MITSUBISHI ELECTRIC

30SFMT40E-B
30SFMT40HE-B
30SFMT40LE-B
70SFMT40E-B
70SFMT40HE-B
70SFMT40LE-B

Type SFMT Circuit Breaker
Spring Mechanism
Single Break SF_6 Puffer Type

Instruction Book MEB0008

10/20

Mitsubishi Electric
Power Products, Inc.

520 Keystone Drive
Warrendale, PA 15086
(800) 624-7425

After Hours Support:
(866) 390-6487

Table of Contents

1 Introduction

1.1 Safety Advisory

Below are the definitions of several advisory terms used in this instruction book that signify potential hazards to those who come into contact with the high-voltage circuit breaker. These cautions must be heeded in order to ensure safe operation of the breaker. Whenever a safety advisory is detailed, care must be taken to heed the instructions detailed in the box. The subsequent page contains explanations of specific meanings of operative words used in the book.

DANGER	Indicates an imminently hazardous situation, which, if not avoided, will result in death or serious personal injury. This signal word is limited to the most extreme situations. This signal word is not used for property damage hazards unless personal injury risk appropriate to this level is also involved.
WARNING	Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. This signal word is not used to indicate property damage hazards unless personal injury risk appropriate to this level is also involved.
CAUTION	Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. This signal word is also used to alert against unsafe practices that may cause property damage.

Note: Indicates a statement of company policy directly or indirectly related to the safety of personnel or protection of property.

The following words are defined in this Instruction Book as:

may: This word is understood to be permissive.

shall: This word is understood to be mandatory.

should: This word is understood to be advisory.

MEPPI: Mitsubishi Electric Power Products, Inc.

1.2 General

The circuit breaker is one of the most important units in the electrical power system. The protection, stability, and continuity of the system depends on the circuit breaker's ability to switch line, load, and exciting currents, and to interrupt fault currents. The SF_6 gas circuit breaker assures the high level of performance required for reliable electrical system operation by taking advantage of the exceptional electrical insulating characteristics and arc quenching properties of sulfur hexafluoride (SF_6) gas.

The SF_6 gas insulating system further increases the reliability of the system while a single-pressure double-flow SF_6 gas puffer interrupter minimizes the number of moving parts and auxiliary systems in the circuit breaker.

1.3 Warning

⚠ WARNING

Proper installation and maintenance are necessary to ensure continued satisfactory operation. Circuit breakers are designed, developed, and tested to protect the circuit by interrupting currents up to and including the nameplate rating. Therefore, circuit breakers are by design a maximum rated device. As a responsible manufacturer, Mitsubishi Electric Power Products, Inc. can not recommend nor assume any liability for any breaker applied above the nameplate rating. Operating a breaker above the rating can cause catastrophic failure that could result in property damage and/or personal injury. Application of the breakers above the rating in so-called "emergency conditions" involves extreme risk and should only be considered when the consequences of a catastrophic failure are deemed acceptable.

MEPPI breakers have been designed and tested to meet the special and rigorous requirements of circuit breaker application. The reliability and safety in operation expected by the electric utility industry requires that circuit breaker parts and components be manufactured with high standards of dimensional and material control. Only renewal parts manufactured or authorized by MEPPI can assure reliable operation and minimize the risk of improper operation that could result in outages, damage, and/or injury. Deviations from recommended installation and maintenance procedures, or use of unauthorized parts or components, will void the warranty and other contractual responsibilities.

When communicating with MEPPI regarding the product covered by this instruction book, include the breaker type and serial number information listed on the nameplate attached to the equipment. Also, to facilitate replies when specific information is desired, state the problem and attendant conditions fully and clearly. For a permanent record, duplicate all nameplate data and retain in a convenient location.

1.4 Scope

This instruction book applies to the Mitsubishi Electric Power Products (MEPPI) Type SFMT circuit breaker. The Type SFMT is a dead tank, single-pressure, SF_6 gas-filled, puffer-type circuit breaker. The information provided in this book includes general description, installation procedures, and instructions for operation and maintenance. The figures included are representative of a circuit breaker. Each particular breaker may differ slightly from these figures.

Refer to the outline drawing, control schematic drawing, control wiring diagram, BCT wiring diagram, and the SF_6 gas schematic drawings for specific information regarding a particular breaker. The instructions in this book apply to circuit breakers with the following ratings:

Table 1.3 Rating

Type		Rated Voltage (kV)	Rated Interrupting Current (kA)	Rated Current (A)	Withstand Voltage (kV)		
					Impulse	S.S.	AC
30SFMT40E-B		38	40	1200/2000/3000/4000	200	–	80
30SFMT40HE-B Low Temperature Breaker with Tank Heaters		38	40	1200/2000/3000/4000	200	–	80
30SFMT40LE-B Low Temperature Breaker De-rated (Temperature Dependent)	-40°C	38	31.5	1200/2000/3000/4000	200	–	80
	-50°C	38	25	1200/2000/3000/4000	200	–	80
70SFMT40E-B		72	40	1200/2000/3000/4000	350	–	160
70SFMT40HE-B Low Temperature Breaker with Tank Heaters		72	40	1200/2000/3000/4000	350	–	160
70SFMT40LE-B Low Temperature Breaker De-rated (Temperature Dependent)	-40°C	72	31.5	1200/2000/3000/4000	350	–	160
	-50°C	72	25	1200/2000/3000/4000	350	–	160

2

Receiving, Handling, and Storage

2.1 Receiving

The circuit breaker is shipped completely assembled and plastic wrapped to protect the circuit breaker and keep it clean during transportation. The plastic wrap should be removed upon arrival, taking care not to damage the components underneath. Visual inspection of the circuit breaker is recommended to verify no damage occurred during transport.

All accessory items, tools and spare parts are packaged in plastic bags and boxes inside the breaker or are crated and shipped with the breaker. This material should be checked against the packing list and inspected for damage.

File a claim with the carrier and notify the MEPPI representative if there are any missing items, damage, or visible signs of rough handling.

2.2 Handling and Unpacking

The weight of the breaker is located in two locations: 1) on the outline drawing and; 2) on the rating nameplate. Use this weight to determine the crane capacity required to safely lift the breaker. Only use nylon slings, which are rated for the breaker weight, to protect the bushings and paint. The cabinet side slings may have to be shortened (or the opposite side lengthened) by several inches so the breaker will lift without tipping. See lifting tag for proper lift points. Do not remove any identification tags from the components until the installation is complete.

2.3 Storage

If installation is not scheduled immediately after receipt and inspection, store the circuit breaker in a protected area, preferably indoors. Store all crates, boxes, accessory items, tools and spare parts indoors in a dry, clean place.

Important Note: If indoor storage of the circuit breaker is not possible and it must be stored outdoors, take the following actions to avoid damage due to dirt and moisture. Storage where the circuit breaker is only 'under roof' is to be considered outdoor storage.

2.3.1 For Short Term Outdoor Storage Less than 3 Months

1. Remove protective shipping plastic wrap and tape from cabinet and unwrap any coverings from bushings.
2. If the circuit breaker is shipped on wooden runners/pallet, either remove the wooden runners/pallet and store on a hard surface (asphalt or similar), or leave the wooden runners/pallet on for storage on softer medium such as gravel, dirt, mud, or anywhere the breaker could sink.
3. If the circuit breaker is shipped with the structural leg pads already assembled (no wooden runners/pallet) store on a hard surface (asphalt or similar). If it must be stored on a soft surface, add wooden runners/pallet or similar to avoid possible sinking.
4. When storing outdoors, the circuit breaker cabinet must be stored at least 150 mm (6 in) off the ground to prevent water on the ground from entering the control compartment.

2.3.2 For Long Term Outdoor Storage Longer than 3 Months

1. When possible move the circuit breaker indoors to a heated area (air conditioning is not necessary) after 3 months.
2. If the circuit breaker must remain outdoors, in addition to steps 1 thru 4 above, ensure all cabinet doors are closed and energize at least one of the anti-condensation heaters after 3 months outside (reference schematic diagram for proper voltage requirements and connections). Remove any obstructions from cabinet vents to permit air circulation within the cabinet.

3

Description

3.1 Type SFMT Circuit Breaker

The type SFMT breaker is a dead tank, three-phase, mechanically-ganged, sulfur hexafluoride (SF_6) gas-insulated circuit breaker. The three phases (or pole units) and the control cabinet are mounted on a common frame. Pressurized sulfur hexafluoride gas insulates the energized parts inside the pole units from the grounded (or dead) tank. Bushing type current transformers are located outside of the tank between the bushing assembly and the interrupter. The SF_6 gas density switch is mounted to the outside of the center phase rear tank end cover in a common gas system configuration. Three SF_6 gas density switches are installed (one per phase) for independent gas system applications. The spring operating mechanism, monitor and breaker controls are located inside the control cabinet.

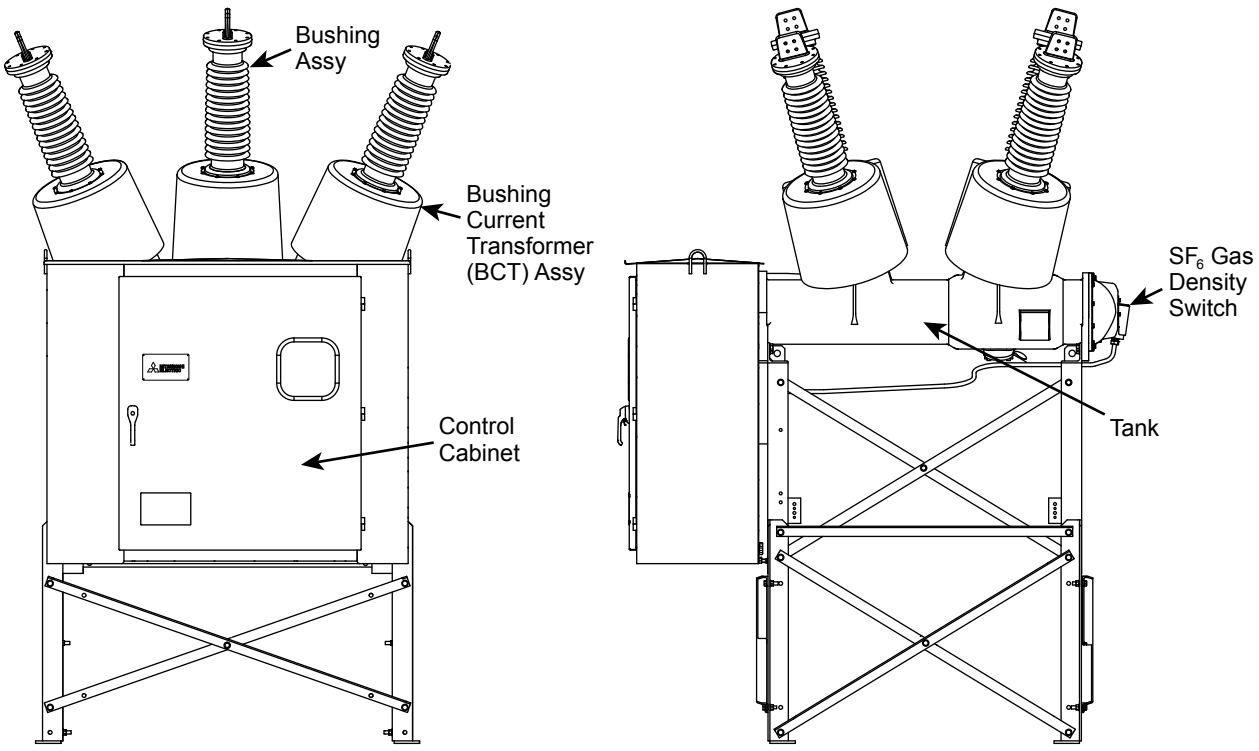


Fig. 3.1-1 Type SFMT Circuit Breaker

3.2 Sulfur Hexafluoride (SF_6) Gas

⚠ CAUTION	Arced SF_6 gas is accompanied by a strong, irritating odor that indicates toxic decomposition products. Avoid exposure to the arc products as they may be injurious. The arc powders react with moisture and, if inhaled, could cause irritation in the nose, throat, and lungs. Contact with body perspiration could cause skin irritation.

3.2.1 Description

Sulfur hexafluoride (SF_6) in its pure state is inert, nontoxic, odorless, nonflammable, and colorless. It has excellent arc quenching properties and thermal stability. The insulating property of SF_6 at atmospheric pressure is 2.5 times the dielectric strength of air. Sulfur hexafluoride liquefies at -26.8°C (-16.2°F) at the gas density normally used in this breaker type.

Arcing, which occurs during the normal operation of the circuit breaker, does not affect the insulating properties of the gas. The solid arc decomposition products--observed as a fine, gray powder--have equally good dielectric properties. Under normal conditions, the arced by-products are not sufficient to require any restriction in operation. If the tank is opened, remove the powder with a vacuum cleaner. The powder adsorbs moisture and becomes conductive if exposed to high humidity.

3.2.2 Precautions Handling Arced SF_6

A chemical breakdown of sulfur hexafluoride (SF_6) occurs when it is exposed to a very high temperature or electrical arc. The decomposition products, gas and fine powder may be toxic, strong irritants that attack the respiratory system.

A strong irritating odor is sufficient warning of the presence of the decomposition products. This would normally be present only after several major fault interruptions or an unusual arcing condition within the tank. If this condition occurs, thoroughly ventilate the area. If work is necessary within this environment prior to the area being adequately ventilated, use a self-contained breathing mask.

Gas that has been subject to heavy arcing and contains considerable decomposition products can be cleaned and reused. Circulate the gas through molecular sieve filters to remove the active products. Most gas service trailers are equipped with molecular sieve filters and provisions for circulating and cleaning the gas.

CAUTION	Make sure that the service trailer adsorbent dryer heaters are turned off, the heaters cooled, and all freshly activated adsorbent cooled to ambient temperature before introducing SF_6 to avoid an exothermic reaction.

Neutralize large accumulations of powder (solid decomposition products that result from abnormal arcing conditions) by mixing in a bucket with a solution of water and bicarbonate of soda. Safely dispose of the mixture.

3.2.3 Handling of Sulfur Hexafluoride

WARNING	Pure SF_6 gas does not support life. Do not enter any tank previously containing SF_6 that is not thoroughly ventilated. SF_6 gas is heavier than air and accumulates in low "pockets." Observe precautions in nearby "trenches" and "depressions" where the SF_6 gas can accumulate for short periods of time before dispersing into the atmosphere.

Sulfur hexafluoride comes in standard industrial type cylinders. The gas is stored in the cylinders at its vaporization pressure which, at 24°C (75°F), is 2,241 kPag (325 psig).

CAUTION	Any connection made to the cylinders must be suitable for 4,137 kPag (600 psig). A pressure regulator is required when connecting a cylinder to a gas tank fitting.

The circuit breaker may be filled with gas directly from the cylinders or from a gas service trailer. When transferring the gas from the cylinders, the process can be accelerated by keeping the cylinders warm to increase the rate of vaporization of the liquid SF_6. Electric cylinder warmers are available from the SF_6 supplier for this purpose.

⚠ WARNING

Do not allow the temperature of the SF_6 cylinders, either in processing as above or in storage, to exceed 51.7°C (125°F). Excessive temperature can result in overpressure and potential cylinder failure.

3.2.4 Greenhouse Gas

The Intergovernmental Panel on Climate Change has identified SF_6 as a greenhouse gas that may contribute to global warming. Therefore, do not deliberately release SF_6 gas into the atmosphere. Carefully follow the gas handling and leak detection procedures described in this instruction book to limit the amount of SF_6 gas released over the life of the circuit breaker. Used SF_6 gas, even after internal arcing, can be effectively filtered for recycling.

The handling of SF_6 should be completed by personnel qualified and trained in accordance with the instructions for the gas processing and handling equipment being used. For guidance on gas processing and handling, also see:

- C37.122.3-2011 IEEE Guide for Sulfur Hexafluoride (SF_6) Gas Handling for High Voltage (over 1000 VAC) Equipment.
- IEC 60480 Guidelines for the checking and treatment of sulfur hexafluoride (SF_6) taken from electrical equipment and specification for its reuse.
- IEC 61634 High-voltage switchgear and controlgear - Use and handling of sulfur hexafluoride (SF_6) in high voltage switchgear and controlgear.

3.2.5 Material Safety Data Sheet

For additional information concerning the composition and characteristics of sulfur hexafluoride gas, review the product safety sheet supplied by the manufacturer of the SF_6 gas. An MSDS is provided at the end of the appendices.

3.3 Pole Unit

Each pole unit consists of an SF_6 gas-filled tank that contains the interrupter assembly supported by insulators at each end (Fig. 3.3-1). Two bushing assemblies extend from the top of the tank and house the conductors that connect the interrupter assembly to the overhead line. The SF_6 gas in the pole unit is common to the tank and the bushing assemblies. An inspection cover at the end of the tank facilitates inspection and maintenance of the interrupters. In a common gas system configuration, all three pole units are connected using flexible stainless steel hose and the center phase pole unit inspection cover is equipped with an SF_6 gas valve and density monitoring system. An independent gas system configuration isolates the SF_6 gas in each pole unit and each inspection cover is equipped with an SF_6 gas valve and density monitoring system. An adsorbent assembly on the inside of the inspection cover maintains the dry atmosphere required inside the SF_6 gas. A non-fragmenting rupture disc assembly is mounted to the bottom of the tank to provide over-pressure protection.

O-rings at each end of the, in the shaft seal assembly through which the operating rod passes, and in the bushing assemblies seal the SF_6 gas in the tank.

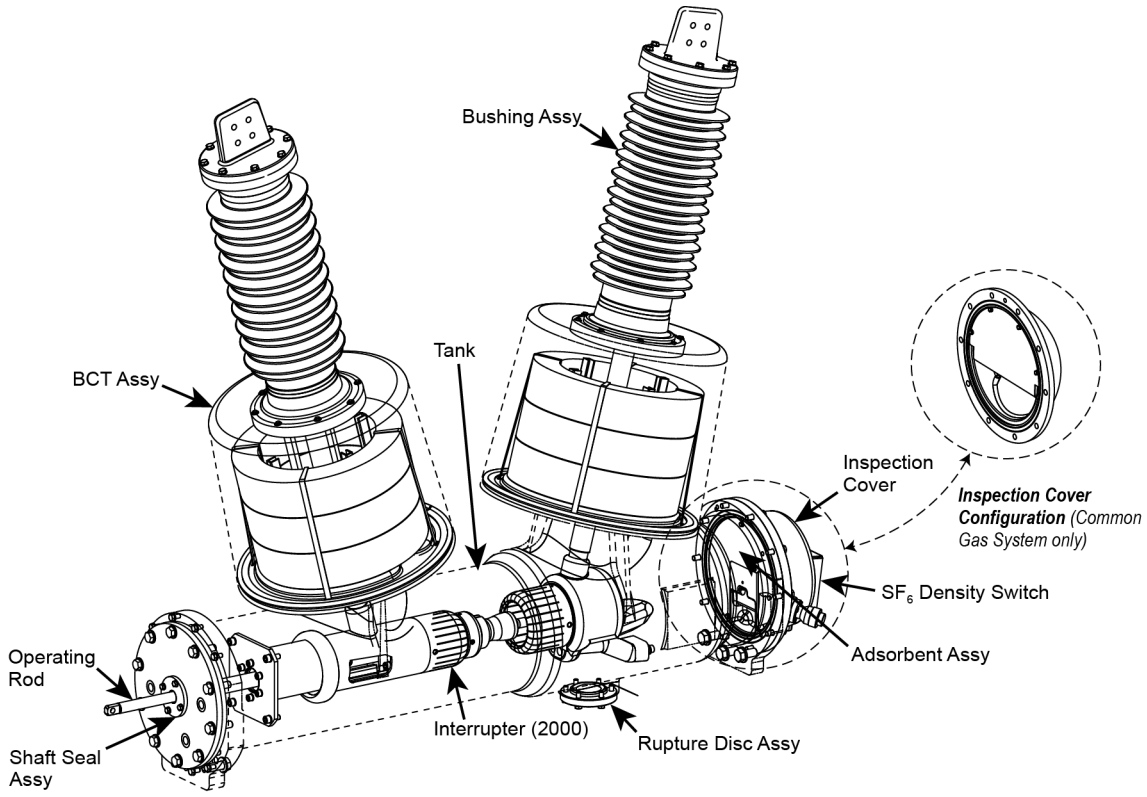


Fig. 3.3-1 Single Break Pole Unit

3.4 Interrupter

Support insulators locate the interrupter assembly concentrically in the tank (Fig. 3.4-1). An insulating rod connects the interrupter's puffer cylinder and moving main contacts to the three-phase linkage and spring mechanism.

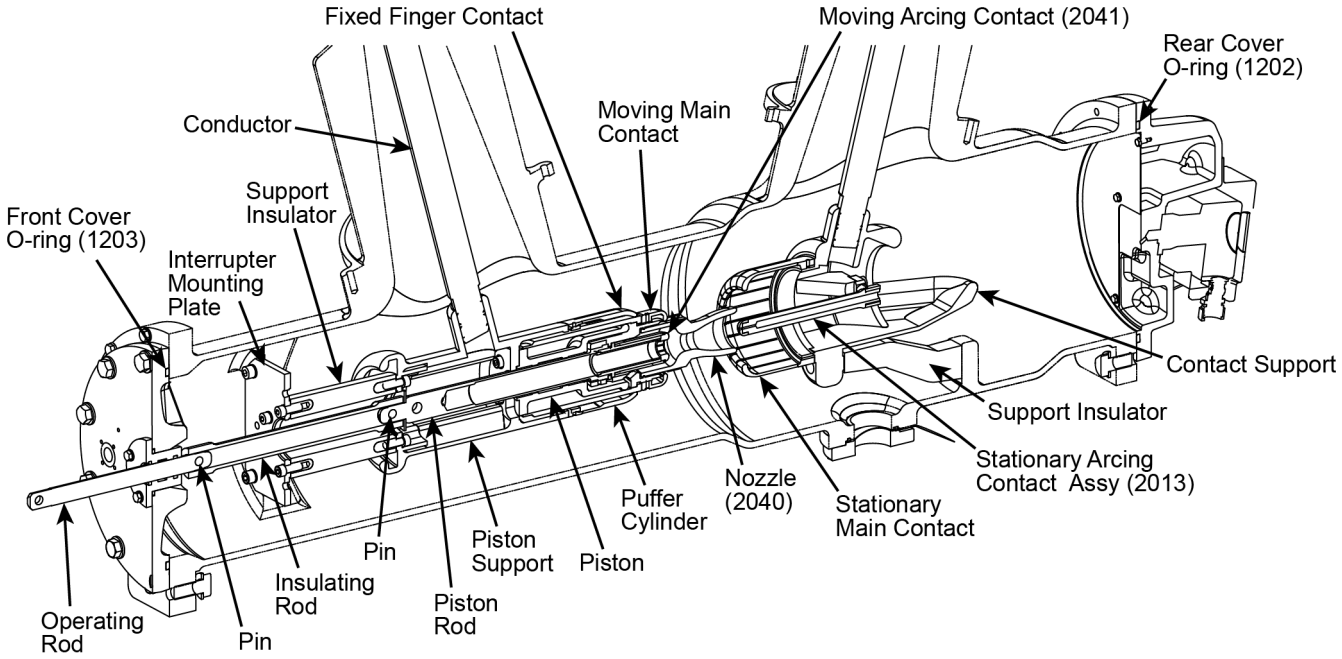


Fig. 3.4-1 Pole Unit and Interrupter

3.4.1 Closed Condition

The current flows from the bushing conductor through plug-in contacts in the bushing receptacle to the piston support, transfers to the puffer cylinder and moving main contact, transfers again to the stationary main contact, and continues through plug-in contacts to the opposite bushing conductor.

3.4.2 Open Operation

The insulating rod and piston rod assembly pulls the moving main contact assembly (consisting of the puffer cylinder, moving main contact, moving arcing contact, and nozzle) to the open position. The current transfers to the still-engaged moving arcing contact as the moving main contact separates from the stationary main contact after traveling a short distance from the closed position. An arc is generated across the arcing contacts inside the nozzle as the moving arcing contact separates from the stationary arcing contact.

The SF_6 gas within the puffer cylinder is compressed and blasted into the arcing region inside the nozzle as the moving main contact assembly travels to the open position. The compression of the gas between the moving cylinder and the stationary piston of the interrupter during the open operation generates the pressure required to blast the SF_6 gas against the arc and interrupt the current. This simple principle is shown in Fig. 3.4-2. The nozzle directs the gas along and across the arc as the gas flows into and through the hollow moving arcing contact and the piston rod.

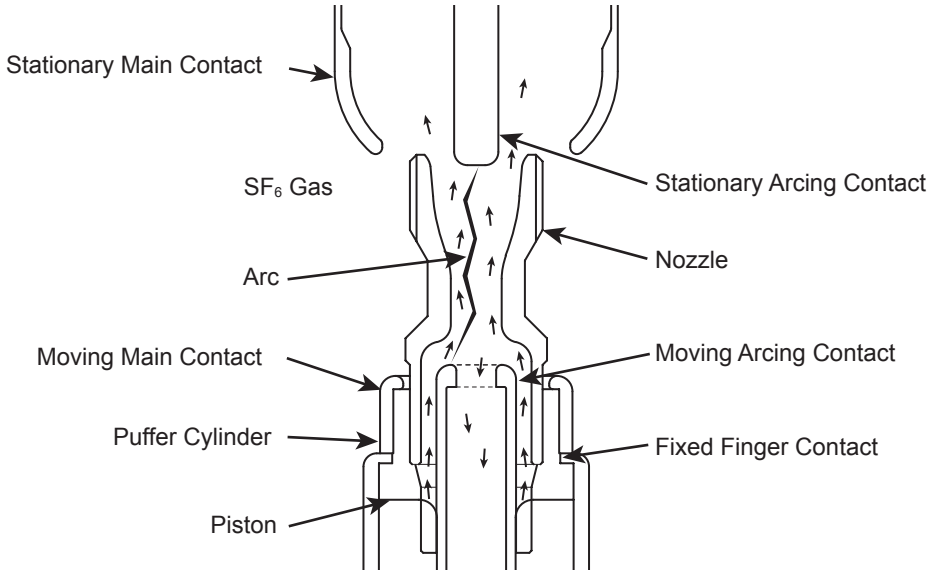


Fig. 3.4-2 Principle of Interrupting Unit

3.4.3 Close Operation

The insulating and piston rods, connected to the operating mechanism, push the moving main contact assembly to the closed position. The SF_6 gas flows back into the puffer cylinder during the close operation in preparation for the next open operation.

3.5 Mechanical Linkage

The operating rod of each interrupter passes through the shaft seal assemblies located in the front cover of the tank inside the cabinet. The rods connect to the lever assembly via the connecting links making all three pole units operate at the same time. The connecting rod attaches the lever assembly to the mechanism.

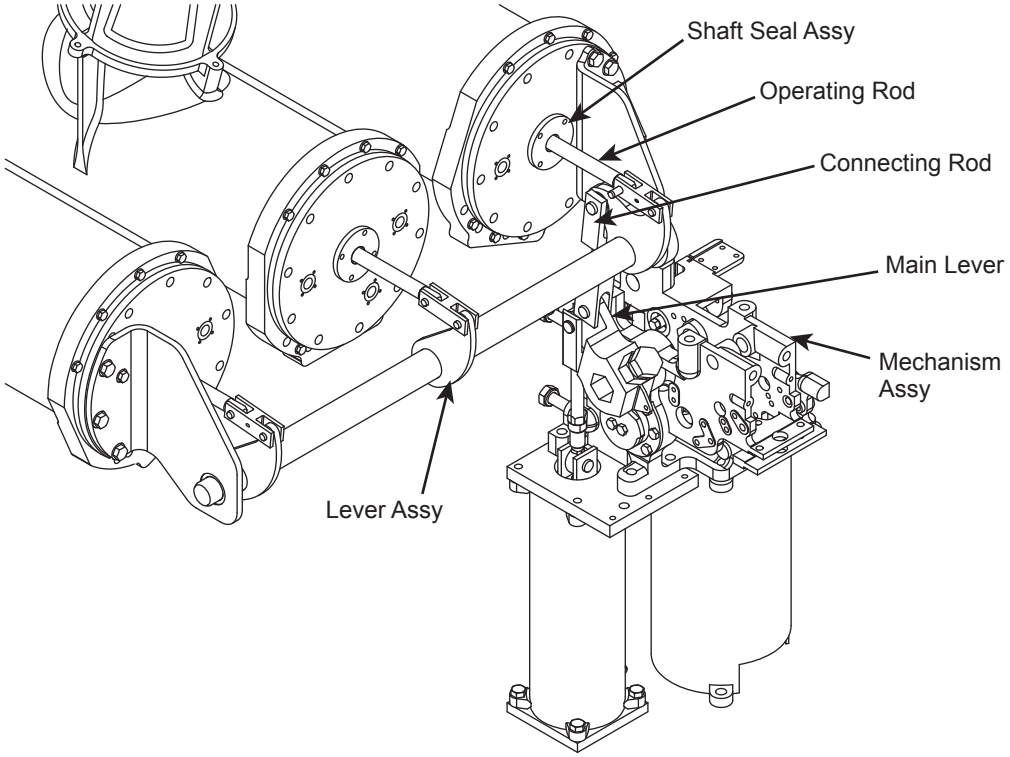


Fig. 3.5-1 Mechanical Linkage

3.6 Spring Operated Mechanism

The type BM-1 spring-operated mechanism (Fig. 3.6-1) uses energy stored in a trip spring to open the circuit breaker. A close spring closes the breaker and its motion recharges the trip spring. A universal motor (VAC/VDC) recharges the close spring at the end of each close operation.

3.6.1 Closed Position, View A

The interrupter, connecting linkage, and the mechanism's main lever are biased towards the open position by the force of the charged trip spring. The trip holding latch, held in place by the trip trigger, latches the interrupter in the closed position.

3.6.2 Open Operation, View A and B

A trip signal energizes the trip coil and causes the trip coil plunger to strike the trip trigger, which rotates counterclockwise and releases the trip holding latch. The trip holding latch disengages from the pin "A" and releases the main lever. The interrupter opens as the main lever rotates clockwise from the force of the discharging trip spring. The shock absorber dampens the mechanical shock at the end of the open operation.

3.6.3 Close Operation, View B and C

The large gear and cam are connected to the cam shaft. The cam shaft is connected to the close spring through the close lever and link. A clockwise torque from the charged close spring is applied to the cam shaft through the close lever and link. The clockwise torque is blocked by the close holding latch engaging the pin "B" on the cam. The close holding latch is held in place by the close trigger.

A close signal energizes the close coil and causes the trigger lever to strike the close trigger. The close trigger rotates counterclockwise and releases the close holding latch. The close holding latch rotates clockwise and disengages from the pin "B."

The interrupter closes as the large gear and cam rotate clockwise from the force of the discharging close spring through the close lever and link. The shock absorber dampens the mechanical shock at the end of the close operation.

The cam, connected to the cam shaft, pushes on the roller of the main lever as the large gear and cam rotate clockwise during the close operation. The cam rotation causes the main lever to rotate counterclockwise and charge the trip spring. The pin "A" on the main lever engages the trip holding latch as the interrupter reaches the closed position.

