pad-mounted switchgear is carefully tested and adjusted at the factory to operate according to published data. Well-equipped test facilities, a detailed testing procedure and thoroughly trained personnel assure accurately calibrated equipment. Each unit leaves the factory ready for installation.

Pre-installation testing is not necessary. However, should verification of switch operation prior to installation be required, the vacuum interrupters can be tested using the following procedure.

High-potential withstand testing of vacuum interrupters

High-potential withstand tests can be performed to check the vacuum integrity of the interrupters used in RVAC vacuum loadbreak switches.

Safety requirements

To prevent accidental contact with high-voltage parts, the switchgear and high-voltage transformer must be placed in a suitable test cage and all proper grounding procedures must be observed.

⚠ WARNING

Hazardous voltage. The switchgear (apparatus and control) and high-voltage transformer must be in a test cage or similar protected area to prevent accidental contact with the high-voltage parts.

Solidly ground all equipment. Failure to comply can result in death, severe personal injury, and equipment damage. T221.5

⚠ CAUTION

Radiation. At voltages up to the specified test voltages, the radiation emitted by the vacuum interrupter is negligible. However, above these voltages, radiation injurious to personnel can be emitted. See *Service Information S280-90-1, Vacuum Interrupter Withstand Test Voltage Ratings Information* for further information. G109.2

With the vacuum interrupters open (manual operating handles in the Open position), perform a high-potential test for one minute across each open vacuum interrupter assembly at the voltages shown in **Table 6**. The interrupter should withstand the test voltage and should not load down the source.

Table 6. High-potential withstand test voltages

RVAC Voltage Rating (kV)	High-Potential Test Voltages
15	25.5 kV rms or 39.75 kV DC
25	30.0 kV rms or 58.5 kV DC
35	52.5 kV rms or 77.25 kV DC

This page is intentionally left blank.

This page is intentionally left blank.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Eaton.com/cooperpowerseries

Printed in USA
Publication No. MN285005EN
March 2018
KA20480369 Rev: 06

For Eaton's Cooper Power series product information, call 1-877-277-4636 or visit: www.eaton.com/cooperpowerseries.

Powering Business Worldwide