The torque of the recharged trip spring is blocked and the interrupter is latched closed as the trip trigger holds the trip holding latch in the engaged position.

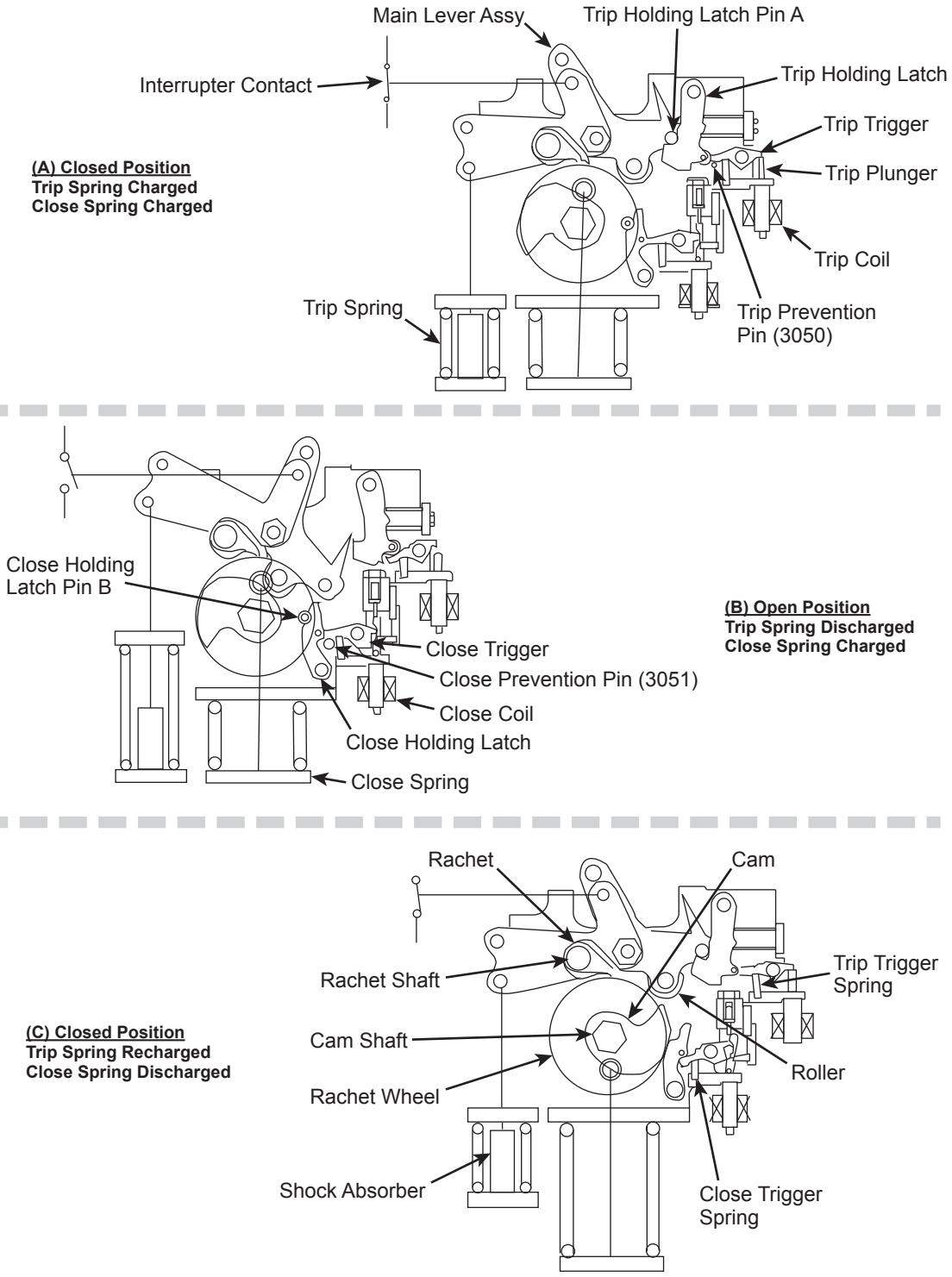


Fig. 3.6-1 Operation of Type BM-1 Spring Operating Mechanism

3.6.4 Charging of the Close Spring

At the end of the close operation, a limit switch (not shown) starts the universal motor (VAC/VDC, not shown) to recharge the close spring. The small gear, connected by a gear train (not shown) to the close spring charging motor, rotates counterclockwise. The large gear and cam on the cam shaft rotate clockwise and recharge the close spring through the close lever and link. When the links attachment to the large gear passes the 'dead point' line, the torque of the recharged close spring drives the large gear and cam with the pin "B" clockwise to the latching position. Simultaneously, the limit switch is engaged by an auxiliary cam on the end of the cam shaft, turning off the charging motor. The clockwise rotation of the large gear and cam is blocked by the close holding latch engaging pin "B".

3.6.5 Shock Absorber

A shock absorber inside the trip spring enclosure gradually decelerates the interrupter and mechanism at the end of the opening stroke. During the close operation, the shock absorber allows the mechanism to "overtravel" past the latching point so the trip holding latch can drop into place and latch its respective pin.

3.6.6 Prevention Pins

Prevention pins are provided to lock the mechanism in the open or closed position during circuit breaker maintenance. The prevention pins stop the trip and close triggers from releasing the trip and close holding latches. The trip prevention pin can only be installed when the breaker is in the closed position while the close prevention pin can be installed when the breaker is in either the closed or open position. The location of the prevention pins can be observed in Fig. 3.7-1.

⚠ CAUTION

Confirm that the prevention pins are removed before attempting to electrically operate the breaker to avoid damage to the coils and/or control circuit components.

3.6.7 Accessories

The mechanism also operates the auxiliary switches, mechanical operation counter, and position indicator.

3.7 Cabinet

The typical cabinet (Fig. 3.7-1) contains the mechanism and its accessories, such as the auxiliary switches, operation counter, and position indicator. Tubular heaters and pressure equalizing valves (PEV) located in the upper and lower corners form the cabinet anti-condensation and temperature control system. The cabinet also contains the controls to operate the breaker, stainless steel interphase SF_6 gas hose (applicable to common gas system), terminal blocks for the connections to the station power sources, and BCT terminal blocks.

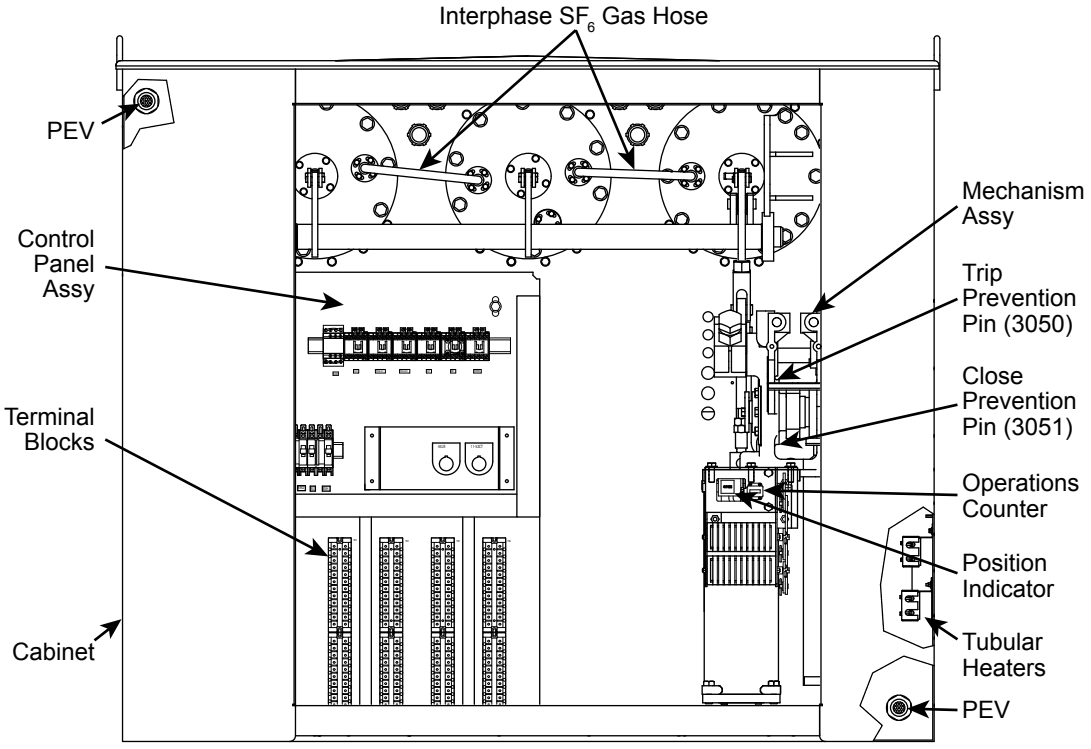


Fig. 3.7-1 Cabinet Assembly

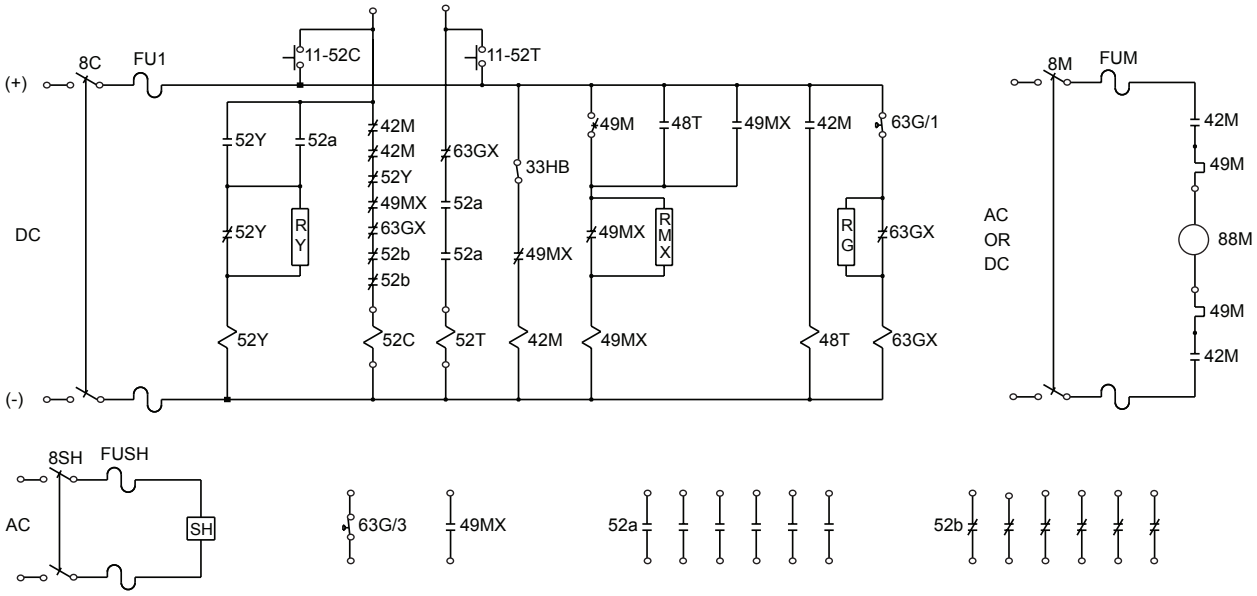
3.8 Electrical Control and Auxiliary System

3.8.1 Trip Circuit

A signal is sent to the trip circuit which energizes the trip coil through a pair of auxiliary switch “a” contacts.

3.8.2 Close Circuit

A close signal energizes the closing coil through a pair of auxiliary switch “b” contacts. The auxiliary switch “b” contacts open and de-energize the close coil as the mechanism travels to the closed position.



ITEM	DESCRIPTION
52C	Close Coil
52T	Trip Coil
63G/3	Low Press. Alarm Switch
63G/1	Low Press. Cutout Switch
63GX	Auxiliary Relay
11-52C	Control Switch-closing
11-52T	Control Switch-tripping
RY	Resistor
RG	Resistor
RMX	Resistor
52a	Auxiliary Switch a Contact
52b	Auxiliary Switch b Contact

ITEM	DESCRIPTION
8C	Knife Switch
8M	Knife Switch
8SH	Knife Switch
33HB	Close Spring Limit Switch
88M	Spring Charging Motor
42M	Motor Contactor
49M	Motor Thermal Overload
49MX	Auxiliary Relay
48T	Time Limit Relay
FU1	Fuse
FUM	Fuse
FUSH	Fuse
SH	Space Heater
52Y	Anti-pump Relay

Circuit Breaker - OPEN
Knife Switches - OPEN
Pressure Switches - LOW PRESSURE
Relays - DE-ENERGIZED
Close Spring - DISCHARGED

Fig. 3.8-1 Typical Electrical Schematic

Note: Refer to customer specific schematic for troubleshooting.

An auxiliary switch “a” contact in the anti-pumping relay circuit closes as the mechanism approaches the closed position and energizes the anti-pumping relay. An anti-pumping relay contact in the close coil circuit opens and remains open as long as the close signal remains, preventing the circuit breaker from reclosing if the breaker trips open. A second anti-pumping relay contact in the anti-pumping relay circuit closes and seals in the anti-pumping relay until the original close signal is removed from the circuit.

3.8.3 Gas Lockout Circuit

Electrical SF_6 gas density switch contacts prevent the circuit breaker from tripping and closing if the SF_6 gas density in the tanks falls below safe operating (lockout) level. At the customer’s request, the lockout circuit can be configured to trip and prevent the breaker from closing. Low density SF_6 gas alarms are also supplied to provide a warning signal before the tank reaches the lockout level. Refer to Section 3.9.2 for specific information related to SF_6 density switches.

3.8.4 Charging of Close Spring

During the close operation, a limit switch closes and energizes the motor’s magnetic contactor, starting the motor and recharging the close spring. The limit switch contact opens when the close spring is recharged, stopping the motor. The motor has thermal overload protection and a time limit relay that opens the motor circuit in the event of a malfunction.

3.8.5 Cabinet Heaters

Heaters in the cabinet provide sufficient heat to reduce condensation. Optional thermostatically controlled supplemental heaters may be provided.

3.9 SF_6 Gas System

The SF_6 gas in the pole unit is common to the tank and the bushing assemblies. In a Common Gas System (CGS) configuration, flexible stainless steel hose connects the three pole units together and the center phase pole unit is fitted with a rear inspection cover containing the SF_6 gas interface and density monitoring system. An Independent Gas System (IGS) configuration isolates the SF_6 gas in all three pole units and each pole unit is fitted with a rear inspection cover containing the SF_6 gas interface and density monitoring system.

The rear inspection cover utilizes a self-sealing DN20 gas valve to provide access to the system for air evacuation and SF_6 gas filling. Also mounted to the rear inspection cover is an intrinsic SF_6 density switch with an integrated pressure gauge for monitoring the gas within the system. Coupling the SF_6 density switch to the rear inspection cover is a self-sealing DN20 valve, which will permit the density switch to be removed from the breaker without depressurizing the breaker gas system. UV stable thermal insulation and a solar cover provide environmental protection for the density switch and gas sealing components. The procedure to verify the density switch calibration using the integrated pressure gauge is provided in Section 5.5.4.1. This procedure is the preferred method since it does not require removal of the density switch and will prevent the loss of SF_6 gas. An alternate method to verify the density switch calibration using external instrumentation is provided in Section 5.5.4.2.

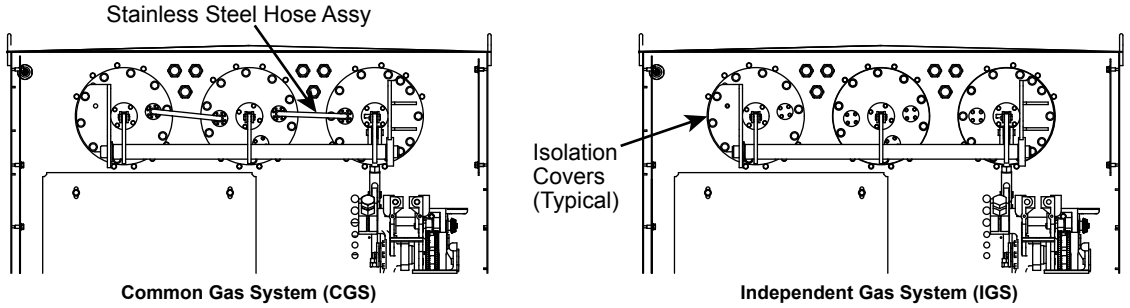


Fig. 3.9-1 SF_6 Gas System

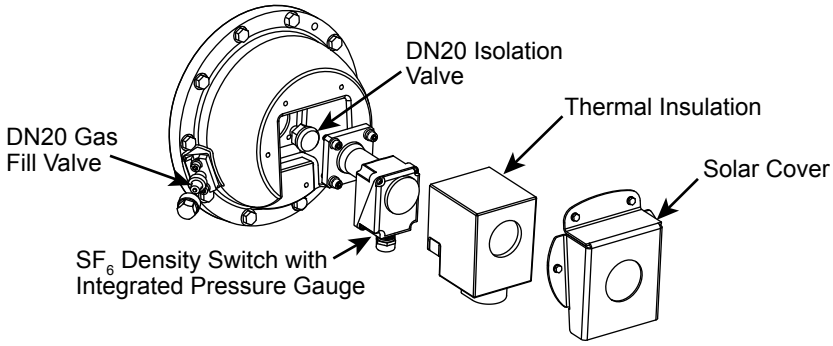


Fig. 3.9-2 SF_6 Gas System

3.9.1 SF_6 Gas Density and System Pressure

The breaker gas system is a sealed, fixed volume, filled with a specific quantity of gas. This results in a gas system pressure, at a constant density, that is subject to change with temperature variations. In both the CGS and IGS, temperature compensation is achieved by integration of the pressure gauge within the intrinsic SF_6 density switch. The correct pressure reading is taken by direct inspection of the pressure gauge with no further compensation necessary.

3.9.2 SF_6 Gas Density Switch

A switch monitors the density of the gas system, compensating for changes in pressure due to temperature changes and responding only to changes in the density of the gas system (gas leaks). Two types of intrinsic temperature compensation devices are available:

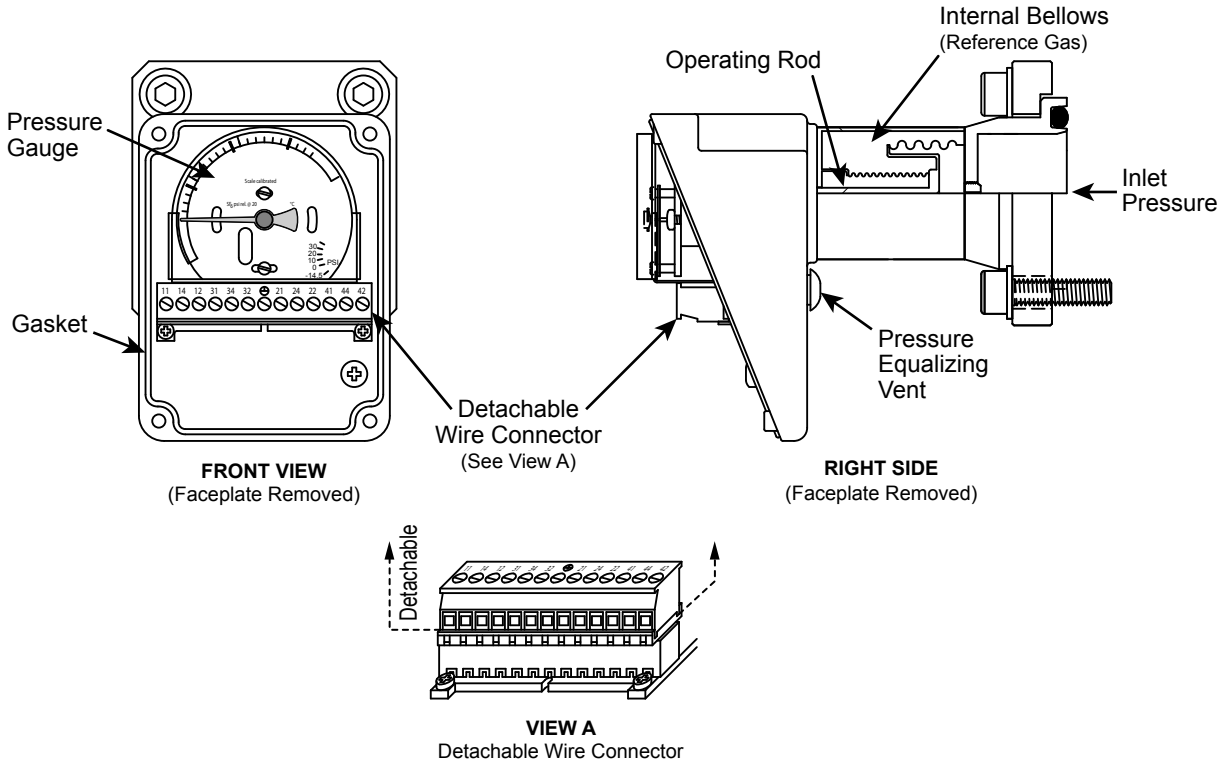


Fig. 3.9.2-1

The density switch in Fig. 3.9.2-1 employs an independent (separate from the breaker gas system) fixed volume of SF_6 gas within a bellows that is filled to a pressure that acts as a "reference" to the breaker gas density. When the "reference" gas housed within a bellows is subjected to the breaker gas system, it will expand and contract as the gas density within the breaker increases or decreases. The reference gas contained within the density switch will respond to changes in the ambient air temperature surrounding switch, providing the method for intrinsic temperature compensation. Coupled to the bellows are linear operating rods that open and close electrical contacts depending on the change in density of the breaker gas system.

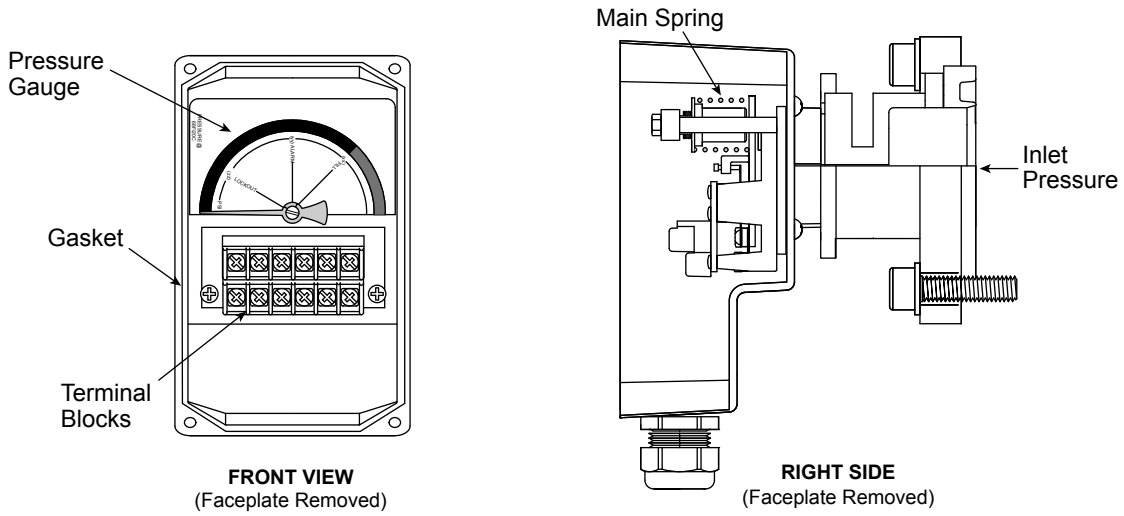


Fig. 3.9.2-2

The density switch in Fig. 3.9.2-2 contains a bellows that is filled using a small quantity of the breaker SF_6 gas that is calibrated by a mainspring and will expand and contract as the gas density within the breaker increases and decreases. Bi-metal discs in the switch mechanism compensate for any movement of the bellows due to changes in the ambient air temperature surrounding the switch. A bi-metal hinge further compensates for the expansion and contraction of the switch parts due to temperature changes.

CAUTION	To avoid damage to the temperature compensating mechanism and electrical contacts, always observe caution when handling the SF_6 density switch.

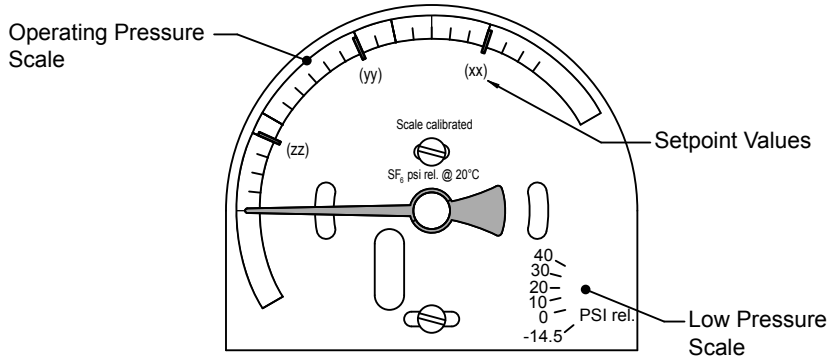
Electrical density switch contacts prevent the circuit breaker form tripping and closing if the SF_6 gas density in the tanks falls below the safe operating (lockout) level (20% of normal pressure @ 20°C). At the customer's request, the lockout circuit can be configured to trip and prevent the breaker from closing. A low pressure alarm is supplied to provide a warning signal (10% of normal pressure @ 20°C) before the tank reaches the lockout level.

Also at the customer's request, one switch contact can be replaced with an analog output signal that will provide a method to continuously monitor the SF_6 gas density within the gas system.

CAUTION	Do not operate the circuit breaker below the SF_6 gas lockout level, except with the manual jack assembly, as serious damage to the circuit breaker will occur.

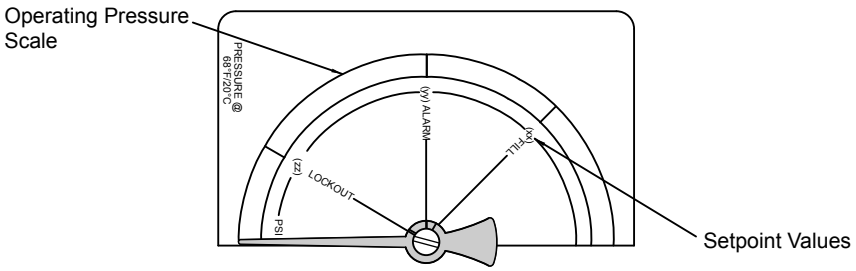
3.9.3 SF_6 Gas Pressure Gauge

An integrated temperature compensated pressure gauge within the SF_6 density switch provides a local visual indication for the SF_6 gas pressure. The gauge will not be damaged when the gas system is under vacuum. Fig.s 3.9.3-1 and 3.9.3-2 show the standard scale configurations. Alternate configurations are available at the request of the customer.



PRESSURE GAUGE DETAIL

Fig. 3.9.3-1



PRESSURE GAUGE DETAIL

Fig. 3.9.3-2

Notes: 1. The SF_6 pressure varies with changes in temperature. The SF_6 gas operating pressure gauge is temperature compensated. Knowledge of the ambient temperature is not required to determine if the SF_6 gas is at the correct pressure.

2. The low pressure scale shown in Fig. 3.9.3-1 provides non-temperature compensated pressure indication from vacuum -100 to 275 kPag (-14.5 to 40 psig). This scale may be used during gas reclaiming and filling operations, or to verify the breaker shipping pressure.

3.9.4 SF_6 Gas Seals

The gas seal of each the bolted joint is made by an o-ring set in a groove of one of the two mating surfaces. The o-ring groove and the mating surface must be clean and smooth, with no scratches or defects, to maintain a good gas seal.

The surface between the o-ring groove and the outside edge of the flange is covered with a gas sealant to protect the surfaces and seal from corrosion. Refer to Appendix A: SF_6 Gas Seals.

3.9.5 Adsorbent

An assembly to store adsorbent is located in each tank. The amount of adsorbent, approximately 10% of the weight of the SF_6 gas, is sufficient to keep the gas dry during the life of the breaker, provided the tank is not opened.

Change the adsorbent each time the tank is opened. The must be sealed and evacuation started within one hour of the new adsorbent's exposure to the atmosphere.

Note: The adsorbent also removes arc by-products and should be handled per Section 3.2.3.

3.9.6 Gas Adapters

A self-sealing **Dilo** DN20 fill valve is provided for evacuating and filling of the breaker.

There are two hose adapters included:

1. DN20 self-sealing female to 1 5/8-12, 37° SAE male thread (7025)
2. 1 5/8-12, 37° SAE female to 9/16-18, 37° SAE male thread (7024)

After the SF_6 gas is added to the breaker, remove the adapter and recap the fill valve.

3.10 Bushing Assembly

The SF_6 gas-filled bushing assemblies at each end of the tank provide the electrical entrance to the inside of the grounded SF_6 circuit breaker tank. The bushing assembly consists of a hollow insulator with flanges cemented on both ends, a conductor assembly, and top and bottom bushing O-rings. A vertical terminal pad at the top of the bushing assembly connects the overhead line to the breaker. A silver-plated contact at the bottom end of the conductor plugs into the interrupter assembly.

Composite insulators are available as an option on Mitsubishi Electric Power Products, Inc. circuit breakers. Refer to Appendix W: Composite Insulators and Appendix AA for special handling instructions.

The contact assembly consists of a set of multi-lam contacts and retainers.

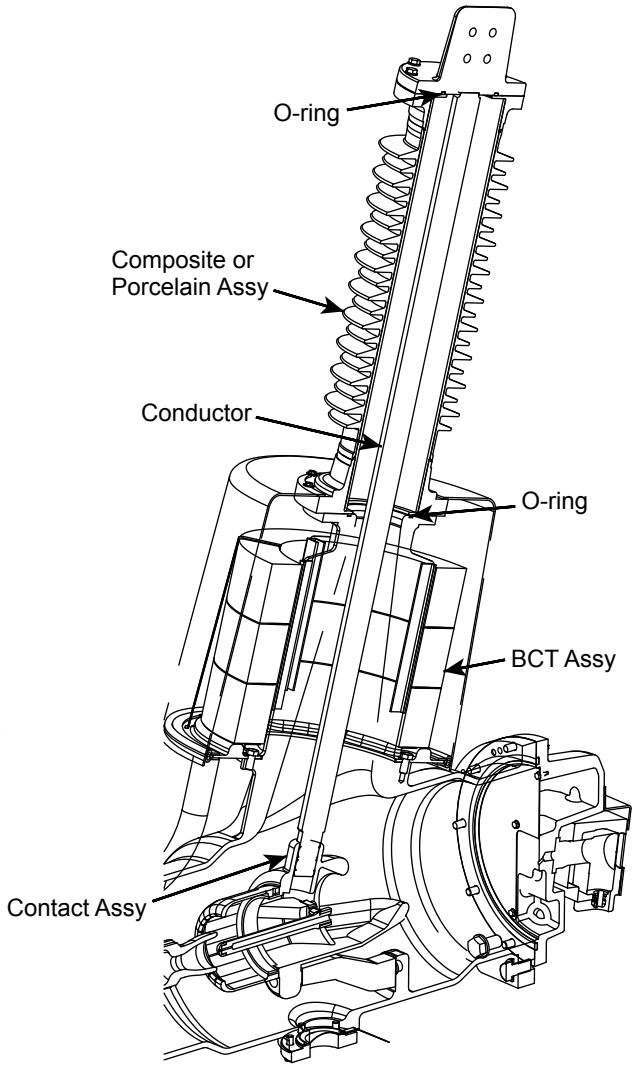


Fig. 3.10-1 Bushing Assembly

3.11 Current Transformer Assembly

The bushing type current transformer (BCT) assembly consists of the current transformers, spacers, strapping, cover, and gasket. The BCT cover is bolted at the top to the bushing flange and weather-proofed with sealant. A gasket, attached to the BCT mounting plate, prevents induced currents from circulating from the tank nozzle through the BCT cover to the mounting plate and back to the tank.

The BCTs are protected from the environment and require no maintenance.

⚠ CAUTION

Either connect the secondary circuits to a load or short-circuit them. If the secondaries are open-circuited, the primary current will induce a very high voltage in the secondary leads. This high voltage may damage the secondary circuit insulation.

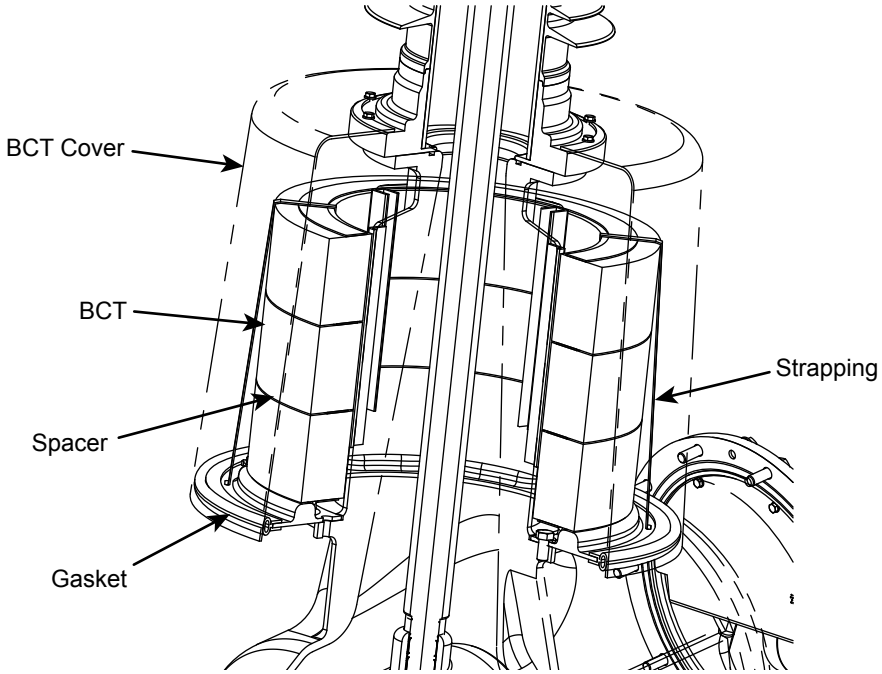


Fig. 3.11-1 Bushing Current Transformer (BCT) Assembly

This page left blank intentionally.

4

Circuit Breaker Operation

4.1 Electrical Operation

Electrical close and open operations can be made from the central station control panel or at the local control panel in the circuit breaker. An SF_6 gas density switch contact prevents closing, and either blocks or trips the breaker if the gas system density falls below the lockout setting. Review the control schematic diagram, received with the breaker, to determine what controls were ordered.

⚠ WARNING

Failure to follow the circuit breaker operating, installation, and maintenance instructions can result in property damage, unscheduled outages, and/or loss of life.

Check the following items before electrically operating the breaker.

- Operation is in accordance with the power company's procedure.
- SF_6 gas system is at normal operating pressure (refer to Appendix E: Filling, Removal, and Leak Detection of SF_6, Figs. E.4-1 and E.4-2).
- Density switch settings are in accordance with those specified in Section 7: Performance Specifications.
- Manual jack, along with the trip and close prevention safety pins, have been removed from the mechanism.
- DC controls and AC auxiliary voltages are normal and all control switches are closed.

This page left blank intentionally.

5

Inspection and Maintenance

5.1 Inspection Program

A proper program of inspection and maintenance assures reliability of the equipment. Maintain a permanent record for each circuit breaker. The inspection requirements vary depending on the length of time in service, and the severity and frequency of operation. A recommended inspection and maintenance program has been divided into four categories identified as follows:

Table 5.1-1 Inspection Based on Service Time

Inspection	Frequency	Description
*Patrol – P	Refer to Section 5.3	External visual inspection of energized breaker.
Routine – R_{12}	Every 12 years	External inspection with breaker de-energized.
2000 operations – Ops, or accumulated interruption current – AIC.	Operations per Table 5.1-2 and Fig. 5.1-1	External and internal inspection. Breaker de-energized and degassed. Replacement of contacts or mechanical parts, lubrication (if required). Operation timing tests.
Special – S	After performing unscheduled maintenance (i.e. opening tanks, mechanism work, etc.)	External and internal inspection. Breaker de-energized and degassed. Replacement of contacts or mechanical parts, lubrication (if required). Operation timing tests.

* Inspect weekly for first two weeks; bi-weekly for next four weeks. Follow company's policy thereafter, intervals not to exceed 6 months.

The above inspection abbreviations (P, R_{12}, etc.) are used in tables throughout Section 5: Inspection and Maintenance.

Table 5.1-2 Accumulated Interrupted Current (AIC) Table

Type	Operating Condition	Inspection Period
Internal and external inspection (including mechanism), and replacement of arcing contacts and nozzle, if required.	Low current interruptions - 0 to 900 A	4,000 operations*
	Current interruptions - >900A to Rated load current	2,000 operations*
	Short circuit interruptions/phase - Rated 40 kA	20 operations*
Replacement of arcing contacts and nozzles	Single bank capacitor switching	2,000 operations non-synchronous
	Back-to-back capacitor switching or reactor switching	500 operations non-synchronous
	Short circuit or load current interruptions	Refer to Fig. 5.1-1

*or accumulated equivalent (refer to Fig. 5.1-1)

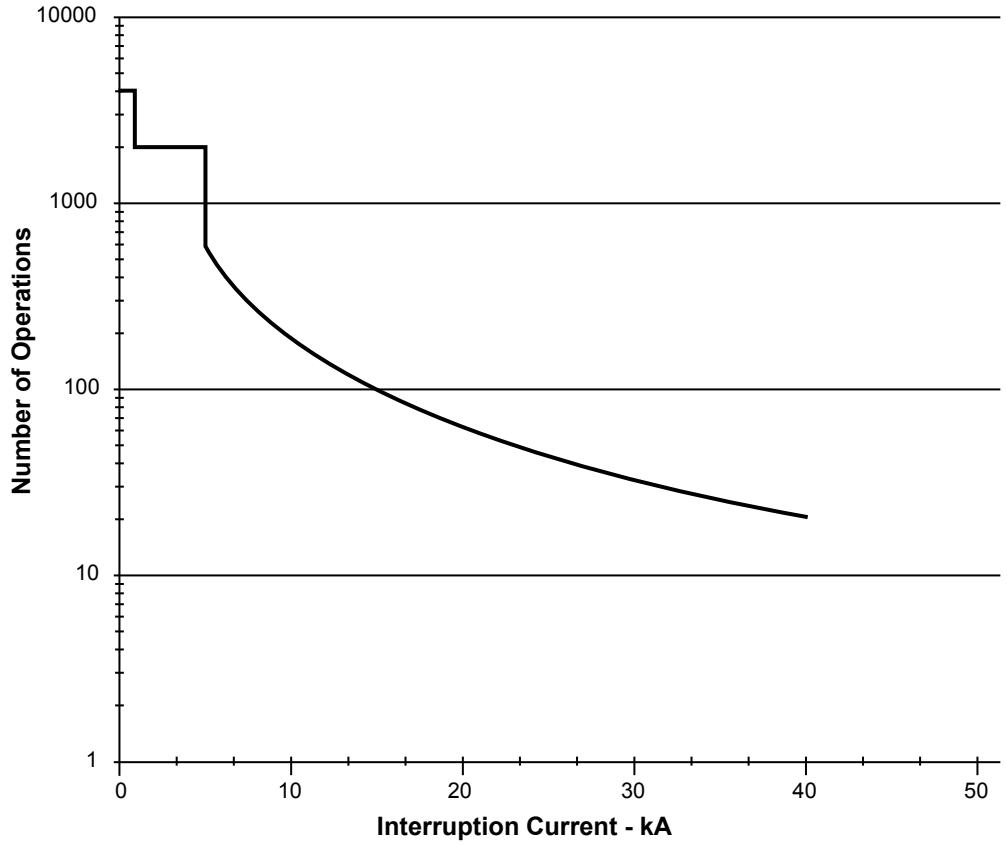


Fig. 5.1-1 Accumulated Interruption Current vs. Allowable Operations – 40 kA

5.2 Maintenance Precautions

The electrical performance of the circuit breaker requires that the interior and insulating parts be clean and dry. Do not expose the interior of the breaker tanks to inclement weather conditions. When the tanks are open, use temporary coverings to prevent exposure to dust, dirt, and moisture. Observe the following detail precautions:

1. De-energize the breaker and apply grounds to the breaker terminals.
2. Open switches to the breaker AC and DC control circuits.
3. Do not open tanks in rain, very high humidity (>80%), or high winds (>10m/sec. (20 mph)).
4. Pure SF_6 gas (less than 20% oxygen) will not support life. Arced SF_6 gas may contain toxic products. Do not enter any tank that previously contained SF_6 gas that is not thoroughly ventilated. Refer to Section 3.2 Sulfur Hexafluoride (SF_6) Gas for precautions when dealing with arced SF_6 gas.
5. Insert close and trip prevention pins, except as required for inspection and tests.
6. Do not operate the breaker when SF_6 pressure is below lockout unless using the manual jack.
7. Do not disassemble the shaft seal assemblies on the operating rods.
8. Cover tank openings with plastic sheeting or bags when work is not actively being performed inside the interrupter tank.
9. Discard retaining rings. Replace with new retaining rings.
10. Replace adsorbent immediately before evacuating each time the tanks are opened.
11. Thoroughly clean the tank interior after inspection and maintenance.
12. Never use cloths or wipes previously used on metal parts to clean insulating parts.
13. Use only denatured alcohol to clean interior insulators.
14. Discard old O-rings. Replace with new O-rings.
15. Perform gas leakage test on any seals disturbed during maintenance.
16. Contact a Mitsubishi Electric Power Product's representative before attempting any maintenance procedures not described in this manual.

5.3 Maintenance Table

		Patrol	Frequency				
System	**Inspection Required**	**P** (6 Mo.)	**R_{12}** (12 Yrs.)	**Ops** (2000 Ops.)	**AIC** (Tbl. 5.1-2)	**S** (Special)	**Actions**
Structural	Terminal Corrosion	X					Visual check for corrosion at terminal connections. Clean with abrasive media and regrease if required.
	Tank, Frame Corrosion	X					Visual check. Clean and touch up with paint or cold galvanizing if required.
	External Hardware			X			Check torque using torque marks. Retorque all loose hardware.
Control Cabinet	Cabinet Heaters		X				Verify function.
	Cabinet Corrosion	X					Clean and touch up with paint if required.
	Weather Seals (gaskets)	X					Replace/fix as required.
Gas System	Gas Pressure	X			X	X	Record and check for correct pressure.
	Temperature	X			X	X	Record.
	Density Switch				X	X	Check pressure settings and condition of switch if required.
	Pressure Gauge				X	X	Check accuracy if required.
	Gas Leakage				X	X	Leak test any disassembled joints.
	Gas				X	X	Sample gas for purity and moisture if breaker is opened.
Interrupter	Main Contacts				X		Measure main circuit resistance.
	Arcing Contacts				X		Inspect for arc erosion via stationary contact length; replace if required.
	Nozzle				X		Inspect for erosion; replace.
	Adsorbent				X	X	Replace.
Mechanism	Operations Counter	X	X				Record.
	Travel			X	X	X	Measure travel curve including velocity, overtravel, contact part.
	Lubrication		X*	X*			Clean and relubricate (If required) - *12 year schedule is for 40°C ambient temperature. If ambient temperature is >40°C, relubrication every 6 years is recommended.
	Hardware and Retaining Rings			X			Check for looseness; retorque or replace as required.
	Shock Absorber			X			Check for oil leakage.
	Close Coil Assembly			X			Check dimensions; reset as required.
	Trip Coil Assembly			X			Check dimensions; reset as required.
	Cam and Roller Gap			X			Check gap, adjust if necessary.
Controls	Wire Terminations			X			Check for tightness and terminations; reterminate or tighten as required.
	Components			X			Check for broken or worn components.
	Ground Terminals					X	Retorque.
Bushings	Insulator	X				X	Check for contamination build up, clean as required.
	Porcelain Chips/ Composite Tears	X				X	Replace as required.
	BCT's					X	Perform ratio and Megger tests.

5.4 Tools and Material

Usually tools and material are not required for the patrolling inspection since the objective is to maintain a log of the breaker's condition and identify any abnormalities that may require maintenance. Obtain tools and material required for the routine (12 yr), AIC, and special (S) inspections before beginning the inspection to avoid unnecessary breaker outage. The tools and parts obtainable from the breaker supplier are identified by the part number in parenthesis.

5.4.1 Tools

Tools Required for Internal Inspection

Moving Arcing Contact Tool (7012)
Nozzle Tool (7011)
Manual Jack Assembly MD100246 (7002) / MD100577 (7003)
Torque Wrench 2200 kg-cm (159 lb-ft)
Torque Wrench 280 kg-cm (20.3 lb-ft)
Ratchet Wrench and Extension
Metric Sockets (8, 10, 13, 17, 19, 24, 36 mm)
Metric Allen Head Sockets 6 and 10 mm
Metric Open End Wrenches (8, 10, 13, 17, 19, 24, 36 mm)
Evacuating and SF_6 Gas Filling Equipment*
Micro-ohm Test Equipment
Megohm Meter Test Set 500 & 1000 V
Timing Equipment
SF_6 Gas Leak Detection Equipment
SF_6 Gas Fill Valve Adapters (7024, 7025)
Mechanic Scale 250 to 300 mm
Long Feeler Gauges
Plastic Scrapers
†**Scotch-Brite**™ - General Purpose Hand Pad #7447**
Multimeter
Vacuum with HEPA Filter
SF_6 Density Switch Test Plug-in (7041)
SF_6 Density Switch Test Kit (7042) when External Calibrated Gauge is Required

* MEPPI recommends using gas handling equipment that meets or exceeds the following requirements: compressor with a delivery rate of 19.4 m^3/h (685 cfm); suction pump with nominal suction capacity of 30 m^3/h (18 cfm); and vacuum pump with nominal suction capacity of 200 m^3/h (118 cfm).

Note: Throughout this book, the generic term **Scotch-Brite is used to refer to this specific type pad.

†**Scotch-Brite**™ is a trademark of 3M Corporation.

5.4.2 Material

Item	Quantity	Inspection Category	
Rear Cover O-ring, EPDM (1202)	3		AIC, S
Gas Sealant Shin-Etsu KE-44-W (9901)	300 g		AIC, S
Weather Sealant Shin-Etsu KE-45-T (9902) or ***Dow Corning**® 737	600 g		AIC, S
Adsorbent, Molecular Sieve Type 13X (1301)	9 lbs		AIC, S
****Loctite**® #242 Blue (9903)		Ops	AIC, S
*****Noxlub**® Contact Grease (9905)	25 cc		AIC, S
Stationary Arcing Contact Assy (2013)	3		AIC, S
Moving Arcing Contact (2041)	3		AIC, S
Nozzle (2040)	3		AIC, S
SF_6 Gas	See Section 7		AIC, S
Diamond #2 Low Temp Grease (9904)	1	Ops	AIC, S
Denatured Alcohol		Ops	AIC, S
Plastic Sheets			AIC, S
Dow Corning #111 Valve Lubricant (9908)		Ops	AIC, S
Loctite #277 Red (9907)		Ops	AIC, S
Darina #2 Contact Grease (9906)	1		AIC, S

5.5 SF_6 Gas System

The SF_6 gas requires no maintenance during inspections aside from recording the SF_6 gas pressure to verify the system is not leaking SF_6 gas. The SF_6 gas density switch and pressure gauge compensate for both temperature and pressure changes. The ambient temperature is not required to determine if the SF_6 gas is at the correct pressure.

***Dow Corning**® is a registered trademark of Dow Chemical Company and Corning, Inc.
****Loctite**® is a registered trademark of Henkel Corporation.
*****Noxlub**® is a registered trademark of Kluber Lubrication Munchen KG

5.5.1 Adding SF_6 Gas

If the pressure has dropped below the normal gas pressure, it may be necessary to restore the breaker to the correct adjusted pressure by adding gas. This can be done by following the procedure in Appendix E: Filling, Removal, and Leak Detection of SF_6.

Note: Add sufficient gas to reset the density switch. Do not over pressurize the tanks.

5.5.2 SF_6 Gas Removal and Filling

Remove the SF_6 gas before opening the tanks to inspect and maintain the interrupter contacts. A DN20 adapter is provided for evacuating and filling the breaker. Reclaim SF_6 down to 1 Torr (1 mmHg) to prevent loss of gas when the tanks are opened. Ventilate the SF_6 tanks with fresh air (preferably dry air or N_2) to zero psig, open the rear cover and remove the SF_6 arc by-products with a vacuum cleaner. Observe all the precautions pertaining to SF_6 gas and the arc by-products. Refer to Appendix E: Filling, Removal, and Leak Detection of SF_6 for more detailed instruction.

Note: Connect the adapter to the hose, then connect the Dilo fitting to the breaker gas fill port. The DN20 gas fill port opens as soon as the DN20 adapter is connected to the port, permitting the passage of the SF_6 gas.

Refer to the order-specific gas system schematic drawing for adapter thread designations.

5.5.3 Gas Leak Inspection

Check all gas seal joints that were disturbed when the breaker was opened for internal inspection to make sure that none are leaking. Use leak detection fluid or an SF_6 leak detector as described in Appendix E: Filling, Removal, and Leak Detection of SF_6.

5.5.4 Gas Density Switch Inspection

5.5.4.1 (Recommended Method)

A self-sealing DN20 valve will isolate the density switch and integrated pressure gauge from the breaker gas system, allowing the switch contacts to be verified. No loss of SF_6 gas will occur when inspecting the gas density switch in accordance with to the following procedure:

⚠ **WARNING**	The breaker must be de-energized and the switch to the DC power source must be open when performing gas density switch inspection. The density switch must be fully secured to the rear inspection cover with all insulation and solar covers installed and the DN20 gas fill valve must be isolated with the cap installed before the breaker is put in service.

Recommended Tools

3/8" Drive Ratchet and Extension
Torque Wrench [Adjustable from 0.0 – 28.25 Nm (0.0 – 20.8 lb-ft)]
3/8" Drive 13mm Metric Socket
6mm 3/8" Square Drive (Long 6") Ball Point Hex Bit Socket
Phillips Screwdriver
Electrical Continuity Test Meter
MEPPI SF_6 Density Switch Test Plug-In (7041)

17. Remove the density switch solar cover by removing the four M8x14mm bolts and washers.

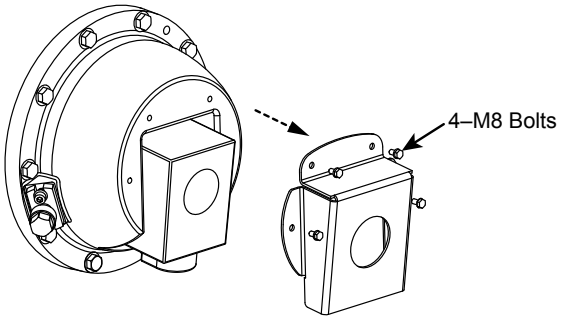


Fig. 5.5.4.1-1

18. Remove the density switch insulation cover by pulling the rear locking tab located at the base of the density switch downward. The front of the insulation cover can be removed by it sliding forward.

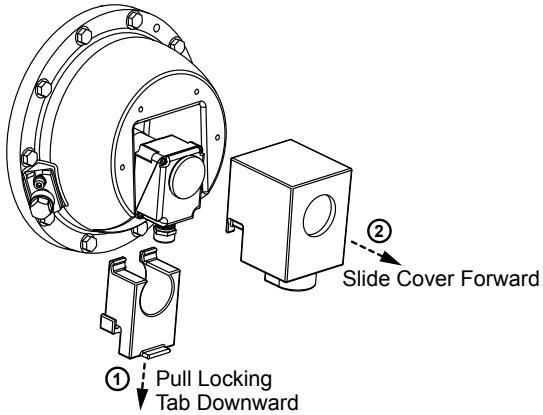


Fig. 5.5.4.1-2

⚠ CAUTION

The density switch retaining ring is secured to the rear inspection cover with two stainless steel M8x25mm bolts and two black coated M8x30mm bolts. The order in which these bolts are removed is critical to ensuring the density switch is not damaged. Personal injury may result if caution is not observed when following this procedure.

19. Using a 6mm (long 6") ball point hex bit socket, remove the two black coated M8x30mm bolts. Note that four washers are fitted to each bolt. Remove three of the four washers from each black coated M8x30mm bolt. Reinstall both black coated M8x30mm bolts with one washer fitted to each bolt. Hand-tighten only, since a small clearance will be present between the washer and switch retaining ring when the bolts are fully engaged. At this step, the two stainless steel bolts are securing the density switch to the rear inspection cover.

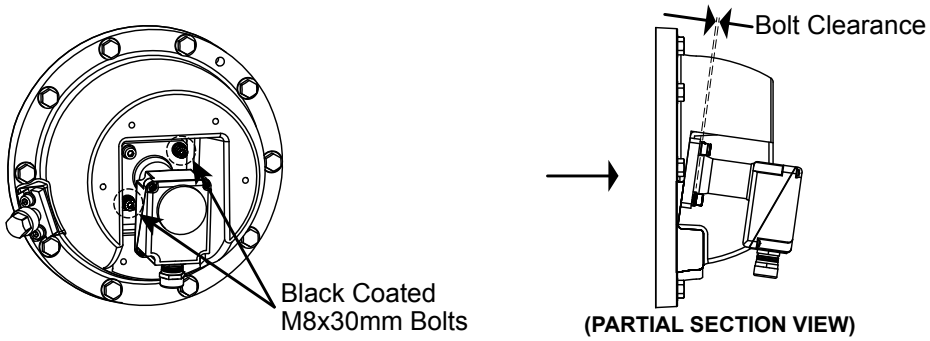


Fig. 5.5.4.1-3

20. Remove the four Phillips head screws that secure the density switch electrical housing cover assembly. Remove the cover slowly. Take care to not apply excessive load on the electrical connections or pressure gauge faceplate during this process.

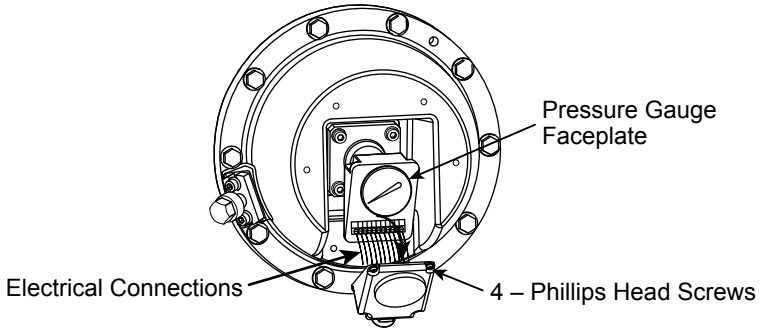


Fig. 5.5.4.1-4

⚠ CAUTION

STEP 5A is applicable when testing is being performed to verify the density switch contact setpoint calibration or to verify the breaker alarm and lockout control circuits.

STEP 5B permits use of a density switch test plug and is only applicable if density switch testing is being performed to verify the calibration of the density switch contact setpoints. DO NOT COMPLETE STEP 5B if the testing is being performed to verify the breaker alarm and lockout control circuits.

5A. Connect the electrical continuity instrument across the alarm and lockout contacts as defined on the gas schematic drawing by making contact with plug-in connector screw terminals.

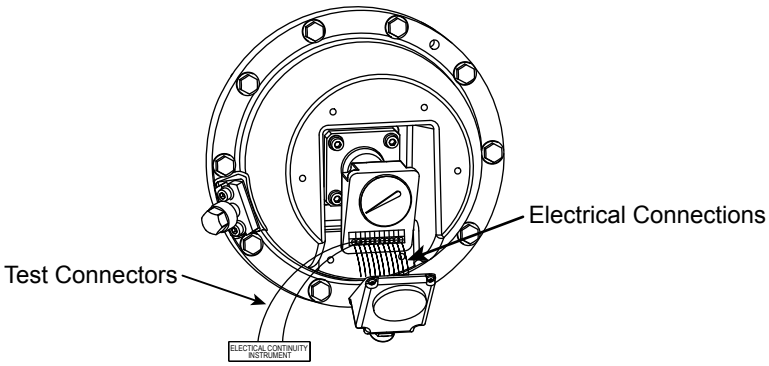


Fig. 5.5.4.1-5

5B. Remove the detachable portion electrical plug-in socket from the density switch connected to the control circuit by pulling upward on the sides of the socket housing. Install the density switch test plug-in socket (7041).

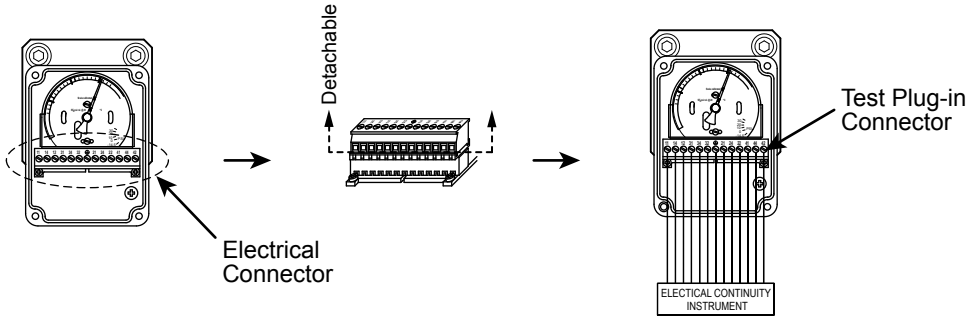


Fig. 5.5.4.1-6

Connect an electrical continuity instrument across the alarm and lockout contacts as defined on the gas schematic drawing by using the wire leads and clips provided on the test plug-in socket.

6. Evenly loosen the two stainless steel M8x25mm bolts, noting that the switch retaining ring will begin to separate from the rear inspection cover base. The pressure will begin to decrease. During this process, the self-sealing DN20 coupling valve will disengage from the density switch, sealing the breaker gas system and trapping a small volume of SF_6 gas within the density switch. If it is observed that the switch is not disengaging evenly when the bolts are loosened, apply a small amount of force to rock the switch body in a vertical motion. This will permit the switch to continue to disengage outward.

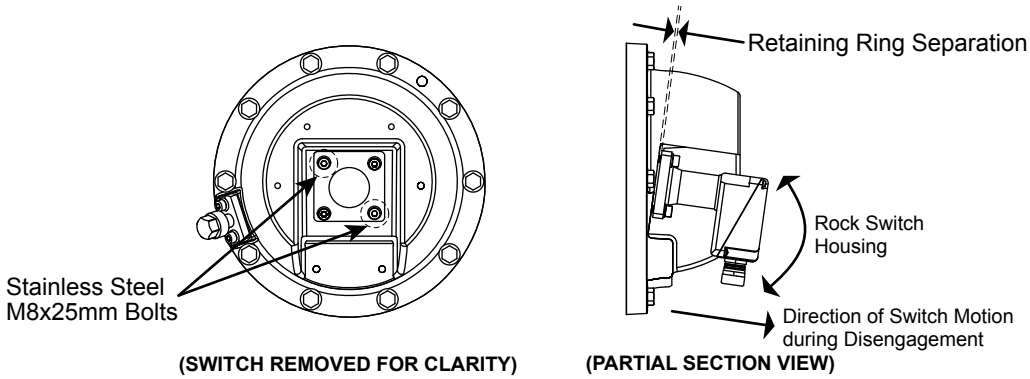


Fig. 5.5.4.1-7

WARNING

Caution should be taken when verifying the breaker alarm and lockout control circuits using this procedure. Severe injury can occur if caution is not observed when following this procedure.

7. Continue to evenly loosen the four M8 bolts that secure the switch retaining ring to the rear breaker cover in a clockwise pattern, observing the drop in pressure indicated on the pressure gauge.

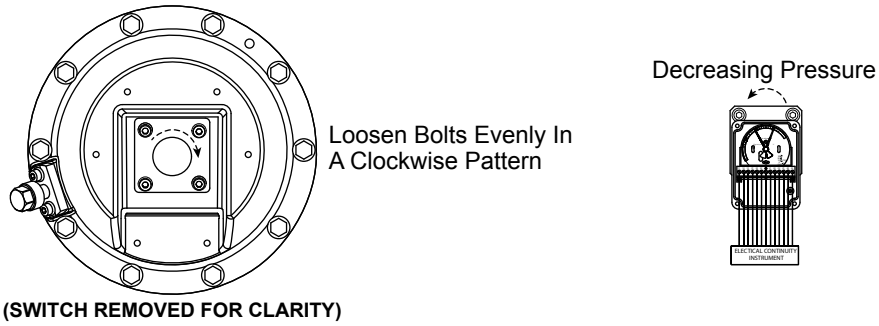


Fig. 5.5.4.1-8

⚠ WARNING

Do not loosen the two black coated M8x30mm bolts more than what is required to verify the lockout contacts. These bolts are not sized to depressurize the trapped gas within the density switch. Reference Section 5.5.4.2 for procedures on how to properly remove the density switch. Personal injury may result if caution is not observed when following this procedure.

8. Record the pressure at which the alarm and lockout contacts operate in the decreasing pressure or "falling" direction. The recorded pressure is temperature compensated when measured using the integrated pressure gauge. No temperature measurement is necessary.

Note: Depending on the switch design, the two stainless steel bolts may be completely removed from the rear inspection cover before all electrical contacts operate. The length of the black bolts has been sized to ensure the density switch will remain secured to the rear inspection cover during this procedure.

9. To verify the contacts in the increasing pressure or “rising” direction, evenly tighten the four M8 bolts that secure the switch retaining ring to the rear inspection cover in a clockwise pattern. Do not over-tighten the M8 black coated bolts during this step. A small clearance will be present between the washer and switch retaining ring when the two stainless steel M8x25mm bolts are fully engaged.

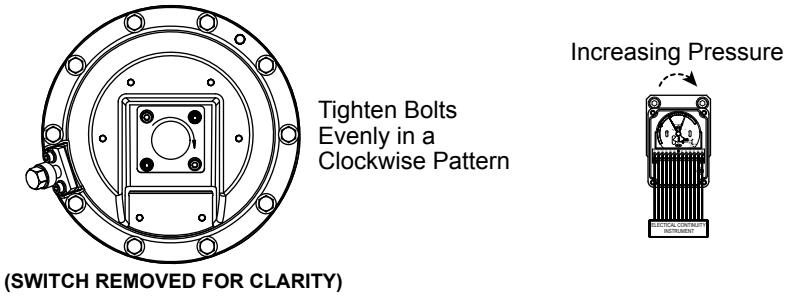


Fig. 5.5.4.1-9

10. Record the pressure at which the lockout and alarm contacts operate.
11. After the last contact setpoint has been recorded, completely remove the two black coated M8x30mm bolts and replace the three washers on each bolt previously removed in Step 3. Reinstall the two black bolts. Evenly tighten and torque all four M8 bolts to 13.7 Nm (10.1 lb-ft).

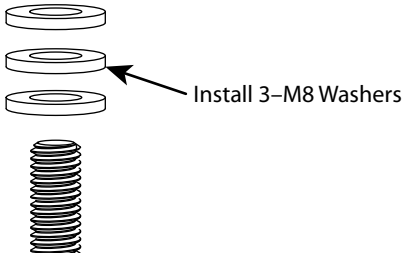


Fig. 5.5.4.1-10

12. Verify the pressure gauge is reading the correct breaker operating pressure.
13. Skip Step 13 if Step 5B was not performed.

    Remove the density switch test plug-in socket (7041). Reinstall the control circuit electrical plug-in socket to the density switch removed in Step 5B.

14. Reinstall the density switch electrical housing cover. Torque the four Phillips head screws to 2.3 Nm (1.7 lb-ft).
15. Reinstall the insulation cover, ensuring the locking tab is secured.
16. Reinstall the solar cover using the four M8x14mm bolts. Torque to 13.7 Nm (10.1 lb-ft).

5.5.4.2 (Alternate Method)

This method may be used when a separate calibrated instrument is required to verity the density switch contact calibration. A small amount of SF_6 gas will be lost to the environment when inspecting the gas density switch according to the following procedure. The amount of SF_6 gas lost during this process (less than 0.001 psi equivalent) will not require the breaker gas system to be replenished.

Recommended Tools and Supplies:

3/8" Drive Ratchet and Extension
Torque Wrench [Adjustable from 0.0 – 28.25 Nm (0.0 – 20.8 lb-ft)]
3/8" Drive 13mm Metric Socket
6mm 3/8" Square Drive (Long 6") Ball Point Hex Bit Socket
Phillips Screwdriver
Electrical Continuity Test Meter
MEPPI SF_6 Density Switch Test Plug-in (7041)
MEPPI SF_6 Density Switch Test Kit (7042)
Denatured Alcohol
Dow Corning #111 Grease (9908)
Loctite #242 Blue (9903)

⚠ WARNING

The breaker must be de-energized and the switch to the DC power source must be open when performing gas density switch inspection.

The density switch must be fully secured to the rear inspection cover with all insulation and solar covers installed and the DN20 gas fill valve must be isolated with the cap installed before the breaker is put in service.

⚠ WARNING

Caution should be taken when verifying the breaker alarm and lockout control circuits using this procedure. Severe injury can occur if the proper precautions and procedures are not observed.

1. Remove the density switch solar cover by removing the four M8x14mm bolts and washers.

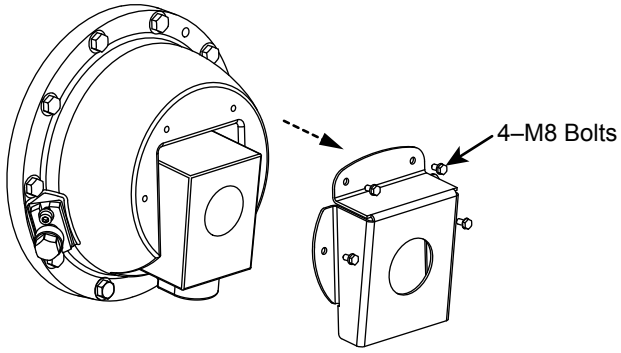


Fig. 5.5.4.2-1

2. Remove the density switch insulation cover by pulling the rear locking tab located at the base of the density switch downward. The front of the insulation cover can be removed by it sliding forward.

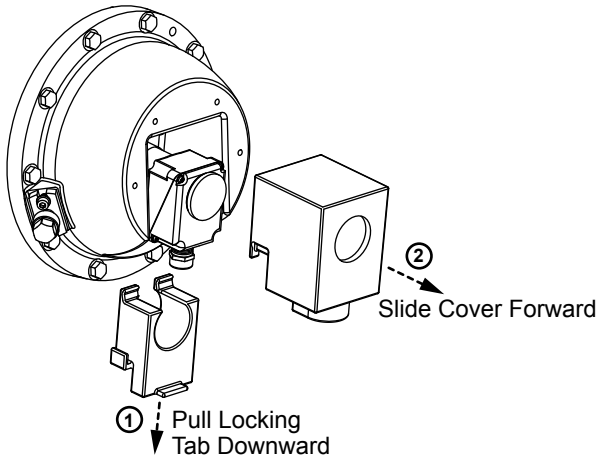


Fig. 5.5.4.2-2

WARNING

The density switch retaining ring is secured to the rear inspection cover with two stainless steel M8x25mm bolts and two black coated M8x30mm bolts. The order in which these bolts are removed is critical to ensuring the density switch is not damaged. Personal injury may result if caution is not observed when following this procedure.

3. Using a 6mm (long 6") ball point hex bit socket, remove the two black coated M8x30mm bolts. Note that four washers are fitted to each bolt. Install the two stainless steel M8x40mm jacking bolts with one washer fitted to each bolt as provided in the test kit (7042). Hand-tighten only, since a small clearance will be present between the washer and switch retaining ring when the bolts are fully engaged. At this step, the two stainless steel M8x25mm bolts are securing the density switch to the rear inspection cover.

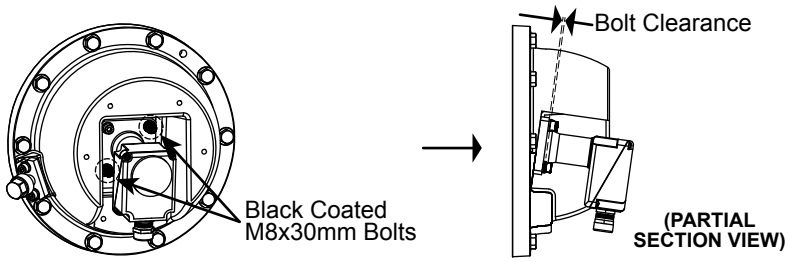


Fig. 5.5.4.2-3

4. Evenly loosen the two stainless steel M8x25mm bolts, noting that the switch retaining ring will begin to separate from the rear inspection cover base. The pressure will begin to decrease. During this process, the self-sealing DN20 coupling valve will disengage from the density switch, sealing the breaker gas system and trapping a small volume of SF_6 gas within the density switch. If it is observed that the switch is not disengaging evenly when the bolts are loosened, apply a small amount of force to rock the switch body in a vertical motion. This will permit the switch to continue to disengage outward.

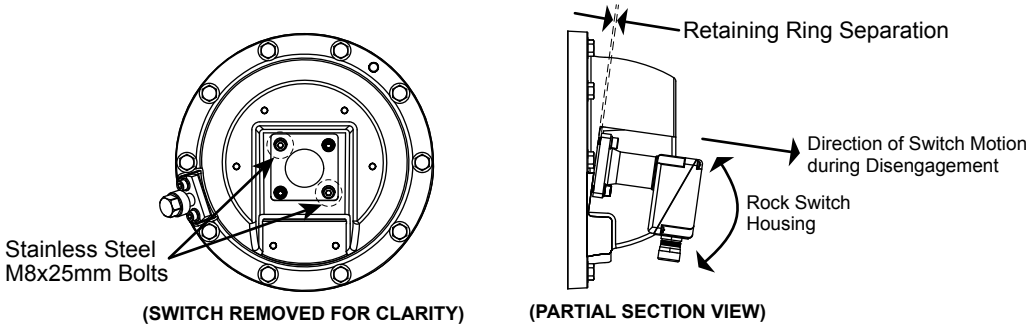


Fig. 5.5.4.2-4

5. Completely remove the two stainless steel M8x25mm bolts and washers from the rear inspection cover.
6. Evenly remove the two stainless steel M8x40mm jacking bolts. Once the pressure switch has separated approximately 20mm from the inspection cover base, an audible venting of the gas will be heard, indicating the density switch is depressurized and is safe to remove.

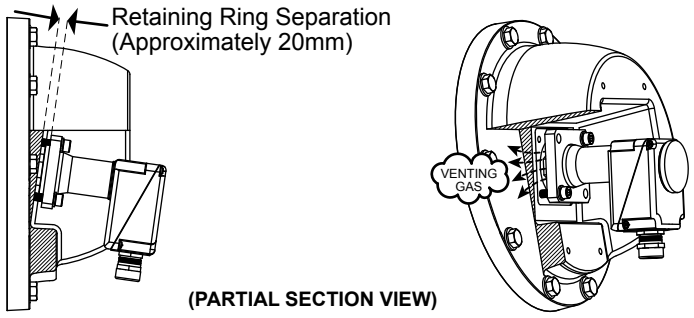


Fig. 5.5.4.2-5

Completely remove the two stainless steel M8x40mm jacking bolts.

7. Slide the density switch forward and allow the conduit locking clamp to support the density switch temporarily. Verify the o-ring in the density switch base remains in the correct position.

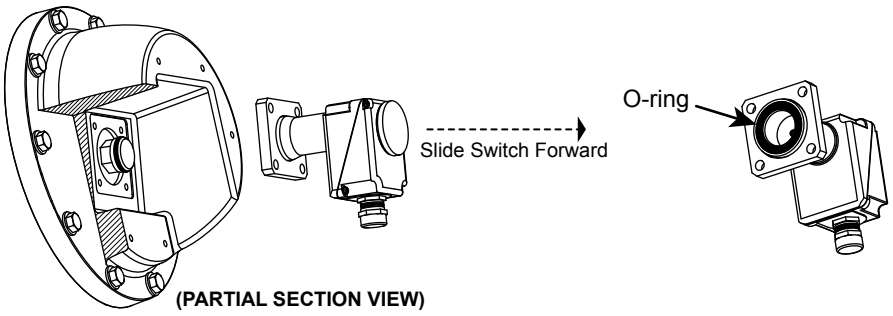


Fig. 5.5.4.2-6

⚠ CAUTION

Do not mishandle the density switch when not secured to the rear inspection cover. Mechanical damage can occur or contact calibration may be affected if care is not observed.

8. Secure the test manifold to the rear inspection cover using the two stainless steel M8x25mm bolts and washers provided in the test kit.

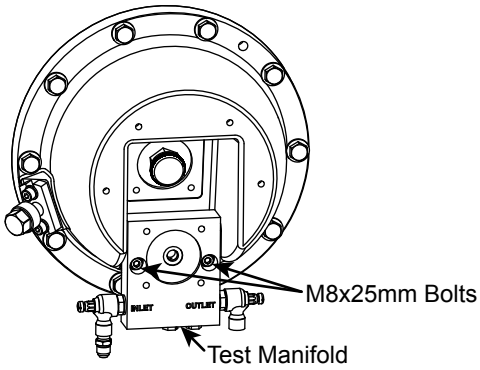


Fig. 5.5.4.2-7

9. Verify the o-ring in the density switch base is still properly located in the o-ring groove. Mount the density switch to the test manifold with the two stainless steel M8x25mm bolts and washers previously used to secure the density switch to the rear inspection cover. Torque to 13.7 Nm (10.1 lb-ft).

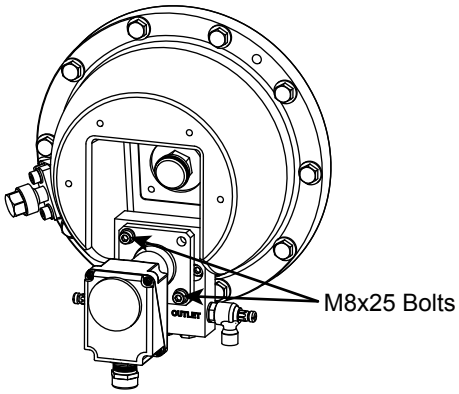


Fig. 5.5.4.2-8

10. Secure a calibrated pressure measurement instrument to one of the 7/16" SAE test ports located at the bottom of the manifold. Verify all unused ports are plugged. Verify both the inlet and outlet manifold valves are in the closed position by turning the valves clockwise.

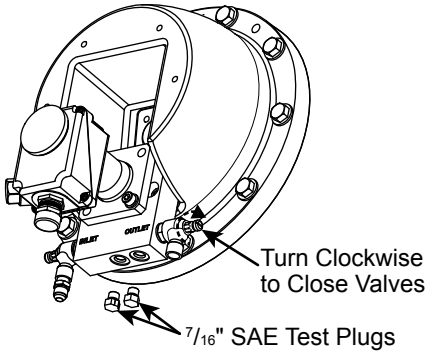


Fig. 5.5.4.2-9

11. Remove the four Phillips head screws that secure the density switch electrical housing cover. Remove the cover slowly. Take care to not put excessive tension on the electrical connections.

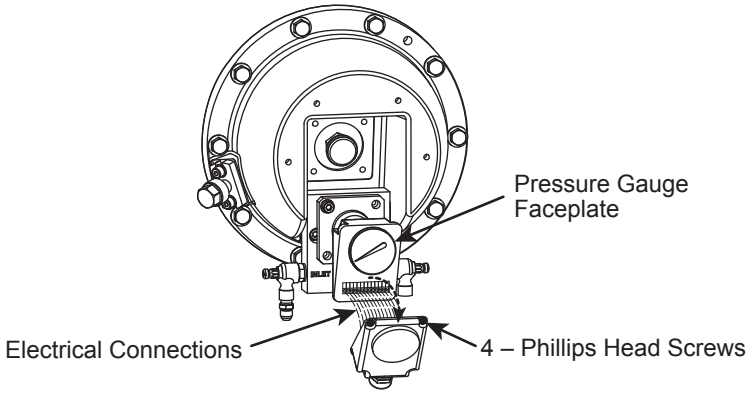


Fig. 5.5.4.2-10

12. Remove the detachable portion electrical plug-in socket from the density switch connected to the control circuit by pulling upward on the sides of the socket housing. Install the density switch test plug-in socket (7041).

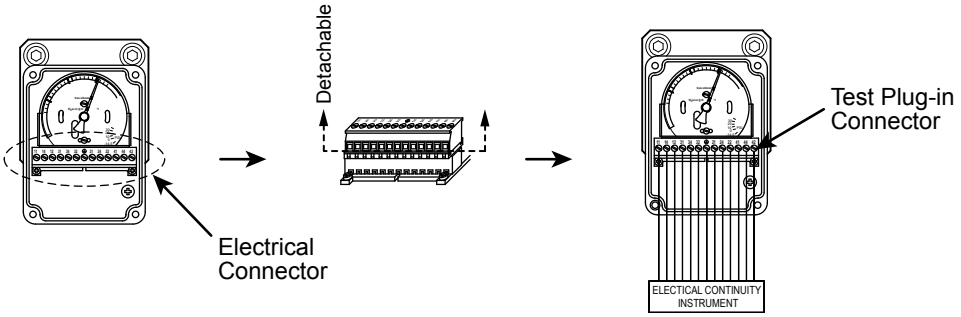


Fig. 5.5.4.2-11

Connect an electrical continuity instrument across the alarm and lockout contacts as defined on the gas schematic drawing by using the wire leads and clips provided on the test plug-in socket.

13. Based on the customer specified test kit, assemble the inlet pressure connection to the inlet valve, keeping the inlet valve in the closed position.

⚠ WARNING

The maximum test manifold pressure is 75 psig. Failure to limit the manifold pressure to 75 psig may result in damage to the density switch.

Verify the maximum inlet pressure is less than 75 psig.

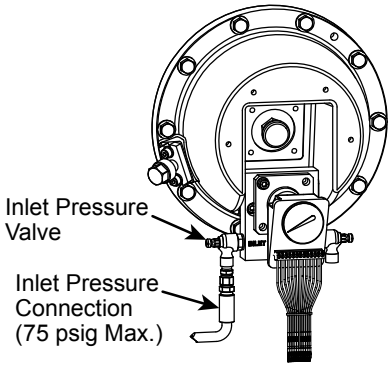


Fig. 5.5.4.2-12

14. Slowly open the inlet pressure valve to pressurize the test manifold by turning the handle counterclockwise. Once the manifold has reached approximately 71 psig, close the inlet pressure valve by turning the inlet valve handle clockwise.
15. Slowly open the manifold outlet valve. Record the pressure at which the alarm and lockout contacts operate in the decreasing pressure or "falling" direction. The recorded pressure is temperature compensated only when measured using the integrated pressure gauge. Temperature and pressure compensation may be required when using an external pressure measurement instrument and can be evaluated using the charts provided in Appendix H.1 and Appendix O.

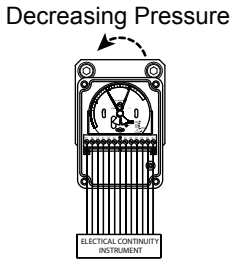


Fig. 5.5.4.2-13

16. Close the outlet valve once all measurements have been recorded.
17. To verify the contacts in the increasing or "rising pressure" direction, slowly open the manifold inlet valve to pressurize the manifold. Record the pressure at which the lockout and alarm contacts operate. The recorded pressure is temperature compensated only when measured using the integrated pressure gauge. Temperature and pressure compensation may be required when using an external pressure measurement instrument and can be evaluated using the charts provided in Appendix H.1 and Appendix O.

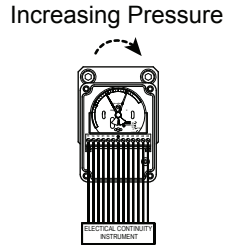


Fig. 5.5.4.2-14

Do not exceed the maximum inlet pressure of 75 psig during this step.

18. Once all measurements have been recorded, close the inlet valve. Completely depressurize the test manifold by opening the outlet valve. Remove the inlet pressure connection from the test manifold.
19. Remove the density switch test plug-in socket (7041) and store. Reinstall the control circuit electrical plug-in socket to the density switch removed in Step 12.
20. Reinstall the density switch electrical housing cover. Torque the four Phillips head screws to 2.3 Nm (1.7 lb-ft).
21. Remove the density switch from the test manifold. Verify the o-ring in the base of the density switch remains installed in the o-ring groove. Inspect the o-ring for any signs of wear or contamination. O-rings can be removed, cleaned with denatured alcohol, and a light coating of **Dow Corning** #111 grease (9908) may be applied if required.

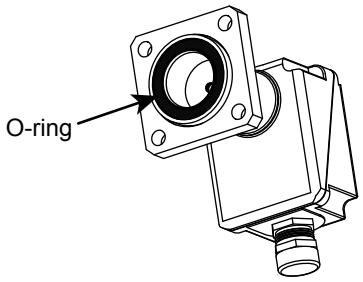


Fig. 5.5.4.2-15

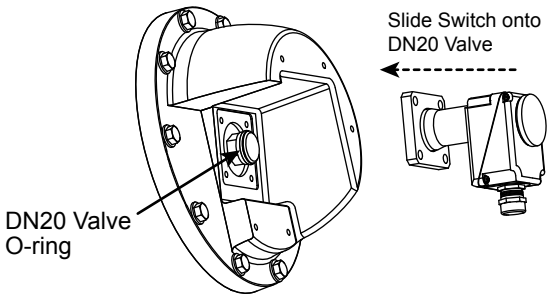
CAUTION

Do not mishandle the density switch when not secured to the rear inspection cover. Mechanical damage can occur or contact calibration may be affected if care is not observed.

22. Remove the test manifold from the rear inspection cover and store.

23. Inspect the o-ring on the DN20 valve mounted to the rear inspection cover for any signs of wear or contamination. O-rings can be removed, cleaned with denatured alcohol, and a light coating of **Dow Corning** #111 grease (9908) may be applied if required.

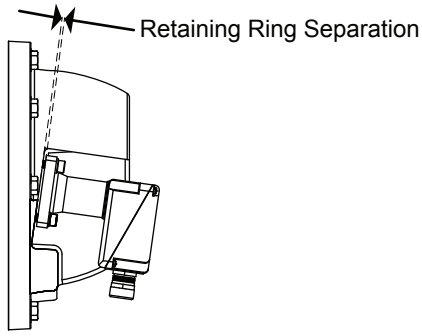
    Reinstall the density switch to the rear inspection cover by aligning and inserting the density switch base onto the DN20 valve. Take care not to damage the o-rings during this process.



(PARTIAL SECTION VIEW)

Fig. 5.5.4.2-16

24. Secure the density switch to the inspection cover by using a 6mm (long 6") ball point hex bit socket to install the two stainless steel M8x40mm jacking bolts and washers provided in the test kit. Evenly hand-tighten since these bolts will be fully engaged before the retaining ring is completely seated to the rear inspection cover base.



(PARTIAL SECTION VIEW)

Fig. 5.5.4.2-17

During this process, the self-sealing DN20 coupling valve will engage the density switch, pressurizing the small volume within the density switch. The density switch pressure gauge should indicate the correct breaker system gas pressure at the end of this step.

25. Apply **Loctite** #242 Blue (9903) to the two stainless steel M8x25mm bolts and install by evenly tighten until the density switch retaining ring is fully seated to the rear inspection cover base.
26. Completely remove the two stainless steel M8x40mm jacking bolts. Apply **Loctite** #242 Blue (9903) and reinstall the two black M8x30mm bolts previously removed in Step 3. Note that four washers should be fitted to each bolt. Evenly tighten and torque all four M8 bolts to 13.7 Nm (10.1 lb-ft).
27. Verify the pressure gauge is reading the correct breaker operating pressure.
28. Reinstall the insulation cover, ensuring the locking tab is secured.
29. Reinstall the solar cover using the four M8x14mm bolts. Torque to 13.7 Nm (10.1 lb-ft).

5.5.5 Gas Moisture Control

Protect the tanks from prolonged exposure to excessive moisture during installation or maintenance. Do not leave the tanks open to the environment for an extended period of time and temporarily seal it during maintenance when work is not actively being performed. If these precautions are observed, the interior and SF_6 gas will be dry and maintained dry by the adsorbent material installed as described in the Appendix D: Adsorbent Application or Replacement.

⚠ CAUTION

Check the control schematic diagram for breaker operation at lockout pressure. The breaker may trip open if SF_6 gas pressure drops to lockout pressure during the moisture content check.

The DN20 fill valve can be used to connect to the owner's moisture measuring instrument. The DN20 fill valve, identified on the gas system schematic, is located on the rear inspection cover.

Note: MEPPI recommends capturing released SF_6 gas to prevent escape to the atmosphere.

Limit the maximum level of moisture in the SF_6 gas to 300 ppm(v). If the initial test for moisture exceeds 300 ppm(v) level, repeat the test to verify the initial moisture test results. If the high moisture level persists, the following recommendations can be attempted to reduce the moisture level to 100 ppm(v) or less:

1. If the moisture test is being performed at pressures below the breaker rated fill pressure, verify the pressure is within the moisture meter manufacturer's recommended inlet pressure range. If the value is not, increase the breaker pressure to at least 5 psig above the moisture meter manufacturer's minimum recommended inlet pressure (typically 10 psig @ 20°C). Do not exceed the moisture meter manufacturer's maximum inlet pressure value.
2. Limit the number of fittings, connections and hose length from the breaker to the moisture meter to the minimum amount necessary.
3. Increase the flow rate through the moisture meter up to 1.0 liter/minute.

If none of these recommendations achieve a moisture level measurement of 100 ppm(v) or less, evacuate the main tank and replace the adsorbent. Fill the breaker using reclaimed SF_6 gas that has been filtered and dried or new dry SF_6 gas that has had the moisture content verified to be within acceptable limits.

5.5.6 Renewal of Adsorbent

The adsorbent is located on the inside of the rear cover of the tanks. Replace the adsorbent and the O-rings each time the tanks are opened to inspect the contacts. The procedure for replacing the adsorbent is described in Appendix D: Adsorbent Application or Replacement. Clean the rear cover and the O-ring seal surfaces, and apply gas sealant as described in Appendix A: SF_6 Gas Seals. Evacuate per Appendix E: Filling, Removal, and Leak Detection of SF_6. Seal around exterior hardware and rear cover joint with weather sealant per Appendix F: Weather Sealant.

5.6 Mechanism and Linkage Inspection

5.6.1 Manual Jack Assembly

A manual jack assembly is provided to perform a slow manual open or close of the breaker without electrical control power.

⚠ DANGER	Do not open or close the breaker with the manual jack assembly if the breaker is energized. The jack assembly is a maintenance tool and must be used only on a de-energized breaker isolated from the power system.

⚠ WARNING	De-energize the circuit breaker and ground the high voltage terminals. De-energize the AC and DC circuits by opening the control and auxiliary circuit switches. Insert trip and/or close prevention pins (as outlined in Section 3.6.6 Prevention Pins) into the mechanism before installing the manual jack.

5.6.1.1 Installing Manual Jack Assembly

Type MD100246

Refer to Fig. 5.6-1 Mounting of Manual Jack for the following steps.

1. Insert the pin into the main lever of the mechanism and secure it with cotter pins.
2. Apply a thin coat of grease to the threads of the jack bar to reduce friction while jacking.
3. Thread the jack nut onto the jack bar.
4. Position the far end of the jack bar over the pin in the mechanism main lever.
5. Place the guide over the jack bar and nut.
6. Secure the guide to the mechanism frame with two M20x40 bolts.
7. A special socket, operated by a M30 socket and wrench, is provided to fit the jack bar nut.
8. Rotate the jack nut by its hex end counterclockwise until the bearing seats in the guide counterbore.
9. Turning the jack nut clockwise will open the main contacts. Turning the jack nut counterclockwise will close the main contacts.

Type MD100577
Refer to Fig. 5.6-1 Mounting of Manual Jack for the following steps.

1. Insert the pin into the main lever of the mechanism and secure it with cotter pins.
2. Apply a thin coat of grease to the threads of the jack bar to reduce friction while jacking.
3. Thread the jack nut onto the guide.
4. Position the far end of the jack bar over the pin in the mechanism main lever.
5. Secure the guide to the mechanism frame with two M20x40 bolts.
6. Using a 19mm socket, rotate the jack nut by its hex end clockwise until the jack bar clevis seats against the pin.
7. Turning the jack nut counterclockwise will open the main contacts. Turning the jack nut
8. clockwise will close the main contacts.

Note: When properly oriented, the jack bar will be under compression.

⚠ **CAUTION**	Incorrect installation and operation of the manual jack may bind the mechanism.

5.6.1.2 Manual Opening

Insert the trip prevention pin. Insert the close prevention pin if the close spring is charged. Assemble the manual jack as per Fig. 5.6-1 Mounting of Manual Jack and jack the mechanism with a counterclockwise rotation (type MD100246) or clockwise (type MD100577)(approximately 1/8 turn) into its overtravel position to relieve the trigger load.

Remove the trip prevention pin. Push on the trip coil assembly's plunger and maintain the force on the trip button while turning the socket clockwise (type MD100246) or counterclockwise (type MD100577) until the trip trigger is disengaged from the trip holding latch. Release the trip plunger and continue the open operation until the jack nut assembly becomes loose. The jack allows the breaker to open slowly by holding against and slowly releasing the force of the mechanism.

CAUTION

Insert the close prevention pin before removing the manual jack assembly from the mechanism when the breaker is in the open position.

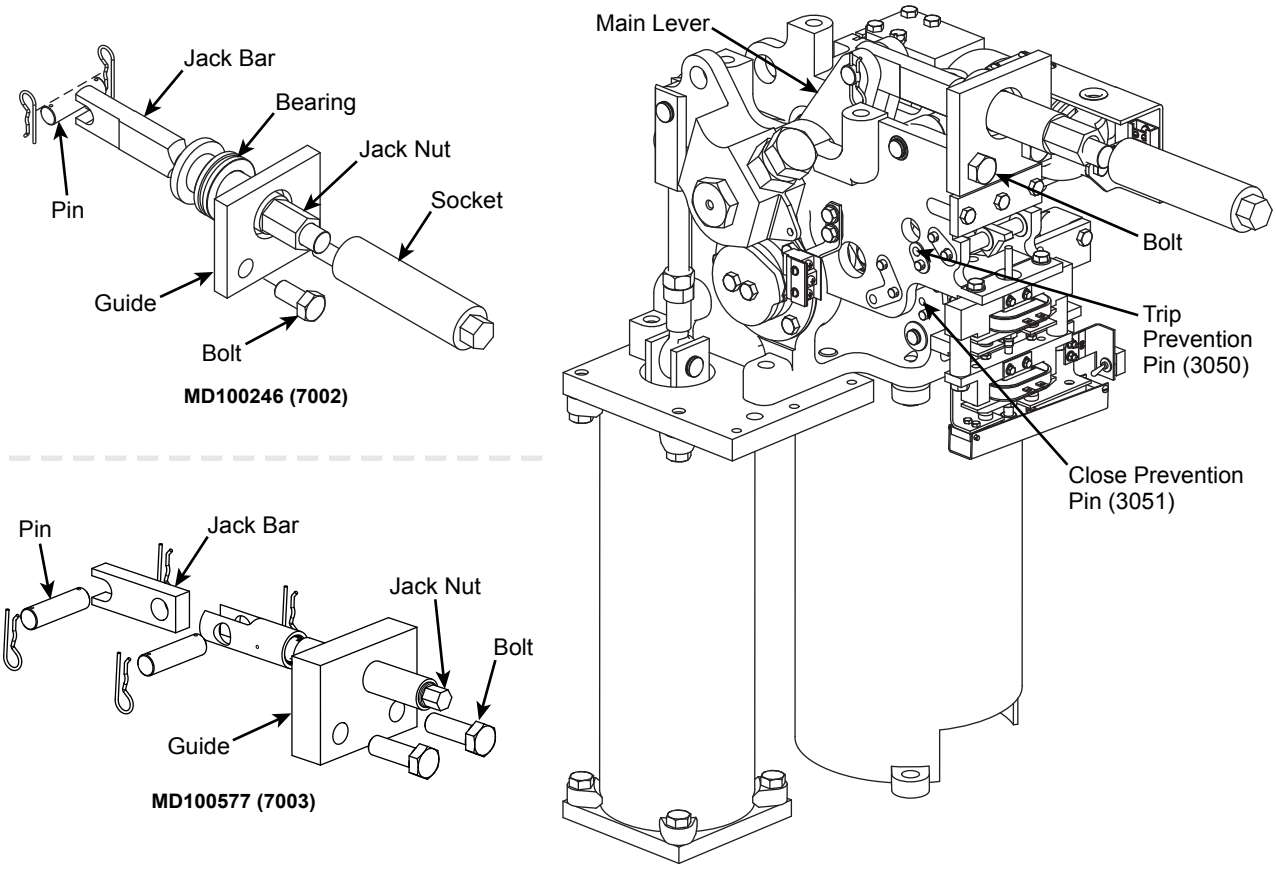


Fig. 5.6-1 Mounting of Manual Jack

5.6.1.3 Manual Closing

1. Install the manual jack per Section 5.6.1.1 Installing Manual Jack Assembly (refer to Fig. 5.6-1).

   Note: The manual jack can be used to close the breaker without removing the close prevention pin. If the close spring is in the charged condition, the close prevention pin should remain installed in the mechanism.

   The close coil assembly plunger does not need to be depressed at the start of the manual jacking closed process.

   Manually jacking the breaker closed will charge the trip spring. The applied force from the trip spring on the ratchet tool will be fairly uniform from start to finish.

2. Rotate the socket counterclockwise (type MD100246) or clockwise (type MD00577) with the ratchet to close the breaker. When the tripping trigger engages the trip holding latch, a distinct click will be heard. The auxiliary switch contacts will also actuate with a slight click about midway through the closing stroke.
3. Insert the trip prevention pin.
4. Rotate the socket clockwise (type MD100246) or counterclockwise (type MD00577) with the ratchet to seat the holding latch on pin "A" which secures the breaker in the closed position. Additional clockwise (type MD100246) or counterclockwise (type MD00577) rotation will loosen the manual jack assembly so that it can be removed from the mechanism bracket.

   Note: The trip and close prevention pins must be removed before attempting electrical operation of the breaker.

⚠ **CAUTION**	Insert the trip prevention pin before removing the manual jack assembly from the mechanism when the breaker is in the closed position.

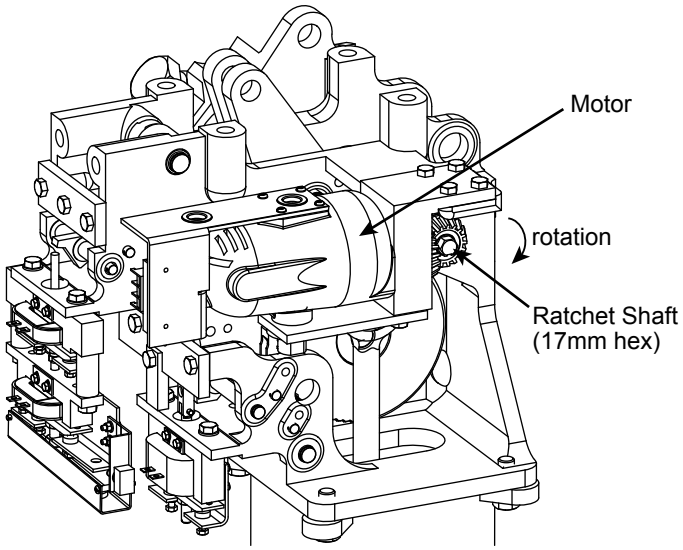


Fig. 5.6-2 Manual Charging of Close Spring

5.6.1.4 Manual Charging of the Close Spring

CAUTION

Do not attempt to manually charge the close spring without first de-energizing the spring charging motor circuit by opening the appropriate motor supply disconnect. Refer to customer specific schematic.

The close spring can be charged in both the closed and open position without electric power by fitting a 17 mm hex socket, extension, and ratchet wrench to the end of the ratchet shaft on the spring mechanism. Rotate the ratchet shaft clockwise until the close holding latch engages the close holding latch pin "B" (refer to Fig. 5.6-2).

Note: The ratchet wheel rotates in the charging direction only. The close spring can not be discharged by rotating the ratchet shaft in the opposite direction.

5.6.1.5 Manual Operation without Jack

The circuit breaker can be opened or closed without electric power by pushing on the trip or close coil's armature inside the mechanism housing if the trip or close springs are charged.

WARNING

The SF_6 lockout switch is bypassed during the manual operation. Check the SF_6 gauge for sufficient pressure before making a manual operation. Do not operate the breaker if the SF_6 gas pressure is below the lockout pressure.

Keep hands, body, and clothing away from mechanism when performing manual operations. The force of the mechanism can injure personnel.

5.6.2 Mechanism Lubrication

Lubrication of the mechanism is required during the routine and special inspections. Diamond low temperature #2 grease, available from Mitsubishi Electric Power Products, is the only authorized grease for this application.

CAUTION

Insert the close and trip prevention pins into the mechanism or mount the manual jack assembly before greasing the spring guide.

Remove as much of the existing grease as possible from the parts before applying the fresh grease.

The following items marked with an single asterik (*) are lubricated every twelve (12) years.

1. Bevel gears of motor drive.
2. Inner surface of close spring guide. The close spring must be in the charged position to grease the required area, Fig. 5.6-3. Insert the close prevention pin or attach the manual jack to the mechanism to prevent the spring from discharging. Apply the grease to the complete circumference of the inner surface from the spring to the short edge.

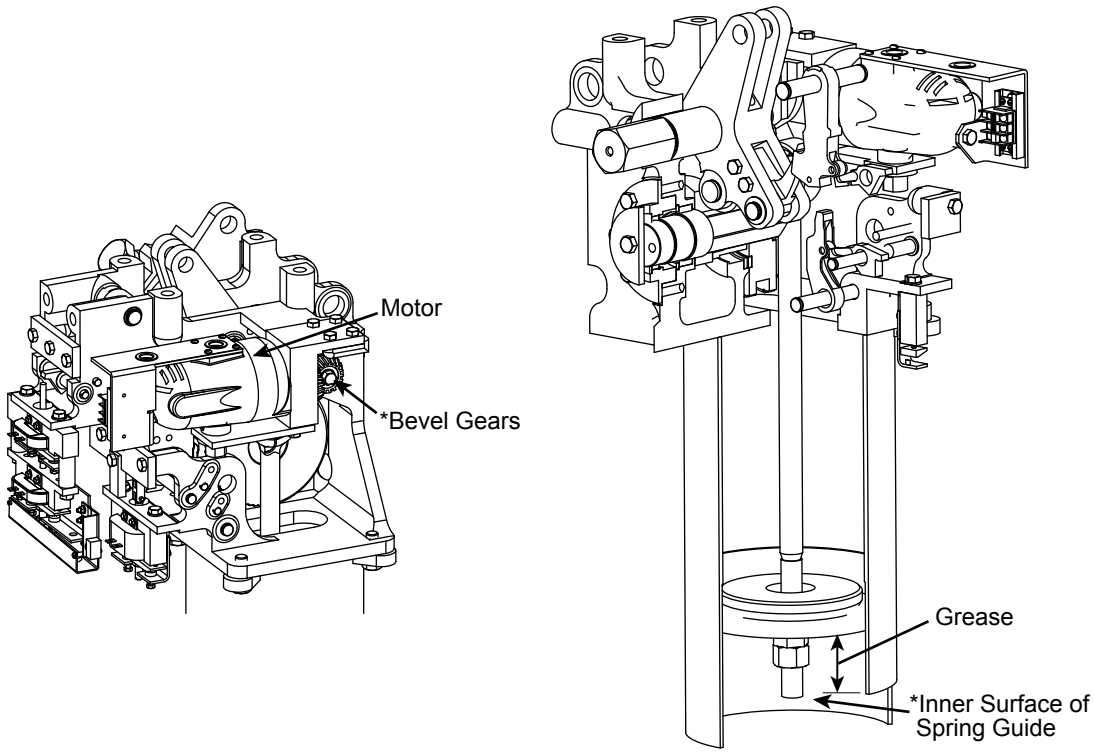


Fig. 5.6-3 Cross-Section View – Type BM-1 Spring Operating Mechanism

5.6.3 Mechanism Adjustments

The cam clearance and settings of the trip and close coil assemblies should be inspected and adjusted if necessary during the routine and special maintenances. Refer to Table 5.6-1 for the proper dimensions.

5.6.3.1 Cam Clearance

With the mechanism in the open position and the close spring charged, measure the gap (G) between the cam and the main lever roller. Adjustment of the gap (G) is made by changing the position (up or down) of the shock absorber's support plate.

⚠ CAUTION Insert the close prevention pin before the inspection or adjustment of Gap (G).

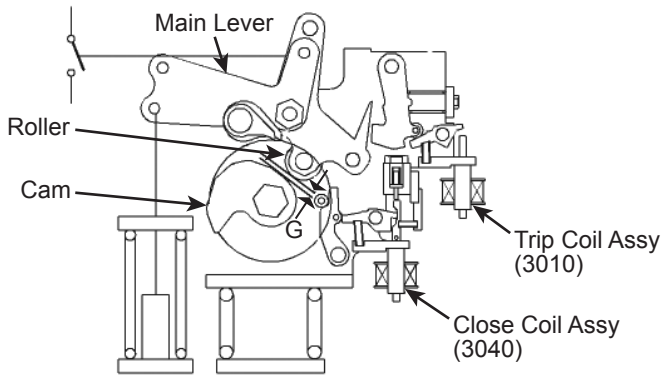


Fig. 5.6-4 Cam Clearance

5.6.3.2 Interrupter Travel (Stroke) and Contact Wipe

During inspection, check the mechanism travel (including the stroke and contact wipe of the interrupter), and the trip and close coil assemblies' settings. Adjust if necessary.

Measure the interrupter stroke from the face of the shaft seal assembly's mounting flange to the pin that connects the operating rod to the links of the three-phase linkage.

Note: Travel measurements must be made with the breaker filled with gas to the rated pressure.

⚠ CAUTION Insert the close prevention pin into the mechanism before inspection or maintenance.

Determine the need for an internal inspection of the interrupter contacts by the number of interruptions specified in Table 5.1-2, Fig. 5.1-1 or by external measurements, such as contact resistance or contact travel, that may identify an abnormal internal condition.

Measure the resistance of the main current path when the breaker is in the closed position with a 100-amp micro-ohm meter connected to the high-voltage bushing terminals. Refer to Section 7: Performance Specifications for criteria.

Measure the interrupter contact stroke and contact wipe by attaching an electrical continuity test instrument to the bushing terminals.

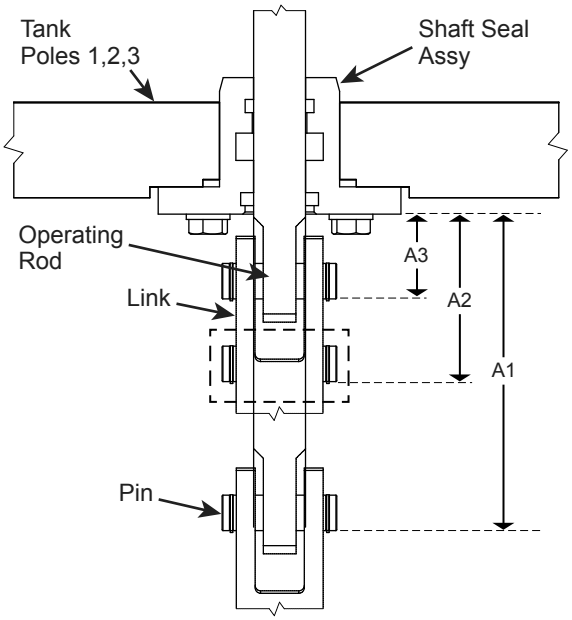


Fig. 5.6-5 Travel (Stroke)

A1 – With the interrupter in the open and latched position, measure the distance, A1, from the face of the shaft seal assembly to the link pin.

A2 – Manually jack the breaker towards the closed position until continuity is established (the interrupter contacts are touching). Jack the breaker open about one turn (until continuity is no longer indicated) and reclose the breaker very slowly until continuity is re-established. Measure the distance, A2, from the face of the shaft seal assembly to the link pin.

A3 – Manually jack the breaker to the fully closed position (until the mechanism is latched).

CAUTION Insert the trip prevention pin.

Loosen the jacking assembly. Measure the distance, A3, from the face of the shaft seal assembly to the link pin.

Interrupter Travel (Stroke)	= A1 - A3 = 145 - 152 mm (5.71 - 5.98 in)
Contact Wipe	= A2 - A3 = 25 - 29 mm (0.98 - 1.14 in)

The contact wipe range listed above applies to the initial breaker installation or when arcing contacts have been replaced. If, after operation in the field, the contact wipe is more than 2 mm from its recorded initial value, replacement of the arcing contacts or a worn linkage is indicated.

5.6.4 Trip Coil Assembly

⚠ CAUTION

With the breaker in the closed position, insert the trip prevention pin before inspection or adjustment of the trip coil assembly.

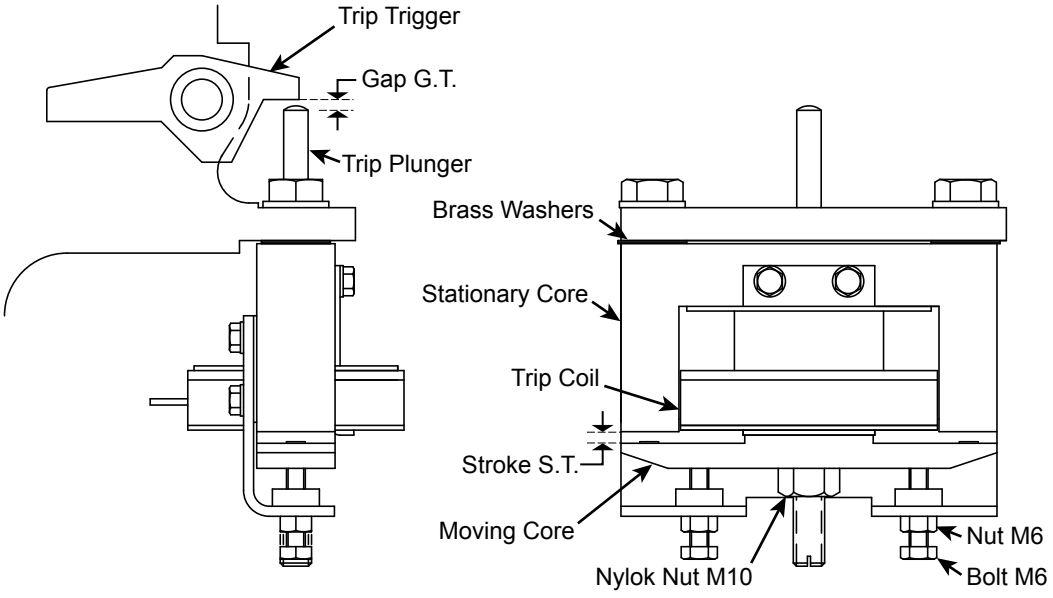


Fig. 5.6-6 Trip Coil Assembly (3010) Settings

Measure the stroke (S.T.) between the moving core and stationary core with a feeler gauge. Adjust the gap (S.T.) by loosening the two M6 nuts and turning the two M6 bolts.

After adjustment, torque the M6 nuts to 60 kg-cm (4.3 lb-ft).

Measure the gap (G.T.) between the trip coil plunger and the trip trigger with a feeler gauge. Adjust the gap (G.T.) by loosening the M10 nut on the plunger and rotating the plunger.

After adjustment, torque the M10 nut to 280 kg-cm (20 lb-ft).

5.6.5 Close Coil Assembly

CAUTION

With the breaker in the open position, insert the close prevention pin before inspecting or adjusting the close coil assembly.

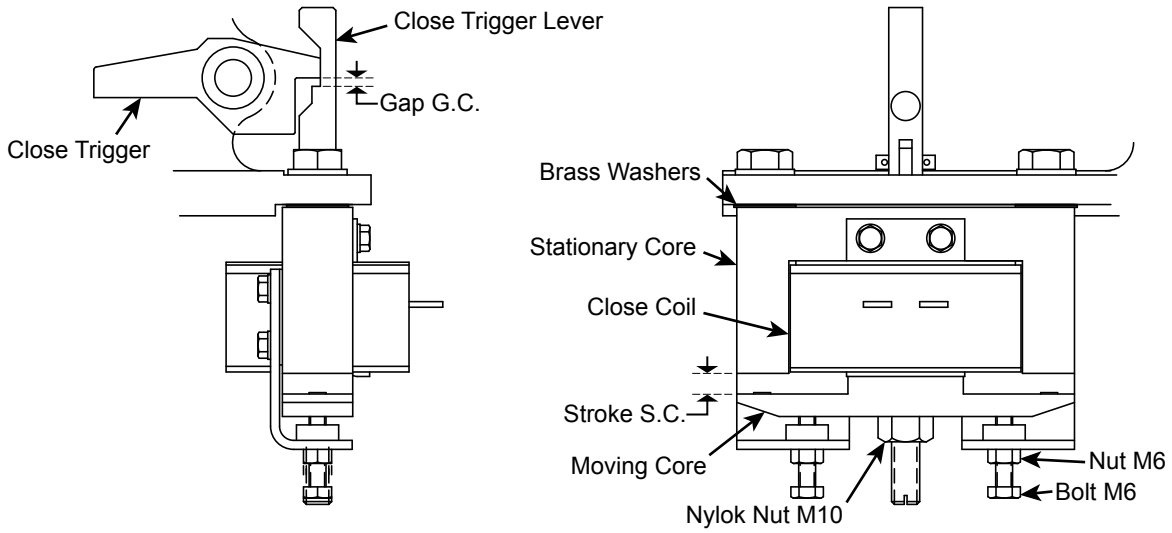


Fig. 5.6-7 Close Coil Assembly (3040) Settings

Determine the stroke (S.C.) of the moving core of the close coil assembly by measuring the gap between the moving core and stationary core. Adjust the stroke (S.C.) by loosening the two M6 nuts and adjusting the two M6 bolts. When adjustment is complete, torque the M6 nuts to 60 kg-cm (4.3 lb-ft) (refer to Fig. 5.6-7).

Measure the gap (G.C.) between the close coil trigger lever and the close trigger with a feeler gauge. Adjust the gap (G.C.) by loosening the M10 nut on the plunger and rotating the plunger. After adjustment, torque the M10 nut to 280 kg-cm (20 lb-ft).

⚠ CAUTION Be sure to torque all hardware that was loosened.

Table 5.6-1 Mechanism Dimensions

Item	Mark	Dimension	Fig No
Gap between roller and cam	G	1.1- 1.7 mm (0.043 - 0.067 in)	Fig. 5.6-4
Stroke of trip coil's moving core	S.T.	2.8 – 3.2 mm (0.110 – 0.126 in)	Fig. 5.6-6
Gap between trip coil plunger and trip trigger	G.T.	0.8 – 1.2 mm (0.031 – 0.047 in)	Fig. 5.6-6
Difference between stroke (S.T.) and gap (G.T.)	S.T. – G.T.	1.6 – 2.4 mm (0.063 – 0.094 in)	
Stroke of close coil's moving core	S.C.	5.0 – 5.5 mm (0.197 – 0.217 in)	Fig. 5.6-7
Gap between close trigger lever and close trigger	G.C.	2.0 – 2.5 mm (0.079 – 0.098 in)	Fig. 5.6-7
Difference between (S.C.) and gap (G.C.)	S.C. – G.C.	3.0 – 3.5 mm (0.118 – 0.138 in)	
Gap between plungers of trip coil 1 and 2 (H)	H	0.0 – 0.10 mm (0.0 – 0.004 in)	

5.7 Interrupter Inspection

Determine whether an internal inspection of the interrupter contacts is needed by referring to the number of interruptions specified in Table 5.1-2, Fig. 5.1-1, or by using external measurements, such as contact resistance or contact travel, that may identify an abnormal internal condition.

5.7.1 External Interrupter Inspection

Follow the procedure outlined in Section 5.6.3.2 Interrupter Travel (Stroke) and Contact Wipe for external interrupter inspection.

5.7.2 Internal Contact Inspection

1. Open the circuit breaker.
2. Open the station disconnect air switches to isolate the breaker.
3. Ground the high voltage terminals.
4. Open the DC control and AC auxiliary power switches.
5. Install the close prevention pin.
6. Remove the SF_6 gas from the tanks (refer to Appendix E: Filling, Removal, and Leak Detection of SF_6).

⚠ DANGER

A tank with a high concentration of SF_6 can be hazardous, causing asphyxiation from lack of oxygen. Before entering, thoroughly ventilate the tanks and clean the interior of powders. A continuous flow of dry, fresh air improves personnel conditions and helps keep the atmosphere air from entering the tanks. Refer to the SF_6 gas section of this instruction book for precautions in an SF_6 environment.

7. Open the rear cover.
8. Ventilate the tanks with dry air to eliminate residual SF_6 gas.
9. Remove any gray powder from the area with a HEPA filtered vacuum cleaner.
10. Remove the stationary arcing contact assembly from the stationary interrupter assembly by removing the two M10 socket head bolts with a 8 mm Allen head socket, extension, and ratchet wrench (refer to Fig. 5.7-1b).
11. Examine the arcing contact for erosion. The service length of the contact is 210 to 220 mm (8.26 to 8.66 in) (refer to Fig. 5.7-2).

Note: Further disassembly is not required and the stationary arcing contact can be reassembled to the interrupter if contact erosion does not exceed the minimum value listed in step #11.

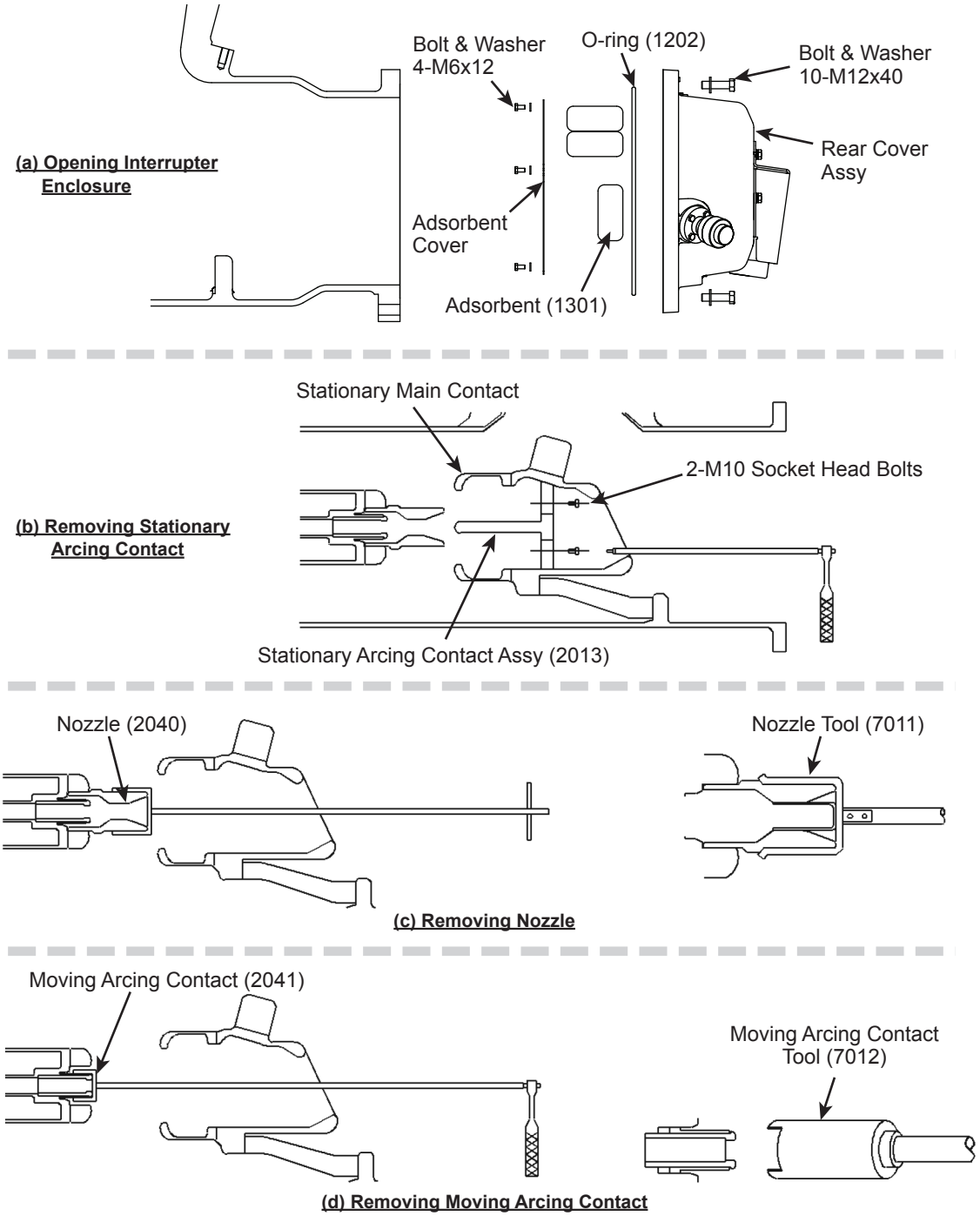


Fig. 5.7-1 Replacing Arcing Contacts and Nozzle

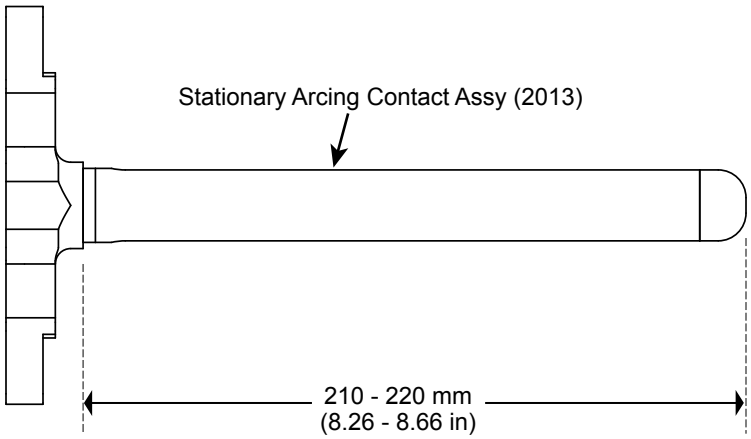


Fig. 5.7-2 Stationary Arcing Contact Service Limit

5.7.3 Removal and Reassembly of the Stationary Arcing Contact

1. Remove the stationary arcing contact assembly per instructions in Section 5.7.2 Internal Contact Inspection.
2. Before replacement of the arcing contact into the breaker:
   a. Remove the abrasions and polish the arcing contact with fine sandpaper, emery cloth, or **Scotch-Brite**.
   b. Remeasure the contact length to verify it is still within the limits specified in Section 5.7.2 Internal Contact Inspection Step #11.
   c. Apply a very light film of **Noxlub** contact grease to the contact surface.
3. If the arc erosion has reduced the length of the stationary arcing contact to less than 210 mm (8.26 in), replace the stationary arcing contact assembly, nozzle, and moving arcing contact with new components.

5.7.4 Removal of the Nozzle and Moving Arcing Contacts

If it is deemed that the stationary arcing contact needs to be replaced, the nozzle and moving arcing contacts shall be replaced at the same time. The procedure for removal of these two items is described below.

1. Insert the nozzle tool into the nozzle and turn counterclockwise to remove the nozzle (refer to Fig. 5.7-1c).
2. Insert the moving arcing contact tool into the moving arcing contacts and turn counterclockwise to remove the moving arcing contact (refer to Fig. 5.7-1d).

5.7.5 Reassembling Arcing Contacts and Nozzle

1. Thoroughly clean the interior of the tanks and the insulating components. Use lint-free cloth and denatured alcohol to clean the insulating parts.
2. Remove the dirt and powders with a HEPA filtered vacuum cleaner.
3. Clean the surfaces of the moving arcing contacts with denatured alcohol.
4. Apply a very light film of **Noxlub** contact grease to the threads and the inside contact surface of the moving contacts.
5. Assemble the moving arcing contacts with the moving arcing contact tool and torque the contact to 2200 kg-cm (159 lb-ft).
6. Clean the new nozzle with denatured alcohol and a lint-free cloth.
7. Install the nozzle using the nozzle installation tool (refer to Fig. 5.7-1c). The nozzle is locked into place by an interference fit. The resistance to threading the nozzle increases after three or four turns and then decreases as the nozzle is screwed into position. When the resistance reduces, remove the handle from the nozzle tool and turn the tool by hand, making sure it turns freely over 90°.

   Note: Do not bottom out the nozzle. It must turn freely after the resistance decreases.

5.7.6 Reassembling the Stationary Arcing Contact Assembly

1. Apply a very thin coat of **Noxlub** contact grease to the tips of the moving arcing contact fingers (refer to Fig. 5.7-3), and to the tip and the surface of the stationary arcing contact (refer to Appendix C: Lubricating).
2. Apply a very thin film of **Noxlub** contact grease to the surface of the stationary contact holder where it mates with the stationary interrupter assembly.
3. Apply **Loctite** #277 Red to the bolts that attach the stationary arcing contact assembly to the stationary interrupter assembly and connect them together torquing the bolts to 280 kg-cm (20.3 lb-ft).

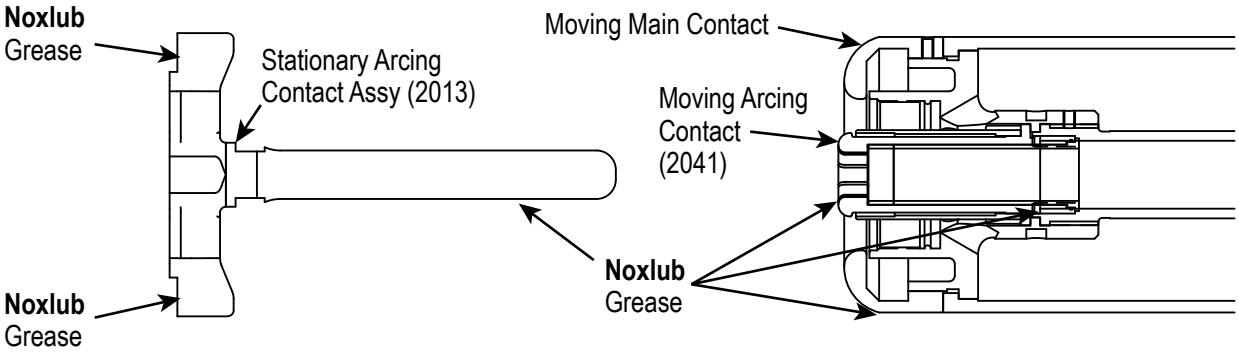


Fig. 5.7-3 Application of Contact Grease

5.7.7 Rear Cover Replacement

1. Remove all the old gas sealant from the tank flange and the rear cover with a plastic scraper and **Scotch-Brite** with denatured alcohol.
2. Replace the adsorbent located in the rear covers (refer to Fig. 5.7-4). Make sure that all adsorbent is inside the sealed SF_6 tank within one hour of its removal from the shipping container and plastic bag.
3. Apply **Loctite** #242 Blue to the threads of the adsorbent cover mounting bolts.
4. Apply new gas sealant to the rear cover flanges and install the gas sealing O-rings according to Appendix A: SF_6 Gas Seals.

Note: Assembly must be completed before the sealant starts to set. The rear cover must be mated to the opposing tank flange in less than 10 minutes after application of a 0.25 mm (0.01 in) thick layer of gas sealant to the seal surface.

5. Inspect, clean, and close the tank. Torque the bolts according to Appendix B: Torquing of Bolts.

   Note: Tank evacuating must be performed within one hour of installing new adsorbent.

6. Evacuate the tanks to 1 Torr (1 mmHg). Continue evacuating for at least an additional half-hour and refill with SF_6 gas to the normal operating pressure.

   Note: To prevent air from contaminating the SF_6 gas in the tanks, bleed all hoses when making connections to fill the breaker with gas.

7. Apply weather sealant to the joints and hardware per Appendix F: Weather Sealing.

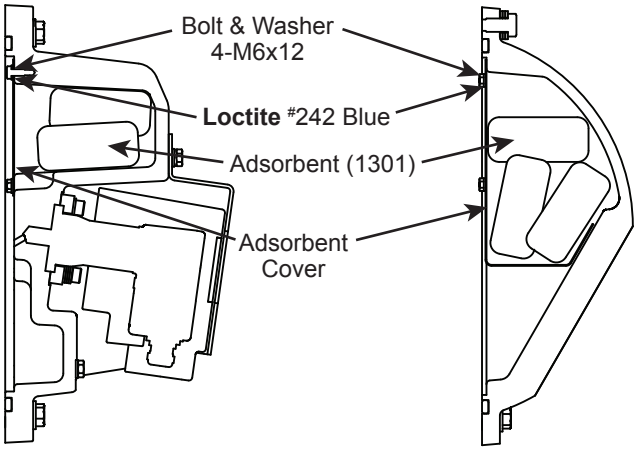


Fig. 5.7-4 Adsorbent Assembly

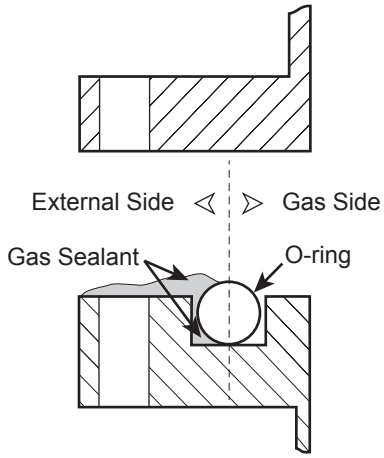


Fig. 5.7-5 Gas Seal Joint

6 Installation

The circuit breaker was completely assembled, adjusted, and tested at the factory before shipping. If proper care is taken during assembly at the site, no adjustments should be necessary and the breaker should operate according to specifications.

Though technical assistance is available from Mitsubishi Electric Power Products, Inc, the timing for it can be minimized if the subframe is bolted to the foundation, the frame is adjusted to its operating position, and the control and current transformer wiring is complete. Use temporary wiring if the permanent wiring can not be completed.

6.1 Installation Material and Tools

The following is a list of materials, tools, and equipment used during circuit breaker installation. Save time by having the material, tools, and equipment at the site before installation begins. Inventory all parts against the packing list and note any shortage.

6.1.1 Supplied with Circuit Breaker

- Manual jack assembly — Manual breaker operation
- Fill valve adapter, 9/16-18 SAE 37° to 1 5/8-12 SAE 37° — Gas filling
- Fill valve adapter, 1 5/8-12 SAE 37° to **Dilo** DN20 — Evacuating & gas filling

6.1.2 Supplied by Purchaser

- Crane and four 3.6 m (12 ft) minimum nylon slings for four-point pickup of circuit breaker (Breaker weight = 2700 to 3600 kg (6,000 to 8,000 lbs)) See breaker nameplate for actual weight
- Two come-a-longs or block-and-tackle of sufficient capacity to accommodate the breaker weights to level load
- Bucket truck or ladder to reach high voltage terminal
- SF_6 gas handling equipment
- SF_6 gas regulator
- SF_6 gas hose with $^9/_{16}$-18 UNF fittings
- Set of metric sockets (8 to 36 mm)
- Set of metric open-end or box wrenches (8 to 36 mm)
- Pliers and screwdriver
- Wire cutter, stripper, and crimper
- Silicon sandpaper and **Scotch-Brite**
- Denatured alcohol
- Shackles
- Hammer and crowbar, or nail puller
- Clean waste cloth or lint-free wipes
- Multi-meter
- Micro-ohmmeter
- Megger (500 & 1000 V)
- Breaker timer
- Nikkei Jointal Z electrical joint compound

6.2 Installation Procedure and Checklist

The following is the sequence of installation and checklist.

Item	Requirement	Optional	Reference	Complete
Foundation	Foundation drawing: check level and shim		6.3.2	
Support Frame	Ground pad orientation		6.3.2	
Breaker Assembly	Level		6.3.2	
	Electrical joint compound		APX-G	
	Torque bolts		APX-B	
	Connect ground leads			
SF_6 System	Fill		6.3.3	
	Leak test		6.4.2	
	Alarm pressure	X	6.4.3	
	Lockout pressure	X	6.4.3	
	Temperature	X	APX-E	
Wiring	Connect station wiring		6.3.4	
	Tightness of all connections		APX-I	
	Insulation test			
Manual Operation	Manual jack		5.6.1	
Contact Resistance			6.4.1	
Phase 1				
Phase 2				
Phase 3				
Breaker Operation			6.4.4	
Breaker Timing			6.4.5	
Final Inspection			6.4.6	
Trip prevention pin removed				
Close prevention pin removed				
DN20 Gas fill valve cap tight				
Operation counter				

6.3 Installation of Circuit Breaker

⚠ CAUTION	Do not apply excess force or heavy impact to the bushings, operating mechanism, cabinet, gas piping, or other circuit breaker components.

6.3.1 Foundation

Verify that the positions of the anchor bolts and grounding wires agree with the breaker outline and foundation drawings. Check that the foundation is level at the leg mounting area. If needed, use shims to level the four surfaces to within 1.6 mm (0.06 in).

⚠ CAUTION	Do not attempt to move the circuit breaker by lifting under the tanks with a forklift. Do not attempt to lift the circuit breaker using the lifting eyes on the cabinet.

6.3.2 Circuit Breaker and Frame Assembly

The lower support legs are attached to the frame assembly in a collapsed position for shipping. Use a crane and four 3.6 m (12 ft) (minimum length) long nylon lifting slings to raise the breaker. Adjust the nylon lifting slings to lift the breaker in a level position. An additional wrap of the sling around the shackle may be required on the cabinet side to obtain a level lift. Refer to Fig. 6.3-1 for the proper locations of the slings. Reposition the slings, if necessary, to ensure that they do not apply excessive pressure to the BCT covers during the lift.

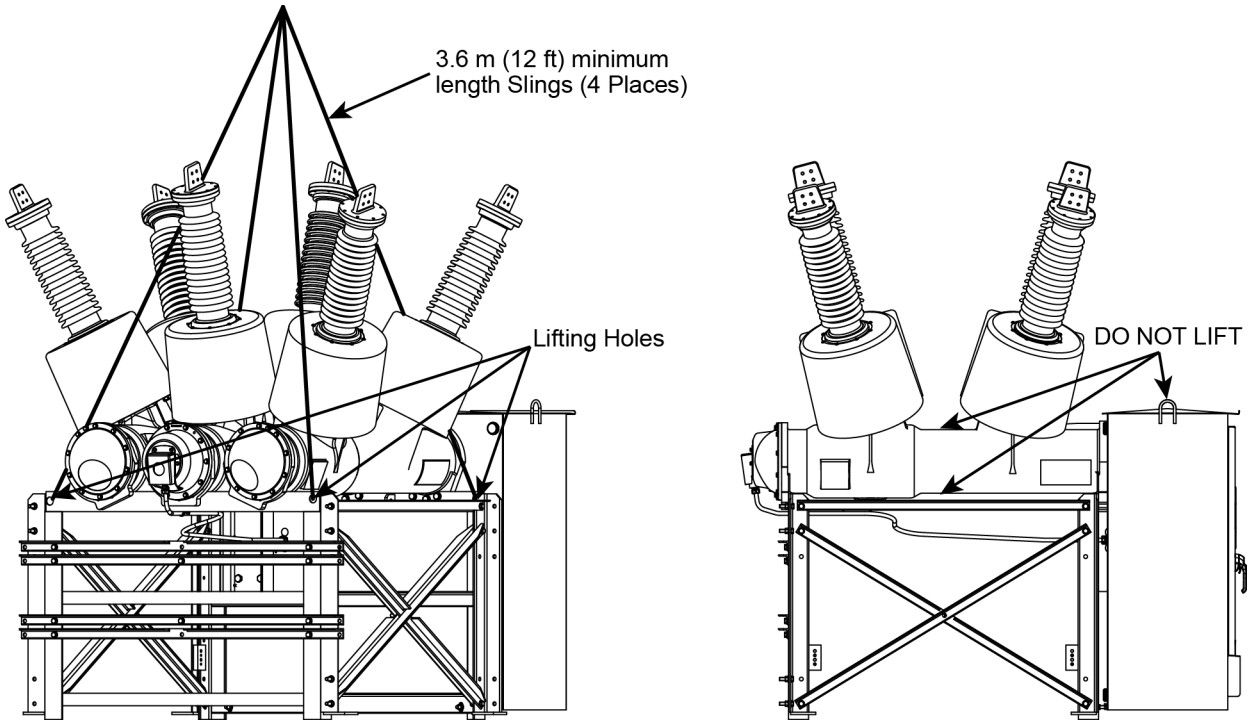


Fig. 6.3-1 Lifting Breaker

The lower support legs are attached to the frame assembly using M16 bolts. Remove the bolts, support legs and bracing from the frame assembly. Apply Nikkei Jointal Z electrical joint compound to the mating surfaces of the upper frame and lower support legs according to Appendix G: Application of Electrical Joint Compound. **Note**: Throughout this book, the generic term joint compound is used to refer to this specific electric joint compound.

Note: Care must be taken when preparing the joints between the frame assembly and lower support legs. These bolted joints provide a grounding connection between the frame and legs. Clean mating surfaces with **Scotch-Brite** and apply electrical joint compound. Verify that all frame components meet squarely and torque all mounting hardware.

Align the correct holes in the lower support legs with those in the upper frame to obtain the appropriate ground pad height as specified on the outline drawing. Install the M16 hardware and temporarily tighten by hand. Install all horizontal and diagonal bracing and temporarily tighten by hand. Slowly place the breaker onto the foundation. Temporarily tighten the foundation bolts by hand.

When the breaker is level and in its proper position, torque the M16 bolts to 1,200 kg-cm (86.8 lb-ft). Torque the foundation nuts to the required torque specification.

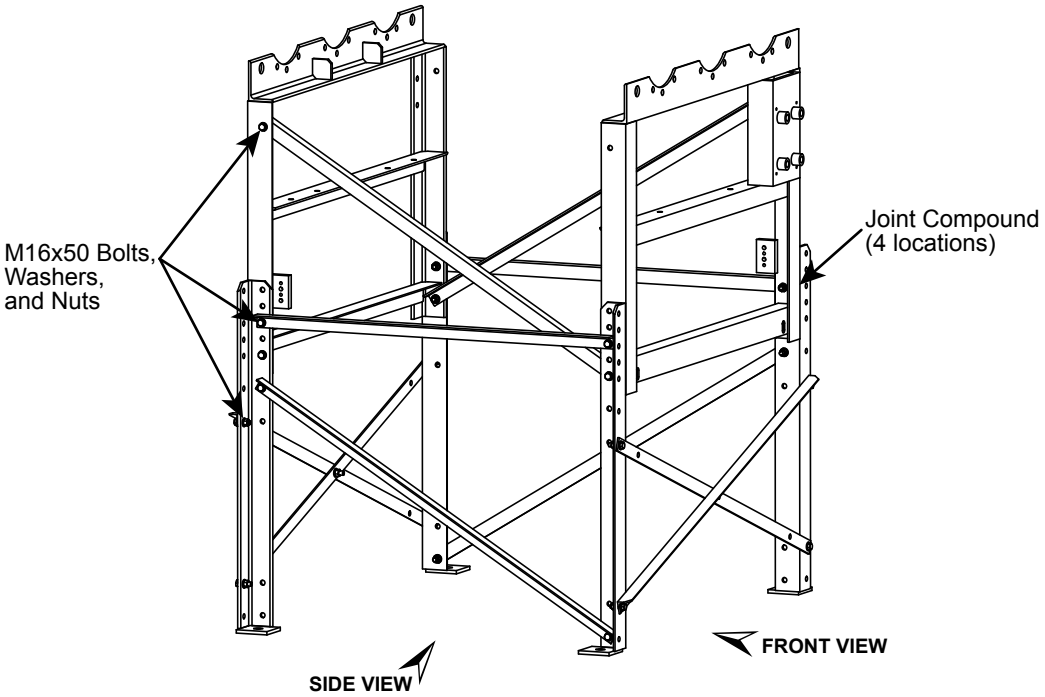


Fig. 6.3-2 Frame Assembly

6.3.3 Fork Truck Lifting

This breaker is capable of being lifted with a fork truck as long as the fork truck tubes are provided. They are a bolt-on option that can easily be added in the field by the customer. The following equipment specifications are required to safely lift a breaker with a fork truck:

Truck: Must be equipped with a shaft type carriage
Size: 15,500 lb capacity @ 24 in load center
Fork Length: 72 in minimum (84 in recommended)

The forks must be inserted into the fork tubes until they contact the stop in the back of the tubes. When the breaker is lifted, it is permissible for the leading end of the breaker to sag by as much as four (4) degrees.

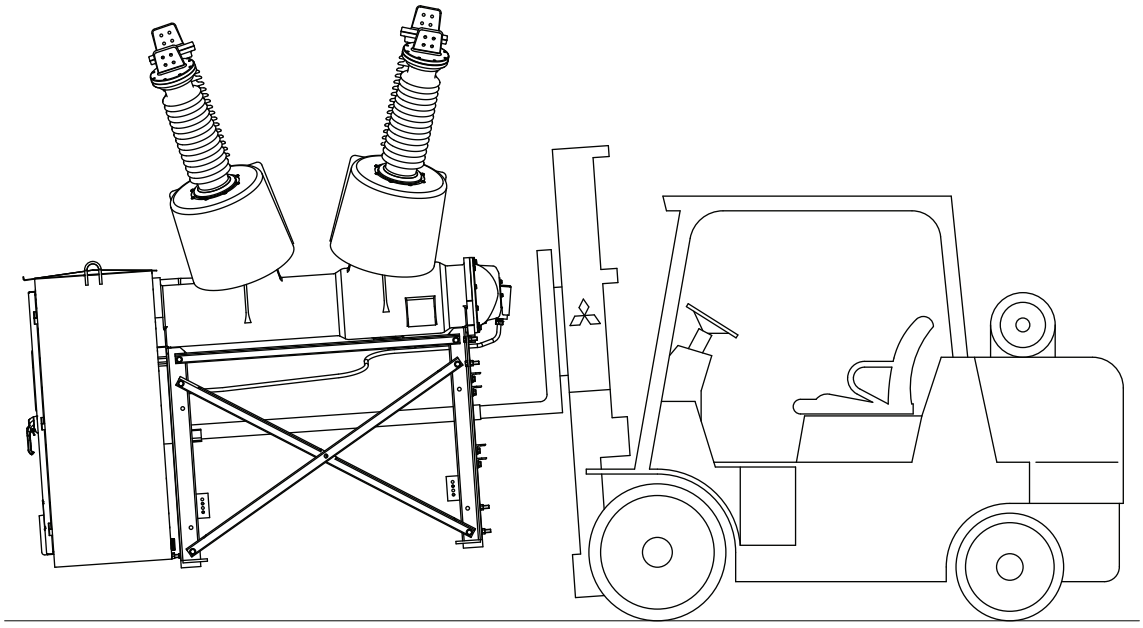


Fig. 6.3-3 Fork Truck Lifting

6.3.4 SF_6 Gas Filling

The circuit breaker is assembled and filled with positive SF_6 gas pressure for shipment. Breaker evacuating after installation and prior to filling with SF_6 gas is not necessary unless the pressure gauge shows no gas pressure, indicating possible shipping damage. If SF_6 gas has been lost, locate and repair the source of the leak (refer to Appendix E: Filling, Removal, and Leak Detection of SF_6).

Remove the cap from the **Dilo** DN20 and connect the hose adapter to the SF_6 gas fill valve on the breaker. Fill the tanks to their normal SF_6 operating pressure.

Note: To prevent air from contaminating the SF_6 gas in the tanks, bleed all hoses when making connections to fill the breaker with gas.

6.3.5 Wiring Connection

Refer to the breaker's wiring diagrams to identify the proper terminals to connect the breaker to the station controls. A recommended procedure for installing and terminating multi-conductor control cable is included in Appendix I: Installing Control Cables.

6.3.6 Manual Circuit Breaker Operation

Manually open and close the circuit breaker using the manual jack before electrical operation to verify that no damage occurred during shipping or installation (refer to Fig. 5.6-1).

6.4 Installation Testing and Inspection

The circuit breaker was completely assembled, tested, and timed as a three-phase unit at the factory. Field tests are performed to confirm that the breaker was not damaged during shipping and was installed correctly.

6.4.1 Contact Resistance

With a minimum current flow of 100 amperes DC, measure the resistance of the high-voltage circuit on each phase from terminal to terminal with the breaker in the closed position. Refer to the factory test report for resistance values. Specific values are listed in Section 7: Performance Specifications.

6.4.2 SF_6 Gas Leak Test

The factory-prepared joints have been leak tested. Since no SF_6 gas seals are made during a standard installation of this type breaker, a leak test is not normally required. Refer to Appendix E: Filling, Removal, and Leak Detection of SF_6 if appropriate.

6.4.3 SF_6 Density Switch Test

Refer to Section 5.5.4 for SF_6 gas density switch calibration verification test procedures if appropriate.

6.4.4 Operation Test

Prior to operations, check the following items:

a. The SF_6 gas density switch is properly installed.
b. SF_6 gas pressure is correct.
c. Manual jack has been removed.
d. Close and trip prevention pins have been removed.

The breaker has been completely tested at the factory. Therefore, repeating all the mechanical operations and timing tests after installation is not necessary. Perform the following operations to confirm that the breaker was wired correctly:

- C - Close
- O - Open (Trip 1)
- O - Open (Trip 2)
- CO - Close-Open
- O CO - Open Close-Open

6.4.5 Timing Tests

Test at the rated voltages and the nominal SF_6 gas pressure. An oscillograph or digital timer may be used for the timing tests.

Under normal installation and maintenance conditions, evaluate the dynamic performance of the circuit breaker by measuring the close and trip operating times using an oscillograph with a minimum of five channels for recording.

1. Trip coil current
2. Close coil current
3. Breaker main contacts (three phases)

If travel timing is required, refer to Appendix T: Breaker Operation Testing.

Take the following measurements at the rated control voltages and the nominal SF_6 gas pressure:

Open Operation
- time from energization of the trip coil to the parting of the last interrupter contact (Open Time). (T2)
- time between the parting of the first and last interrupter contact (Synchronization). (T4)

Close Operation
- time from energization of the close coil to the making of the last interrupter contact (Close Time). (T1)
- time between the making of the first and last interrupter contact (Synchronization). (T3)

Note: Open signal and close signal traces depict the current flowing through the trip coil and the close coil.

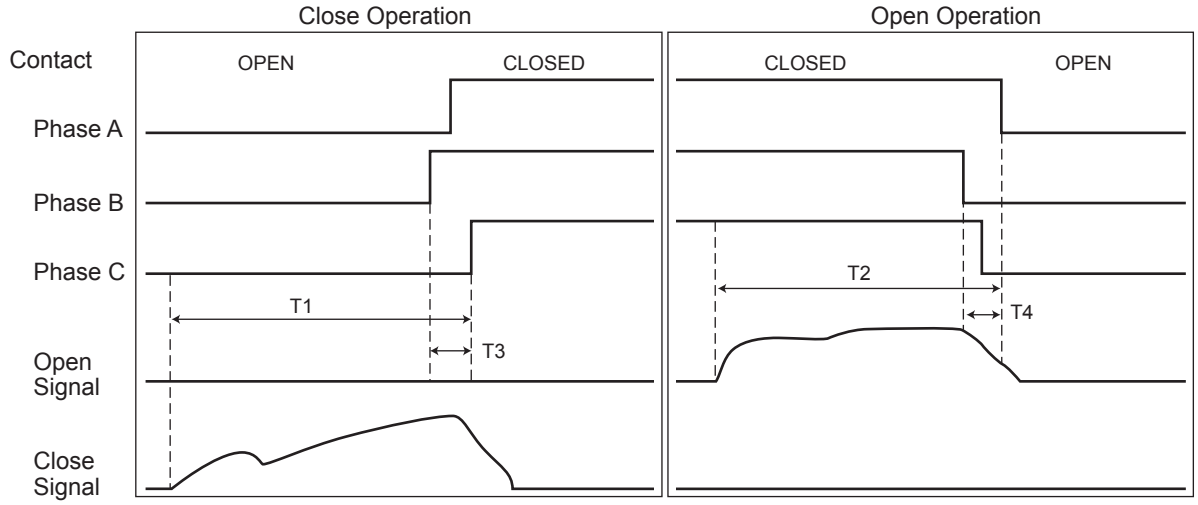


Fig. 6.4-1 Timing Trace

6.4.6 Final Inspection

Make a final visual inspection of the equipment. Use the touch-up paint supplied with the equipment to repair any areas where paint chipped during shipping and installation.

This page left blank intentionally.

7

Performance Specifications

Pressure Description	Fill Pressure 30/70SFMT40E-B		Temp	
	(kPag)	(psig)	(°C)	(°F)
Rated Pressure	490	71	20	68
Maximum Pressure	510	74		
*Low Pressure Alarm (63GA)	440±21	64±3		
*Low Pressure Lockout (63GL)	390±21	57±3		
Alarm minus Lockout (63GA-63GL)	50	7		

Breaker Designation	**SF_6 Gas Weight	
	(kg)	(lb)
30SFMT40E-B	18	40
70SFMT40E-B	18	40

Breaker Designation	Main Circuit Resistance @ 20°C		Current Transformer Resistance @ 500V	Control Circuit Insulation Resistance @ 500V
	Max Field Value	New Breaker Value		
	(micro-ohms)	(micro-ohms)	(Megohms)	(Megohms)
30SFMT40E-B	≤200	≤100	≥1	≥1
70SFMT40E-B	≤200	≤100	≥1	≥1

Notes:

*Tolerances shown are for Trafag density switch. Refer to customer specific gas system outline for alternate density switch devices.

**Refer to customer specific outline drawing for the specific gas weight.

SF_6 Gas Leakage Per Year	≤ 0.5%

Timing Data	125VDC	48VDC
Open Operation		
Contact Part	≤ 28 ms	≤ 33 ms
Contact Synchronization, Maximum	≤ 2 ms	≤ 2 ms
Close Operation		
***Contact Make	≤ 105 ms	≤ 105 ms
Contact Synchronization, Maximum	≤ 4 ms	≤ 4 ms
Reclose Operation - Trip Coil		
Energization to Contact Make	≤ 300 ms	≤ 300 ms
Note: This circuit breaker has no minimum reclose time delay requirement for proper mechanical function of the mechanism. Routine MEPPI production testing includes a 200ms simulated delay to demonstrate a typical reclose time delay. It is the responsibility of the end user to ensure conformance with the minimum reclose time requirements of IEEE C37.04-1999 or local requirements.		

Note: Above data applies to standard breaker designs. Values may differ on breakers supplied with optional components. Refer to data identified in the factory test report for a specific circuit breaker. Values from factory test reports may differ from information contained within the instruction book due to tighter tolerances required during factory testing. Contact a MEPPI associate with concerns pertaining to non-conformance values received during commissioning.

*** Values given do not include any close time delays.

Appendices General Procedures

The appendices feature installation, inspection, and maintenance procedures common to all MEPPI SF_6 gas circuit breakers. MEPPI recommends that maintenance personnel familiarize themselves with these procedures before working on the equipment.

A	SF_6 Gas Seals
B	Torquing of Bolts
C	Lubricating
D	Adsorbent Application or Replacement
E	Filling, Removal, and Leak Detection of SF_6
F	Weather Sealing
G	Electrical Joint Compound Application
H	Temperature Compensation Charts
I	Installing Control Cables
O	Gauge (SF_6) Pressure vs. Altitude
P	Internal-External Retaining Ring
Q	Tank Heaters
T	Breaker Operation Testing
U	SF_6 Gas Quality
W	Composite Insulators
Y	Replacing Rupture Disk
AA	Bushing Maintenance and Replacement
AB	Trip and Close Coil Replacement
DS	Material Safety Data Sheet

This page left blank intentionally.

A

Appendix A: SF_6 Gas Seals

These instructions describe the procedure to create leak-tight seals for bolted O-ring joints on SF_6 gas-filled equipment. Gas sealant is applied to the complete surface of the flange face between the O-ring groove and the outside edge of the flange eliminates corrosion caused by water entering between the flanges.

Note: Do not reuse O-rings from previous gas sealed joints.

A.1 Material

- Gas sealant 100g, Shin-Etsu KE-44-W
- Denatured alcohol
- ***Kimwipes**®
- **Dow Corning** #111 Valve Lubricant

A.2 Installation of O-ring

Clean the O-ring groove, flange face, and the adjoining sealing surface with clean waste cloth or **Kimwipes** towels moistened with denatured alcohol. Use a plastic or wooden paint scraper to remove old gas sealant.

Dry the groove and sealing surface and inspect for defects such as nicks, dents, lint, and dirt.

Inspect the O-ring for dust, along with cuts, pits, or other surface defects. Clean the O-ring with denatured alcohol, dry it, and place it in the groove to make sure that it is the proper size.

A.3 Applying the Gas Sealant

Apply the gas sealant to the O-ring groove and the flange surface according to the procedures outlined in Fig. A.5-1.

***Kimwipes**® is a registered trademark of Kimberly-Clark Worldwide, Inc.

A.4 General Precautions

Do not apply the sealant to the gas side of the O-ring groove.

Do not use any type of metal scraper on the sealing surface.

The joint must be mated to the opposing flange in less than 10 minutes after the application of a 0.25 mm (0.01 in) thick layer of gas sealant to the seal surface.

Do not mix grease with the sealant.

Remove excess sealant after the joint is assembled.

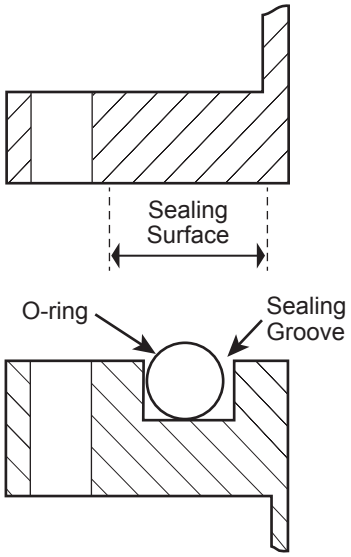


Fig. A.4-1

A.5 Small SF_6 Gas Seals

Apply the gas sealant to the complete surface of small flanges with O-ring grooves (≤38 mm (1.5 in) dia.) used in the SF_6 gas piping system. Use **Dow Corning** #111 Valve Lubricant on flexible gas piping fittings.

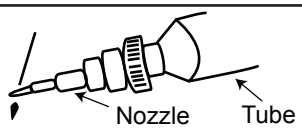
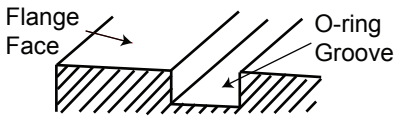
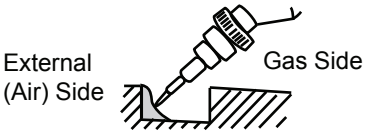
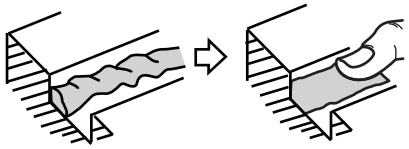
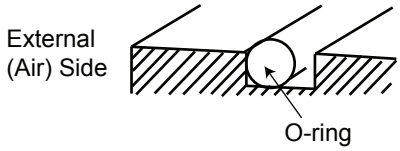
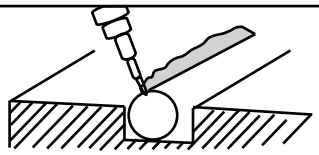
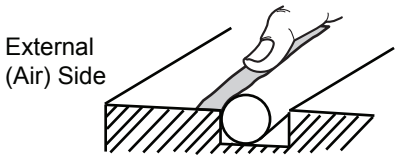
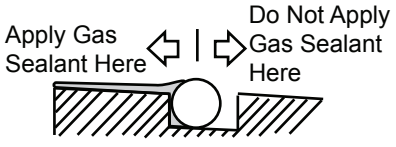
1		Attach the nozzle to the gas sealant tube. Cut the nozzle at a slant at the location that will create a 3.2 to 4.8 mm ($^1/_8$ to $^3/_{16}$ in) bead of sealant.
2		Clean the O-ring groove and flange face. Wipe the groove and flange face with solvent and dry thoroughly.
3		Apply the sealant around the entire external bottom side of the O-ring groove.
4		Lightly smooth the uneven surface of the gas sealant, filling in the corner with sealant.
5		Insert the O-ring into the groove and work it to the outside edge.
6		Apply the gas sealant between the O-ring and the top edge of the flange face.
7		Smooth the sealant by spreading the excess onto the flange face towards the external edge.
8		Cover the flange face with a thin film — approximately 0.25 mm (0.01 in) thick — of gas sealant from the O-ring to the external (air) edge of the flange. (For waterproofing and corrosion protection).
9	Assembly must be completed before the sealant starts to set. The joint must be mated to the opposing flange in less than 10 minutes after the application of a 0.25 mm (0.01 in) thick layer of gas sealant to the seal surface.	

Fig. A.5-1 Application Procedure for Gas Sealant

This page left blank intentionally.

B

Appendix B: Torquing of Bolts

These instructions cover the torque values and standard method of tightening bolts on circuit breakers.

Note: Consult MEPPI for torque values on all other connections (i.e., hose fittings, tubing fittings, conduit connections, etc.).

B.1 Torque Values

Torquing the bolts is recommended to obtain uniformity in the bolt loads and to avoid the possibility of bolt failure in pressure-tight joints. When multiple bolts are used to fasten two parts together, the load carried by each bolt depends on the tightness of the bolt relative to the other bolts; the tighter the bolt, the greater the load. It is also important that bolts be torqued symmetrically.

The standard torque values below apply to metal-to-metal bolted joints with bolts of various sizes. The torque values are reduced considerably for bolted joints that have an insulator between the metal flanges. Do not over-torque joints between insulators and metal components. Consult MEPPI for the torque value if a joint has an insulator between the flanges.

Table B.1-1 Standard Torque Values

Bolt Size	Hex Head Width (mm)	Allen Head Width (mm)	Torque (kg-cm) Standard	Torque (Nm) Standard	Torque (lb-ft) Standard
M3	5	2.5	8	0.8	0.6
M4	7	3	18	1.8	1.3
M5	8	4	35	3.4	2.5
M6	10	5	60	5.9	4.3
M8	13	6	140	13.7	10.1
M10	17	8	280	27.5	20.3
M12	19	10	480	47.1	34.7
M16	24	14	1200	118	86.8
M20	30	17	2200	215	159
M22	32	17	3000	294	217
M24	36	19	3900	382	282
M30	46	22	7700	755	557

Bolt size is designated by “Mxx.” example M6
Hex head (wrench size) is designated by “xx mm.” example 6 mm

B.2 Torquing Sequence (1-2-3-4. etc.)

Torque the bolts in a symmetrical order with a torque wrench. Repeat the sequence to assure each bolt is tightened to the proper torque.

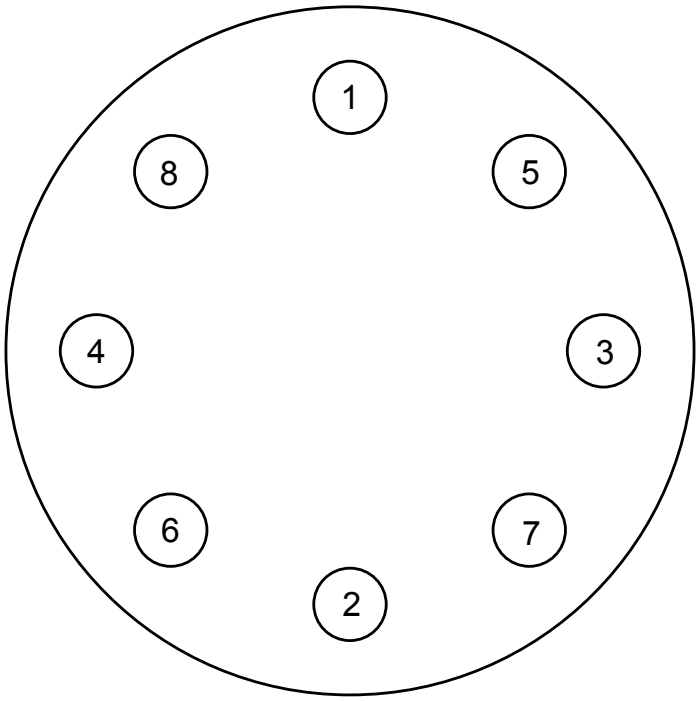


Fig. B.2-1

C

Appendix C: Lubricating

The correct lubricant must be applied and used as specified in this instruction book. These lubricants can be ordered through the Mitsubishi Electric Power Products' sales office.

C.1 Application of Lubricants

Diamond Low Temperature Grease #2 Mitsubishi Oil Company	Linkage and Mechanism in Air
***Darina**® Grease #2 Shell Oil Company	Linkage and Mechanism in SF_6 Gas
Noxlub Contact Grease Kluber Lubrication N.A., Inc.	Interrupter and Bushing Conductor Contacts
Dow Corning #111 Valve Lubricant Dow Corning Corporation	Small O-rings in Gas Fittings

C.2 Procedure

a. Clean the parts of the equipment that will be greased. Remove oil, water, dust, and the old grease.

b. Keep the lubricants and greases clean and free of contaminants. Confirm by feeling the grease between fingers.

c. Apply the grease thinly and uniformly to the part.

⚠ CAUTION Do not mix different greases. Never use a spray lubricant like ****WD-40**®.

d. Assemble the parts before they or the grease become contaminated with dust or dirt.

***Darina**® is a registered trademark of Shell Oil Company.
****WD-40**® is a registered trademark of WD-40 Company, Inc.

This page left blank intentionally.

Appendix D: Adsorbent Application or Replacement

D

These instructions cover the installation or replacement of adsorbent in SF_6 gas tanks.

D.1 Purpose of Adsorbent

Adsorbent is used in the SF_6 gas tanks to maintain a dry atmosphere. Replace the adsorbent each time the tank is opened.

D.2 General Cautions

Keep the adsorbent inside a sealed container until the tanks are ready to be closed.

Install the new adsorbent in the tanks within one hour of removing the adsorbent from its container and plastic bag.

After the adsorbent is placed inside the tanks, evacuate them within one hour.

Do not expose the adsorbent directly to moisture, such as rain or high relative humidity.

D.3 Adsorbent Material and Accessories

The adsorbent is a molecular sieve material available in prepackaged bags inside sealed containers.

Prepackaged Adsorbent Bags	Molecular Sieve
Adhesive	**Loctite** #242 Blue

D.4 Procedure

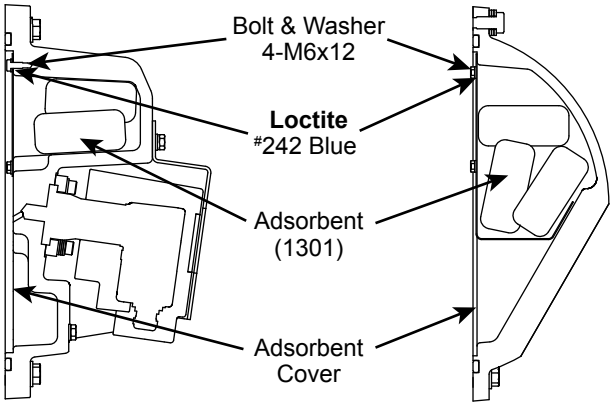


Fig. D.4-1 Rear Cover Assembly

CAUTION

Properly handle and support the rear inspection cover when not secured to the tank. Failure to observe caution could result in SF_6 density switch mechanical damage or calibration errors.

Remove the rear cover with the attached adsorbent cover from the tank.

Remove the adsorbent cover from the rear cover. Discard the original adsorbent and replace the adsorbent in the cover.

Note: Mitsubishi Electric Power Products, Inc. recommends installing new adsorbent when sealing the tanks after maintenance.

Replace the adsorbent cover and the rear cover using the bolts provided.

CAUTION

Apply adhesive (ex: **Loctite** #242 Blue) to the M6x12 bolt threads before installing the bolts.

Clean the sealing surfaces of the rear cover and the flange of the tank. Insert the O-ring and attach the cover according to the procedure outlined in Appendix A: SF_6 Gas Seals.

Appendix E: Filling, Removal, and Leak Detection of SF_6

The following section provides the instructions for evacuating, filling, and adding SF_6 gas during installation or servicing of the circuit breaker. Refer to Section 3: Description of this instruction book for instructions and precautions to be followed when handling SF_6 gas.

E.1 Gas Handling Equipment

To refill the gas, use an SF_6 gas service trailer capable of evacuating air and gas to 1 mm vacuum. A typical unit is shown in Fig. E.1-1. The trailer contains a vacuum pump, compressor, storage tank, SF_6 filter and dryer, along with the valving and instrumentation necessary to evacuate air and to remove, store, or fill the breaker with SF_6 gas. Refer to Section 5.4-1 Tools for MEPPI's recommended gas filling and evacuating specifications.

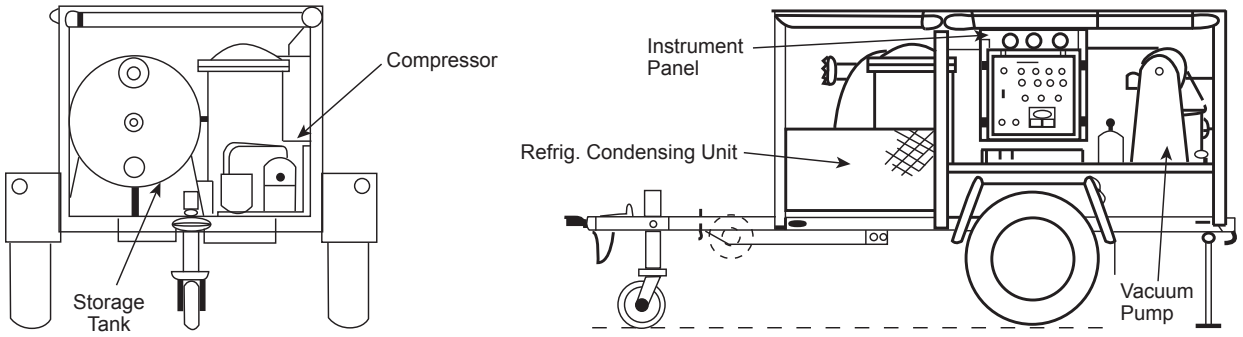


Fig. E.1-1 SF_6 Gas Reclaimer

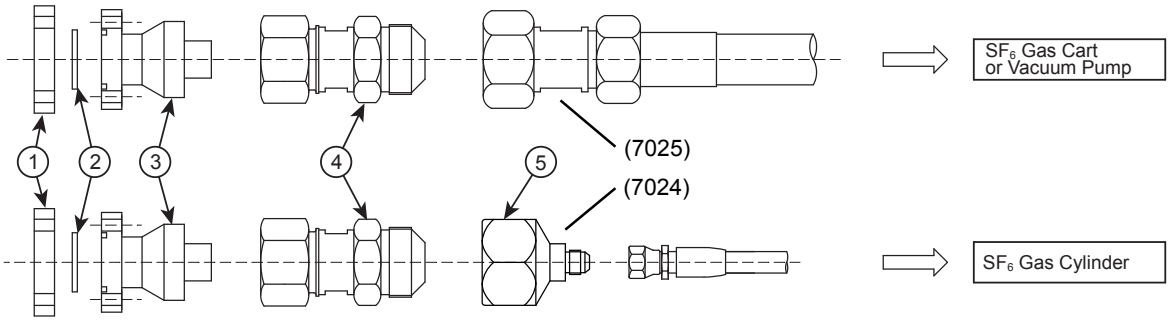
E.2 Evacuating and SF_6 Gas Filling Adapters

SF_6 gas service trailers are usually supplied with 1 1/4 in hoses terminated with a female 1 5/8-12 37° SAE fitting for SF_6 gas evacuating and filling. An optional adapter connects to the hose and is bolted to the gas fill valve of the breaker after the cap is removed. The adapter for evacuating the gas is terminated with a male 5/8-12 37° SAE thread.

A second adapter used for gas filling from an SF_6 gas cylinder is terminated with a male 9/16-18 37° SAE thread. This adapter mates with a female 9/16-18 37° SAE thread on a 5/8 in hose available from most hose suppliers. These adapters are normally supplied with each order.

CAUTION

When connecting to the **Dilo** gas fill valve, the opposite end of the hose must be connected to a gas cylinder or gas service trailer to assure that the gas currently in the breaker is not released to the atmosphere.



Item No.	Description
1	Gas Fill Manifold
2	O-ring
3	**Dilo** DN20 Gas Fill Valve
4	**Dilo** DN20 Adapter
5	Adapter (7025, 7024)

Fig. E.2-1 Evacuating and Gas Filling Adapters

E.3 Evacuating and SF_6 Gas Filling

Some circuit breakers are shipped from the factory partially filled with SF_6 gas. Evacuating of these breakers is not necessary as long as neither the breaker tanks nor gas system were opened during storage or installation. Fill these breakers with SF_6 to the proper pressure by following the procedures in Appendix E.4 Adding SF_6 Gas of this appendix. Refer to Section 5.5.5 if guidance on gas moisture measurement is required.

Circuit breakers that have been open to the atmosphere, either during installation or servicing, require evacuating before being filled with SF_6 gas.

E.3.1 Evacuating

The tanks must be evacuated to remove the air and any moisture that may have accumulated in the tank while it was open and exposed to the atmosphere.

1. Remove the cap from the fill valve.
2. Attach the appropriate fittings to both ends of the hose.
3. Attach the hose to the vacuum pump.
4. Attach the hose to the breaker fill valve.
5. Start the vacuum pump.
6. Allow the vacuum pump exit to vent to the atmosphere.
7. Pull vacuum until the pressure gauge reads 1 Torr (1 mmHg).
8. Continue operating the vacuum pump for a minimum of 1 hour. Extend the evacuating time when high humidity conditions exist.
9. Remove the hose from breaker fill valve.
10. Turn off the vacuum pump.

⚠ CAUTION	A tank under vacuum can suck the oil from some vacuum pumps into the evacuated tank when the pump is not running. If the vacuum pump stops, immediately close the valve between the pump and the hose. Check to determine if the vacuum pump oil backflowed into the hose.

E.3.2 Vacuum Leak Check

Close the valve on the service hose to the vacuum pump and shut off the vacuum pump. Measure the gas pressure.

The breaker passes the leak test if the pressure has not risen more than 1 Torr (1 mmHg) in four hours. If the pressure rises more than 1 Torr (1 mmHg) in four hours, repeat the evacuating and leak test procedure. If the pressure rise is due to a leak, it must be located and repaired.

The pressure rise may be the result of moisture in the gas. Determine if this is the case by graphing the pressure rise versus time. Measure the pressure rise every half hour and record it on the graph. If, after connecting the points, the slope of the line is positive and linear, the breaker has a leak. If the curve is exponential, the rise is due to moisture in the gas. In the case of the latter, continue the evacuating process until the pressure rise is within the 1 Torr (1 mmHg) limit.

E.3.3 Gas Filling

If using a gas service trailer, fill the breaker with SF_6 gas with the same hose used for evacuating. Follow the service trailer instructions.

If not using a service trailer, fill the breaker with gas directly from SF_6 bottles as follows:

1. Remove the hose from the breaker fill valve.
2. Stop the vacuum pump.
3. Attach a pressure regulator with an SF_6 cylinder fitting to the bottle of SF_6 gas (an SF_6 cylinder with a 120 psig pressure relief valve may be substituted if a regulator is not available).
4. Attach the appropriate fill adapter fittings to the hose.
5. Attach and tighten the hose to the bottle connector.
6. MEPPI recommends evacuating the hose and filling it with SF_6 gas before connecting the hose to the breaker fill valve.
7. Tighten the adapter to the hose fitting.
8. Attach the hose and adapter to the breaker fill valve.
9. Open the SF_6 cylinder valve and fill the breaker with SF_6 gas.
10. After reaching the proper pressure, close the SF_6 supply valve.
11. Disconnect the hose at the breaker fill valve.
12. Cap the breaker fill valve. **Note**: Do NOT apply gas sealant to this joint.

Note: The pressure gauges provided with the breaker are temperature compensated. If using a separate gauge, determine the normal fill pressure by measuring the ambient temperature and referring to the pressure versus temperature graphs (Fig. H.1-1 or H.1-2 (Derated)). If pressure correction for altitude is required, refer to Appendix O. Fill the system with SF_6 gas to the required pressure.

E.4 Adding SF_6 Gas

If the gas pressure drops below normal, but not below lockout, adding gas may be necessary to restore the breaker to the correct pressure by following the procedure below.

⚠ CAUTION

Do not attempt to add SF_6 gas to a breaker in which operating gas pressure has fallen below the lockout pressure. The breaker must be taken out of service before adding gas to restore the breaker to normal operating pressure.

1. Remove the cap from the fill valve.
2. Attach a pressure regulator with an SF_6 cylinder fitting to the bottle of SF_6 gas (an SF_6 cylinder with a 120 psig pressure relief valve may be substituted if a regulator is not available).
3. Attach the appropriate fill adapter fittings to the hose.
4. Attach and tighten the hose to the bottle connector.
5. MEPPI recommends evacuating the hose and filling it with SF_6 gas before connecting the hose to the breaker fill valve.
6. Tighten the adapter to the hose fitting.
7. Attach the hose and adapter to the breaker fill valve.
8. Open the SF_6 cylinder valve and fill the breaker with gas.
9. After reaching the proper pressure, close the SF_6 supply valve.
10. Disconnect the hose at the breaker fill valve.
11. Cap the breaker fill valve. **Note**: Do NOT apply gas sealant to this joint.

E.5 Removal of SF_6 Gas

Before servicing a breaker, review Section 3: Description of this instruction book. Arcing in SF_6 gas results in decomposition products. Observe precautions when servicing a breaker that has been in use, particularly one that has experienced several fault interruptions.

DANGER	SF_6 is heavier than air and does not support life. Do not enter any tank that previously contained SF_6 that is not thoroughly ventilated. Because it is heavier than air, SF_6 gas can accumulate, or be trapped in, low "pockets." If SF_6 is released to the atmosphere, observe precautions in nearby trenches and depressions where the gas can accumulate for short periods of time before dispersing into the atmosphere.

CAUTION	Arced SF_6 gas is accompanied by a strong, irritating odor that indicates toxic decomposition products. Avoid exposure to these injurious products. The arc powders react with moisture and, if inhaled, can irritate the nose, throat, and lungs. Contact with body perspiration can irritate skin. Thoroughly ventilate the area until the odor is insignificant. Remove the powders, preferably with a vacuum cleaner. Wear a dust mask to prevent inhalation.

E.5.1 Salvaging

1. Weigh bottles to be used for SF_6 transfer.
2. Remove the cap from the fill valve.
3. Attach the appropriate fittings to both ends of the hose.
4. Attach the hose to the cart.
5. Pull vacuum on the hose to eliminate all entrapped air.
6. Attach hose to the breaker fill valve.
7. Attach bottle to cart.
8. Open bottle valve.
9. Start compressor.
10. Continue filling bottle until full or transfer rate drops to a minimum.
11. Stop compressor.
12. Remove hose at breaker fill valve.
13. Close valve at bottle.
14. Exchange filled bottle with an empty bottle and repeat steps 5 thru 14.
15. Fill final bottle until pressure falls below zero psig.
16. Continue pulling vacuum until the pressure gauge reads 1 Torr.
17. Close valve on bottle.
18. Turn off compressor.
19. Remove hose from breaker fill valve.
20. Attach **Dilo** DN20 female fitting (without hose attached) to the breaker fill valve to equalize the pressure in the breaker with atmospheric pressure.

⚠ CAUTION	Arc powders are reactive and can irritate the nose, lungs, and skin. Thoroughly ventilate tanks before entering. Remove powders, preferably with a vacuum cleaner. If a considerable amount of powder is evident, wear a dust mask to prevent inhalation.

E.6 Leak Inspection

E.6.1 Leak Check with Leak Test Solution

Daub test solution over the gas-sealed connection. Allow thirty seconds for bubbles to appear. If no bubbles are evident, wipe off the solution. If bubbles are evident, degas breaker, repair leak, repressurize breaker and leak test.

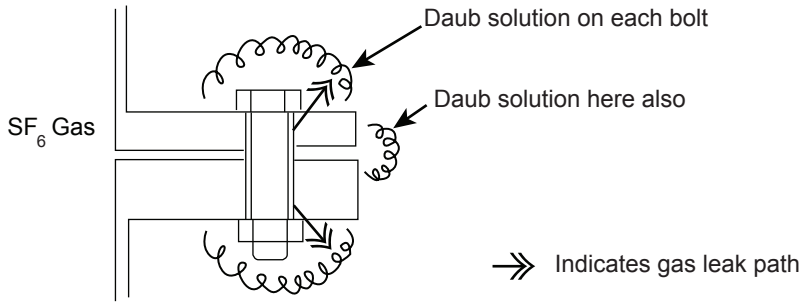


Fig. E.6-1 Leak Check with Leak Test Solution

E.6.2 SF_6 Leak Detector

The permissible leak rate from the breaker is less than 0.5% per year. Determine the leak rate by using an SF_6 leak detector and enclosing the components. Envelope the sealed SF_6 gas connection in a bag made of plastic sheeting and leave for more than three hours. Check for leaks with an SF_6 gas leak detector. The operating procedure for the SF_6 gas leak detector is explained in the leak detector instruction manual.

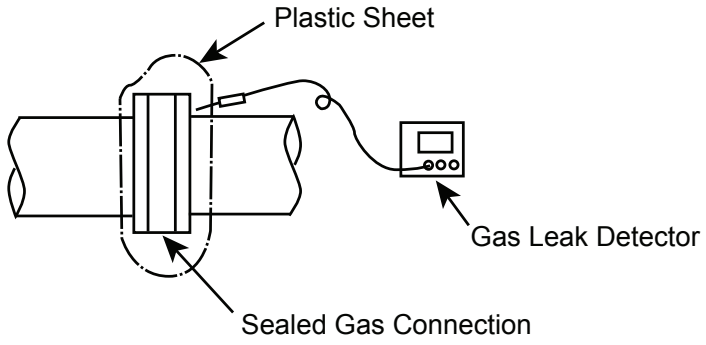


Fig. E.6-2 Leak Check with Leak Detector

E.6.3 Leak Test with Pressure Gauge (Long Term)

Periodic recording of the gas pressure will identify a leak rate. Unless the leak is excessive and requires immediate corrective action, make several gas pressure readings over a period of days or weeks to properly identify the leak rate.

This page left blank intentionally.

F

Appendix F: Weather Sealing

This section provides instructions for weather-sealing the joints and hardware to prevent corrosion of the circuit breaker. Outdoor high-voltage circuit breakers are exposed to moisture and other pollutants that react to cause serious damage to the equipment. The following weather-sealing procedures are recommended to reduce corrosion and extend the life of the equipment.

F.1 Weather Sealant Material

Weather sealant 100g Shin-Etsu KE-45-T RTV or **Dow Corning** 737.

F.2 Application

The surface and parts to be sealed shall be clean and free from any deposit of the solvent used for cleaning.

Sufficiently apply the weather sealant to the entire joint area to prevent moisture from penetrating.

Finish assembling the parts where the sealant is applied between mating surfaces within thirty minutes, before the sealant hardens.

F.3 General Cautions

Do not mix the weather sealant with grease or water.

Apply a uniform bead around the parts being sealed. Make sure that no voids or air bubbles are trapped in the sealant.

Smooth any weather sealant that extrudes from flange surfaces.

Replace the cap of the weather sealant tube before storing.

F.4 External Joints

Seal the joints between the flanges and the hardware, particularly in the horizontal position, with the weather sealant.

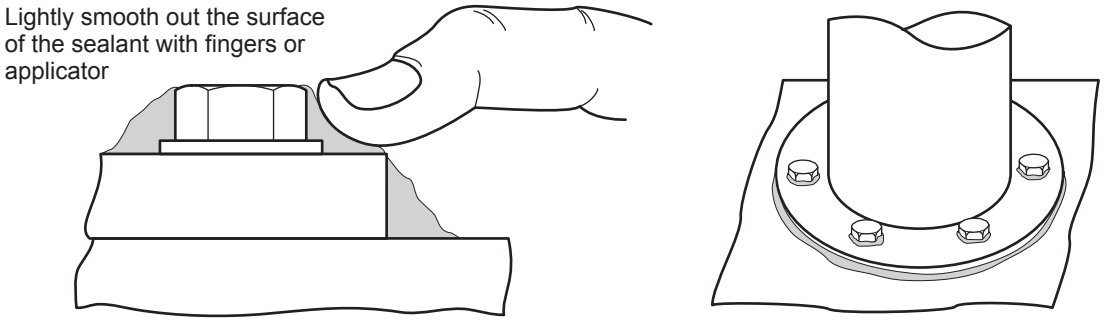


Fig. F.4-1 External Joint Application

F.5 Attaching Nameplates, etc.

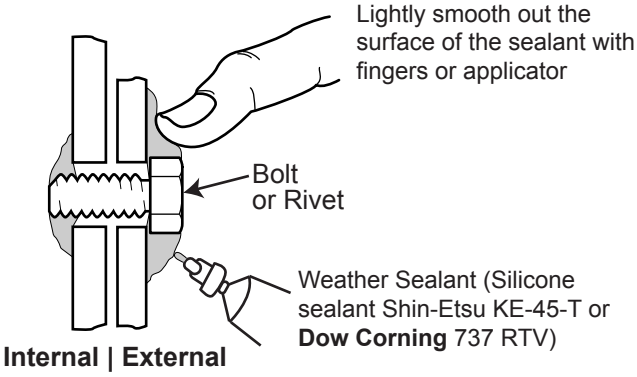


Fig. F.5-1 Nameplate Application

Appendix G: Electrical Joint Compound Application

G

These instructions cover the application of electrical joint compound to aluminum high-voltage connections.

G.1 Scope

When aluminum, copper, and galvanized surfaces are exposed to air, a thin film of oxide or salt forms on their surfaces. Aluminum develops the film very quickly. Though this oxide film protects the metal from further corrosion, it has a high resistance value and acts as an insulator. Remove the oxide film and apply joint compound to the connecting surfaces to maintain the efficiency of the metals as connectors. The joint compound also helps penetrate the film of oxide during the cleaning process.

G.2 Procedure

1. Apply a coat of joint compound to the mating surfaces of the joint.
2. Remove the oxide with a non-metallic abrasive paper or stainless steel brush (for galvanized surfaces), a brass brush (for copper connectors only), or a stainless steel or aluminum brush (for aluminum connectors only).
3. Wipe off the joint compound that contains metal particles.
4. Apply a generous amount of new joint compound to the connecting surfaces within three minutes of removing the previous compound.
5. Bolt the connectors together.
6. Remove any excess joint compound.

Note: Do not use a brush or abrasive paper on silver-plated or tin-plated connectors. Use **Scotch-Brite** to lightly buff the plated surfaces to a bright finish.

This page left blank intentionally.

Appendix H: Temperature Compensation Charts

H

The use of the following figures and charts are only required when using a pressure gauge other than the one provided with the breaker. The pressure gauges provided with the breaker are temperature compensated. If using a separate gauge, determine the normal fill pressure by measuring the ambient temperature and referring to the pressure versus temperature graphs (Figure H.1-1 or H.1-2 (Derated)).

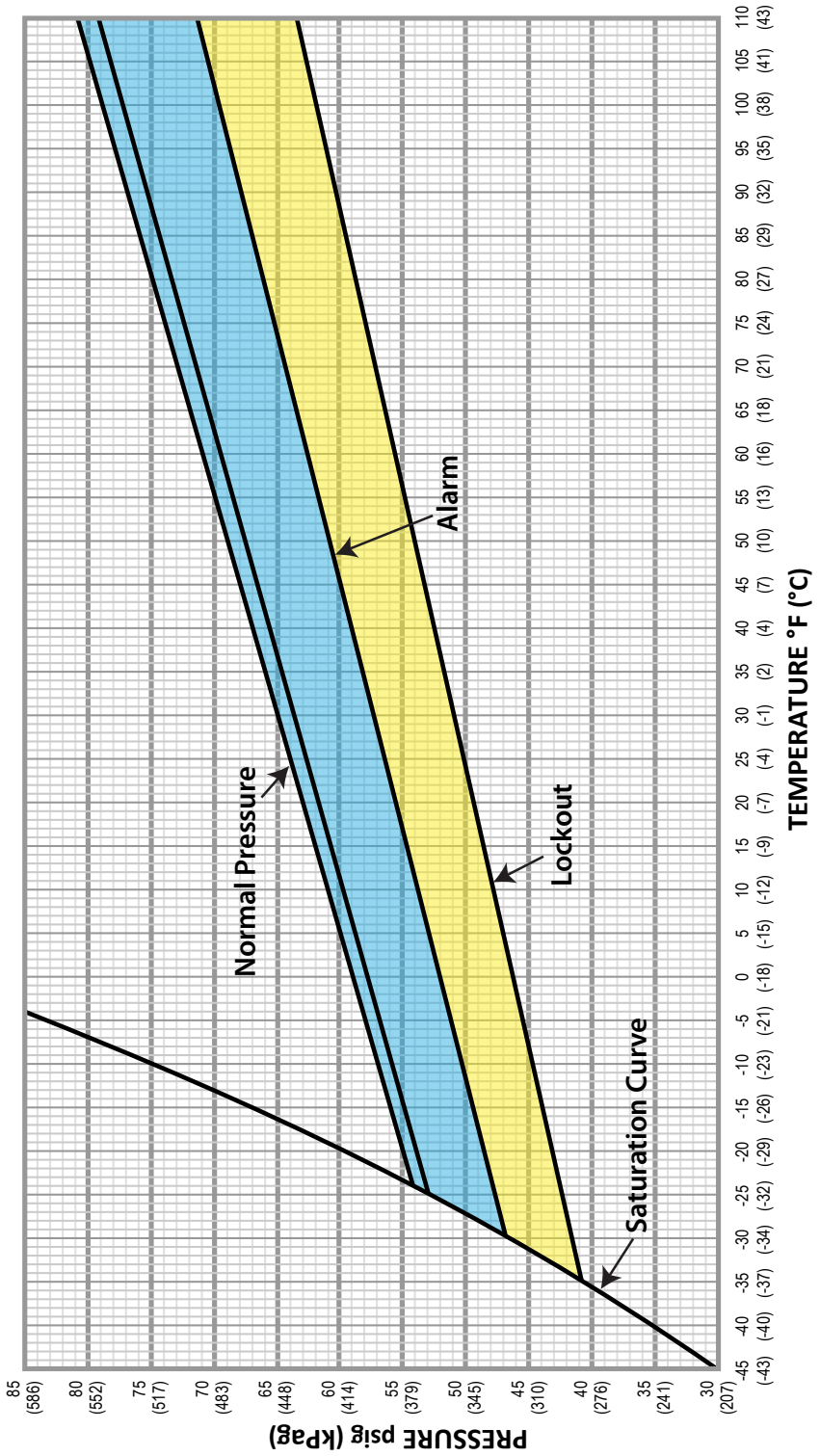


Fig. H.1-1 Pressure vs. Temperature for Normal Pressure of 71psig (490 kPag) SF_6 Gas

Table H.1-1 Pressure vs. Temperature for Normal Pressure of 71 psig (490 kPag) SF_6 Gas

TEMPERATURE °F (°C)	FILL psig	FILL kPag	ALARM psig	ALARM kPag	LOCKOUT psig	LOCKOUT kPag
-45 (-43)	*	*	*	*	*	*
-40 (-40)	*	*	*	*	*	*
-35 (-37)	*	*	*	*	40.2	277
-30 (-34)	*	*	46.2	319	41.4	286
-25 (-32)	52.6	363	47.5	328	42.2	291
-20 (-29)	53.8	371	48.4	334	43.0	297
-15 (-26)	54.8	378	49.3	340	43.9	302
-10 (-23)	55.8	384	50.2	346	44.7	308
-5 (-21)	56.8	391	51.1	353	45.5	313
0 (-18)	57.8	398	52.0	359	46.3	319
5 (-15)	58.7	405	52.9	365	47.1	325
10 (-12)	59.7	412	53.8	371	47.9	330
15 (-9)	60.7	419	54.7	377	48.7	336
20 (-7)	61.7	425	55.6	383	49.5	341
25 (-4)	62.7	432	56.5	389	50.3	346
30 (-1)	63.7	439	57.4	395	51.0	352
35 (2)	64.6	446	58.2	402	51.8	357
40 (4)	65.6	452	59.1	408	52.6	363
45 (7)	66.6	459	60.0	414	53.4	368
50 (10)	67.5	466	60.9	420	54.2	374
55 (13)	68.5	472	61.7	426	55.0	379
60 (16)	69.5	479	62.6	432	55.8	384
65 (18)	70.4	486	63.5	438	56.5	390
68 (20)	71	490	64.0	441	57.0	393
70 (21)	71.4	492	64.3	444	57.3	395
75 (24)	72.3	499	65.2	450	58.1	401
80 (27)	73.3	505	66.1	456	58.9	406
85 (29)	74.3	512	66.9	462	59.6	411
90 (32)	75.2	519	67.8	468	60.4	417
95 (35)	76.2	525	68.7	473	61.2	422
100 (38)	77.1	532	69.5	479	62.0	427
105 (41)	78.1	538	70.4	485	62.7	433
110 (43)	79	545	71.3	491	63.5	438

WARNING

* This Is The Liquifaction Phase For SF_6 Gas. The Breaker Should Not Be Filled In This Condition.

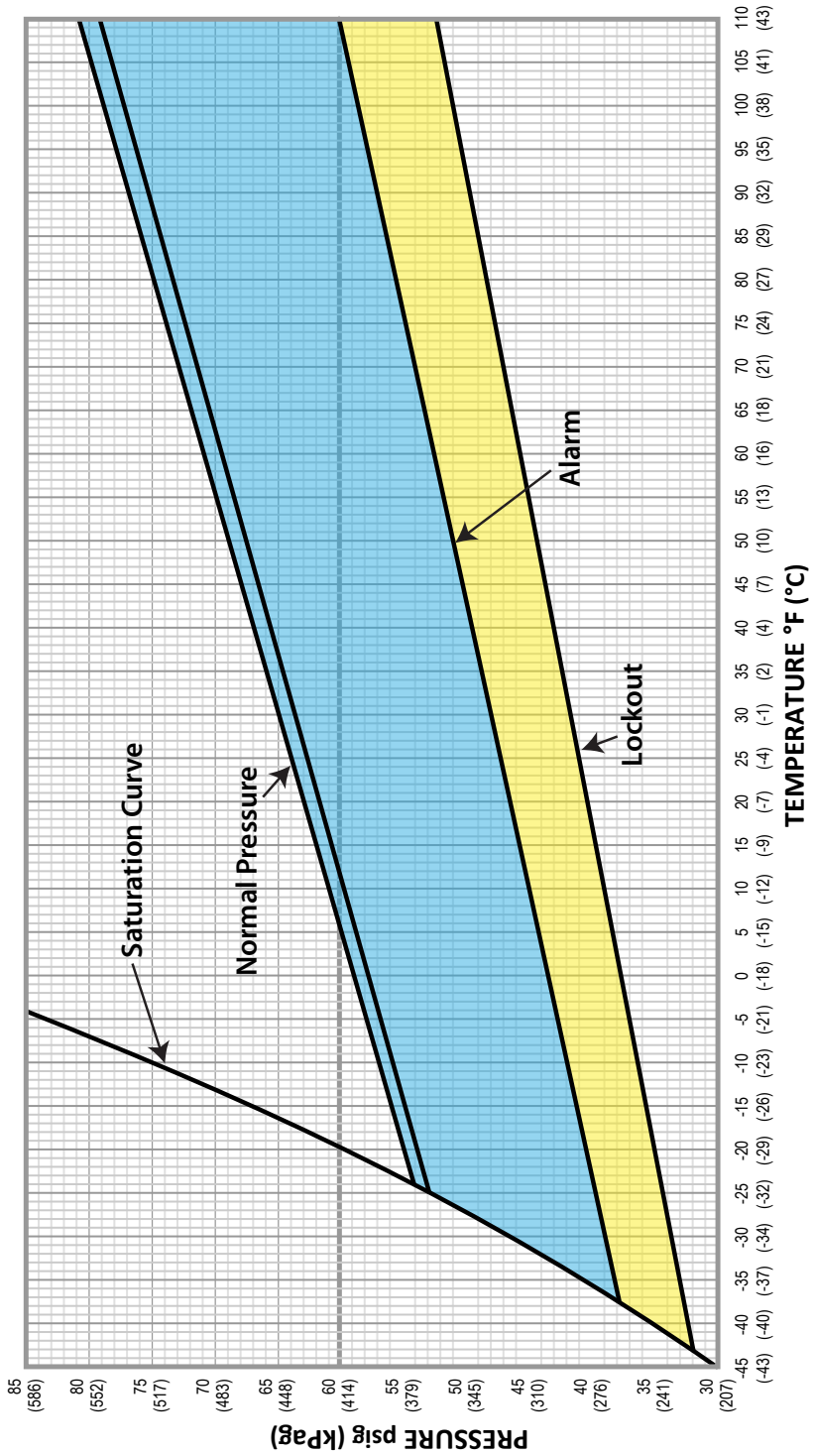


Fig. H.1-2 Pressure vs. Temperature for Normal Pressure of 71 psig (490 kPag) SF_6 Gas: Derated

Table H.1-2 Pressure vs. Temperature for Normal Pressure of 71 psig (490 kPag) SF_6 Gas: Derated

TEMPERATURE °F (°C)	FILL psig	FILL kPag	ALARM psig	ALARM kPag	LOCKOUT psig	LOCKOUT kPag
-45 (-43)	*	*	*	*	*	*
-40 (-40)	*	*	*	*	32.5	224
-35 (-37)	*	*	38.4	265	33.2	229
-30 (-34)	*	*	39.2	270	33.9	234
-25 (-32)	52.6	363	39.9	275	34.6	238
-20 (-29)	53.8	371	40.7	281	35.3	243
-15 (-26)	54.8	378	41.5	286	35.9	248
-10 (-23)	55.8	384	42.3	291	36.6	252
-5 (-21)	56.8	391	43.0	297	37.3	257
0 (-18)	57.8	398	43.8	302	38.0	262
5 (-15)	58.7	405	44.5	307	38.6	266
10 (-12)	59.7	412	45.3	312	39.3	271
15 (-9)	60.7	419	46.1	318	40.0	276
20 (-7)	61.7	425	46.8	323	40.6	280
25 (-4)	62.7	432	47.6	328	41.3	285
30 (-1)	63.7	439	48.3	333	42.0	289
35 (2)	64.6	446	49.1	338	42.6	294
40 (4)	65.6	452	49.8	344	43.3	299
45 (7)	66.6	459	50.6	349	44.0	303
50 (10)	67.5	466	51.3	354	44.6	308
55 (13)	68.5	472	52.1	359	45.3	312
60 (16)	69.5	479	52.8	364	45.9	317
65 (18)	70.4	486	53.6	369	46.6	321
68 (20)	71.0	490	54.0	372	47.0	324
70 (21)	71.4	492	54.3	374	47.3	326
75 (24)	72.3	499	55.0	379	47.9	330
80 (27)	73.3	505	55.8	385	48.6	335
85 (29)	74.3	512	56.5	390	49.2	339
90 (32)	75.2	519	57.3	395	49.9	344
95 (35)	76.2	525	58.0	400	50.5	348
100 (38)	77.1	532	58.7	405	51.2	353
105 (41)	78.1	538	59.5	410	51.8	357
110 (43)	79.0	545	60.2	415	52.5	362

WARNING

* This is the liquifaction phase for SF_6 gas. The breaker should not be filled in this condition.

This page left blank intentionally.

Appendix I: Installing Control Cables

I

I.1 Scope

These instructions cover the installation and termination of control cables to the breaker. This is not intended to supersede established utility practices, but to provide minimum guidelines.

I.2 Installing Control Cables

1. All control cables to the breaker shall be run in conduit or other suitable protective means.
2. After installing it in the cabinet, provide proper strain relief to the cable to ensure that the terminals are not mechanically stressed.
3. After all the wires have been terminated, check the control wiring using a bell or multi-circuit tester.
4. Check all connections, as small nuts and clips may have become loose during transit and handling.
5. After checking the connections, seal the conduit pipe with duct-seal compound.

I.3 Treatment of Cable End

1. Cut the cable jacket back to a length greater than the terminal block length (refer to Fig. I.3-1).
2. Strip the metal and vinyl sheaths as shown in Fig. I.3-1.
3. Attach the ground lead to the cable's metal sheath by soldering or clamping. Some cabling will have the ground lead already installed and no clamping or soldering is necessary.

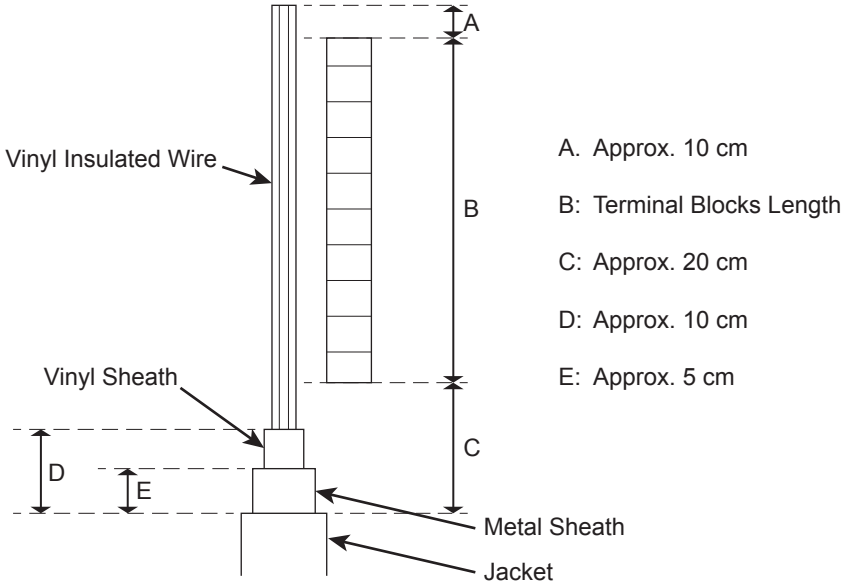


Fig. I.3-1 Cutting Back Cables

4. To waterproof the cable insulation, daub both ends with silicone compound before wrapping with insulation tape. Wind the insulation tape around the end of the jacket, metal sheath, and vinyl sheath in a half-turn overlap and double-winding fashion (ex. FB tape).

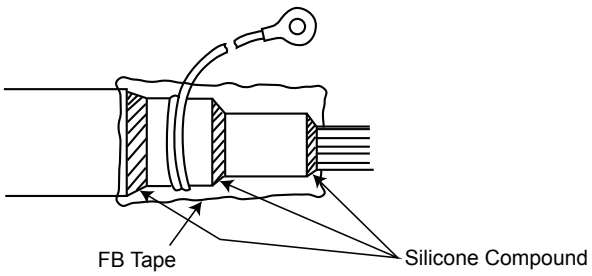


Fig. I.3-2 Terminating Cable Wires

5. Connect the ground lead of each cable to the grounding bar in the cabinet. The metal sheath of the cable is grounded **at one end only** (except as noted on MEPPI wiring diagram or as required by site specific conditions).

Appendix O: Gauge [SF_6] Pressure vs. Altitude

O

The pressure gauge is set at sea level at the factory. The gauge reads approximately 3.65 kPa (0.53 psi) higher than the actual gas pressure in the tank for each 1,000 feet above sea level.

To compensate for the higher altitude, either recalibrate the gauge with a test gauge calibrated for the higher altitude or add gas to the tank.

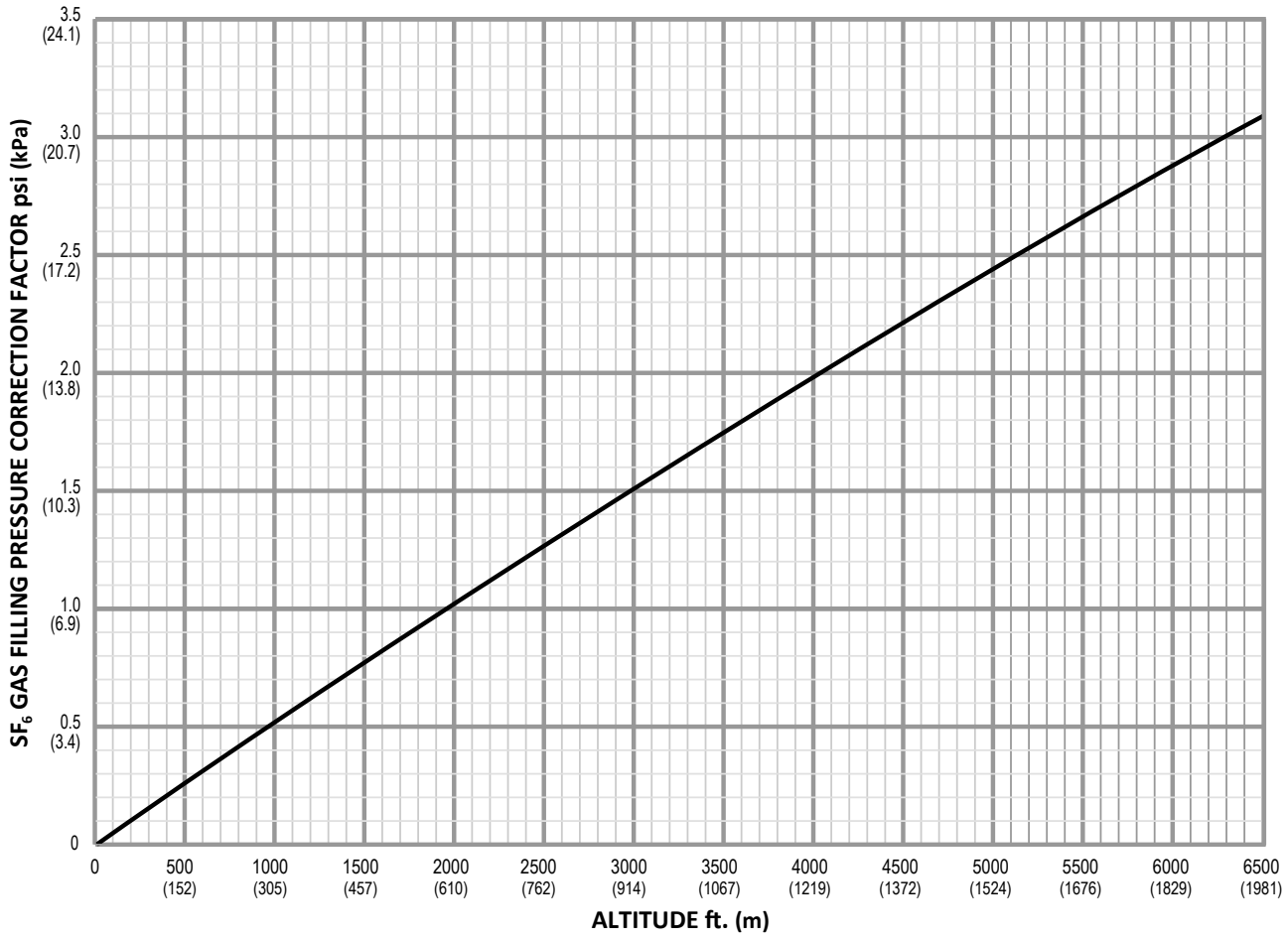


Fig. O-1 Correction Factor vs. Altitude

Table 0-1 Correction Factor vs. Altitude

Altitude		Correction Factor	
(ft)	(m)	(psi)	(kPa)
0	0	0.0	0.0
500	152	0.3	1.8
1000	305	0.5	3.6
1500	457	0.8	5.4
2000	610	1.0	7.1
2500	762	1.3	8.8
3000	914	1.5	10.4
3500	1067	1.7	12.1
4000	1219	2.0	13.7
4500	1372	2.2	15.2
5000	1524	2.4	16.8
5500	1676	2.7	18.3
6000	1829	2.9	19.8
6500	1981	3.1	21.2

Appendix P: Internal-External Retaining Ring

These instructions describe the attachment method of the internal/external retaining ring. The method of attaching the retaining ring is critical.

Note: Do not reuse retaining rings after removal for service.

1. Use retaining ring pliers, type 51-1A or 51-1B, when attaching retaining rings from sizes 8 to 20.
2. The distance between the two holes in the retaining ring should not be greater than dimension "A" in Table P-1 when spreading the holes to attach the ring.

Table P-1

Retaining Ring Size	Dimension A (mm)
13	11.5
16	13.0
19	14.5
20	15.0
22	15.5
25	16.5
40	26.0
55	30.0

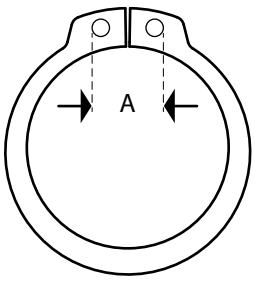


Fig. P-1 Retaining Ring

3. The square edge of the ring should be toward the end of the bar pin and the round edge should be toward the backside of the bar pin groove.

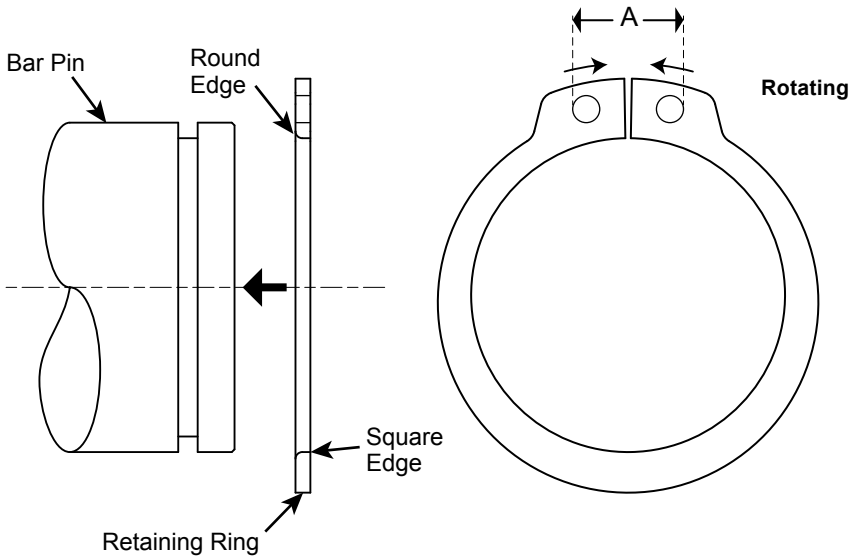


Fig. P-2 Retaining Ring Installation

4. Confirm that the retaining ring is in the groove properly by inserting the ring pliers in the left hole of the ring and rotating the ring clockwise, or inserting the ring pliers in the right hole and rotating the ring counterclockwise.

Appendix Q: Tank Heaters

Q.1 Heating System

SF_6 gas at the nominal operating pressure starts to condense to its liquid form when the temperature reaches -35°C (-31°F). Heaters can be provided for the gas-filled tanks to prevent the SF_6 from condensing when the circuit breaker is exposed to ambient temperatures below -35°C (-31°F). The heating system consists of a flexible blanket heater wrapped around the tank, insulation to direct the heat into the tank, and a metal cover to protect the insulation and heater from the elements.

The thermostat and the controls for the heater are located in the cabinet. The temperature sensing device of the thermostat is located on the bottom of the control panel in the cabinet.

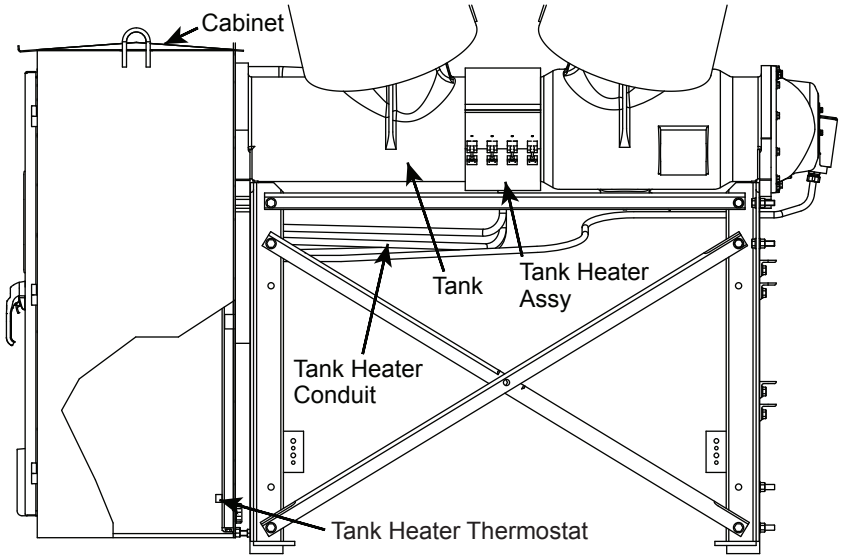


Fig. Q.1-1 Heating System

Q.2 Electrical Controls (Fig. Q.2-1)

The thermostat (23TH) contact closes and energizes the contactor (42TH) when the temperature sensing device senses that the ambient temperature has dropped to -15°C ± 3.3°C (5°F ± 6°F). The contactor (42TH) closes and energizes the heaters for the tanks. When the ambient temperature warms by 4.4°C (8°F) max from actuation point, the thermostat contacts open and the heaters de-energize.

Note: Refer to the customer specific control schematic diagram for the actual arrangement of the electric circuit. The heater's wattage may vary between customer orders depending on the minimum ambient temperature.

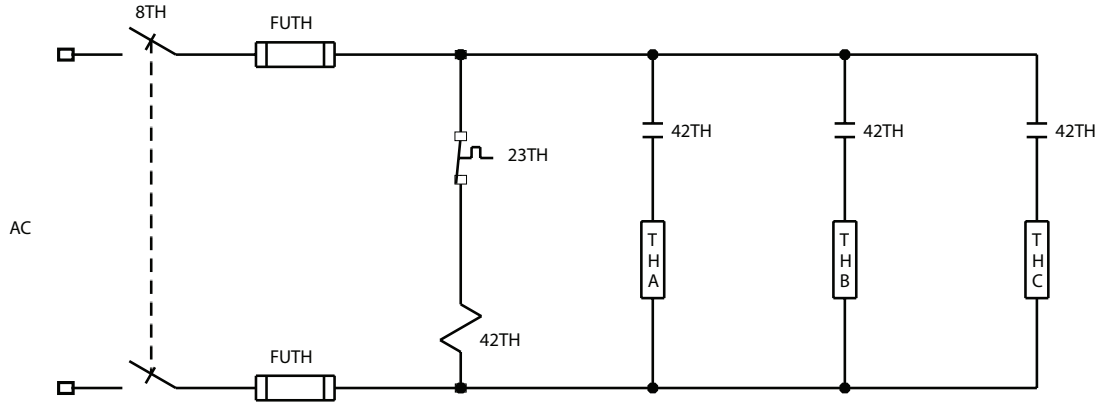


Fig. Q.2-1 Typical Electrical Controls for Tank Heating System

Q.3 Replacement of Heater Elements

1. Disconnect heater element wires.
2. Remove heater wires from bundle inside the cabinet.
3. Remove weather sealant from edges of heater assembly.
4. Secure shroud with tape or ratchet strap before removing hardware.

⚠ CAUTION	Failure to secure shroud could result in injury to personnel when shroud 'springs' free after removal of the bolts.

5. Remove heater assembly from tank and pull wiring from conduit attached to shroud.
6. Clean and inspect tank surface and remove old traces of weather sealant.
7. Remove burrs that could damage new heater element.
8. Thread leads through the small hole in the insulation.
9. Position the heater attached to the heater plate along with the insulation on the tank surface, large hole in insulation towards the bottom of the tank.
10. Secure assembly to tank with tape.
11. Orient the heater leads so that they run along the surface of the insulation until they reach the large conduit hole.
12. Inspect conduit fitting on the shroud. Replace or repair if damaged.
13. Run wires through conduit and back into cabinet.
14. Wrap shroud around insulation.
15. Align conduit fitting with large hole in insulation.
16. Install ratchet strap around shroud to pull the ends together.
17. Apply a thin coat of anti-seize to shroud bolts.
18. Install domed side of conical spring washer towards the head of the bolt.
19. Align and insert hardware.
20. Tighten hardware.
21. Route and terminate wiring per schematic diagram supplied with the breaker.
22. Reapply clear weather sealant to the seams of the heater assembly. Make sure there are no holes or gaps in the sealant which would allow water to enter.

⚠ CAUTION	Water entering the heater assembly will reduce the effective life of the heater element.

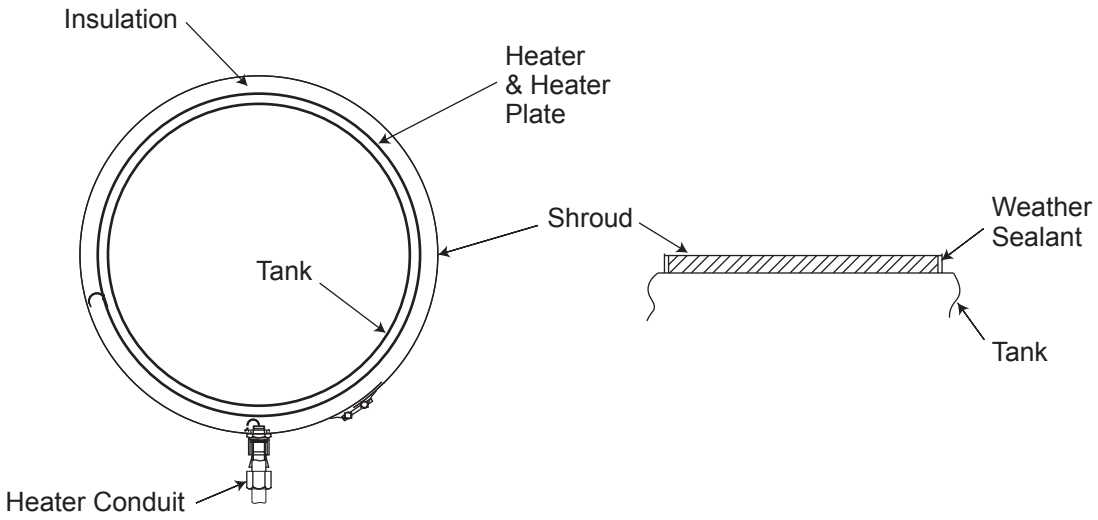


Fig. Q.3-1 Heater Assembly

Appendix T: Breaker Operation Testing

T.1 Contact Travel

Record the mechanism's travel characteristics using an oscillograph, oscilloscope, or a breaker travel analyzer. Connect the timing device transducer to the interrupter's operating rod with a timing rod, rod end, and rod. Transducer mounting kits are not usually supplied with the circuit breaker, but can be ordered as an optional item. Specify the type of transducer when ordering.

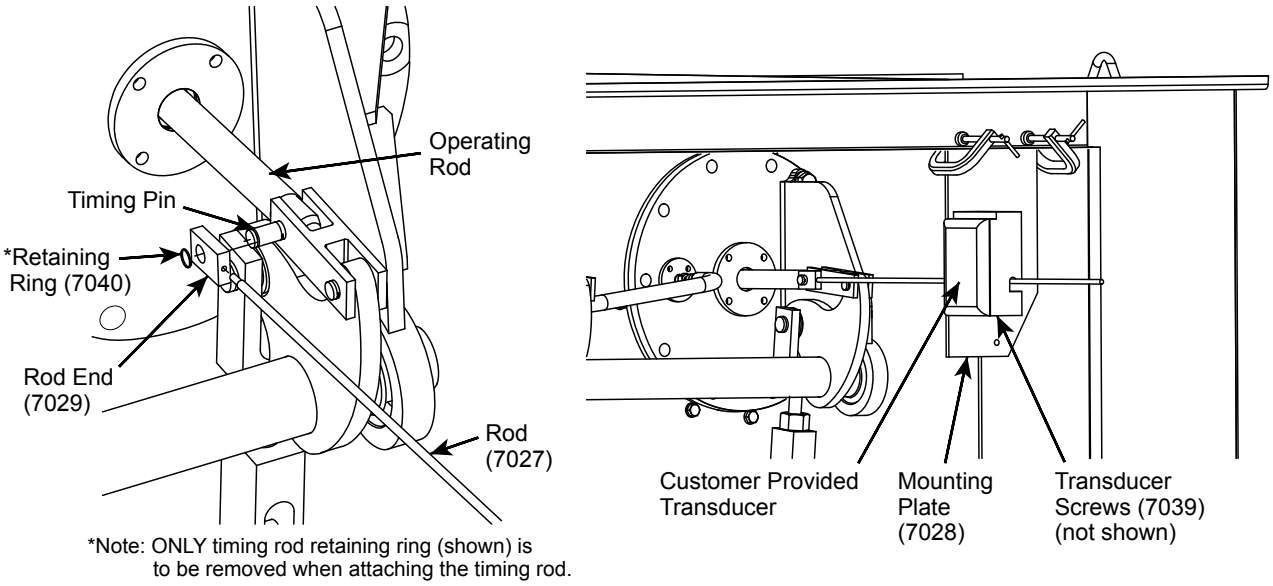


Fig. T.1-1 Adapter for Circuit Breaker Operation Analyzer (7026)

Take mechanical timing measurements at rated control voltage for the close, open, close-open, and open-close open operations. Measure the following characteristics:

Open Operation

Open Time: Time from energizing trip coil to last phase contact to part.

Contact Synchronization: Time from first phase contact to part to last phase contact to part.

Average Open Velocity: Velocity from contact part to 90% of travel.

Close Operation

Close Time: Time from energizing close coil to last phase contact to make.

Contact Synchronization: Time from first phase contact to make to last phase contact to make.

Average Close Velocity: Velocity measured from 10% of travel to contact make point.

Close-open Operation

Close Time: Same as above.

Open Time: Same as above.

Trip Energization: Time of energizing trip coil measured from breaker main contact make.

Open-close open Operation

Open Time: Same as above.

Reclose Time: Time from energizing trip coil to breaker main contact make.

The specifications for these characteristics are listed in Section 7: Performance Specifications of this instruction book. Typical oscillogram records identify the characteristics to be measured.

Note: Contact travel and wipe dimensions indicated in Section 5.6.3.2 Interrupter Travel (Stroke) and Contact Wipe apply to static measurements taken while using the manual jack assembly. Dynamic measurements obtained from travel transducer and timing equipment may fall outside of the specified tolerances.

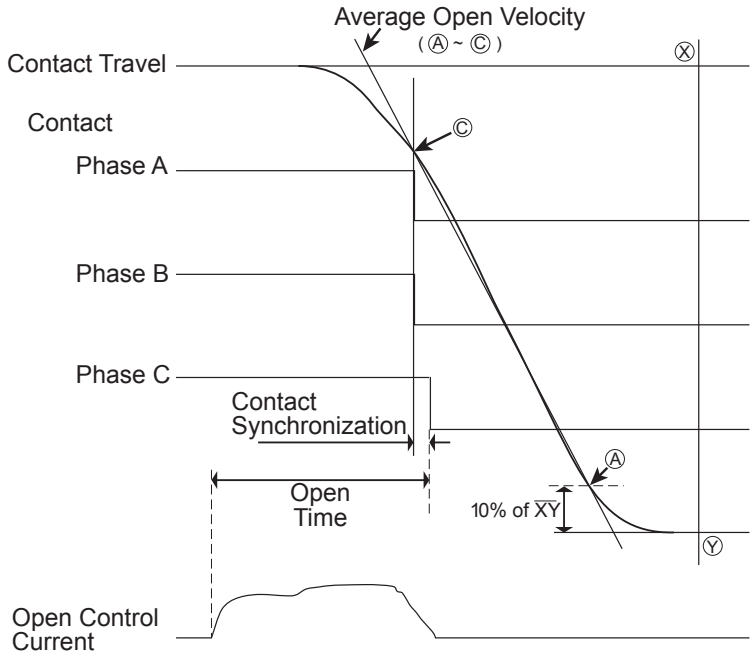


Fig. T.1-2 Open Operation

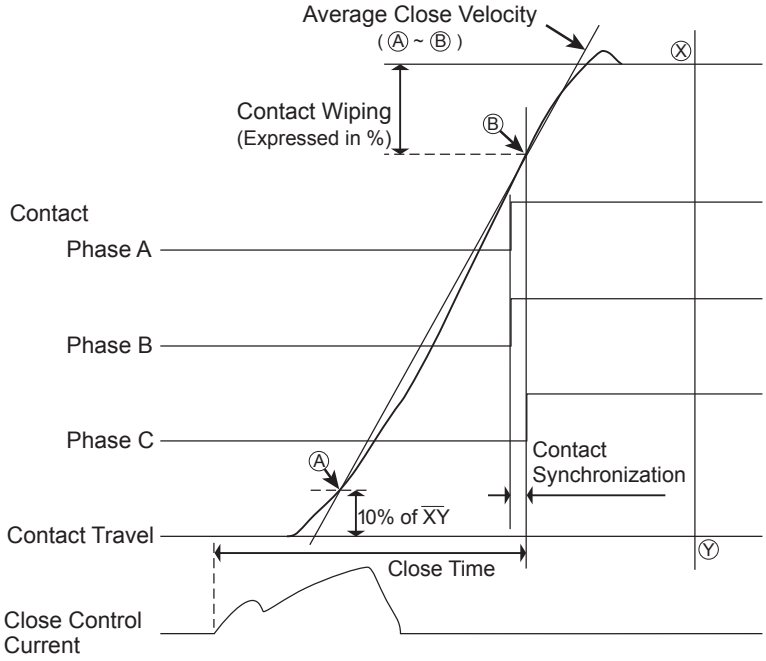


Fig. T.1-3 Close Operation

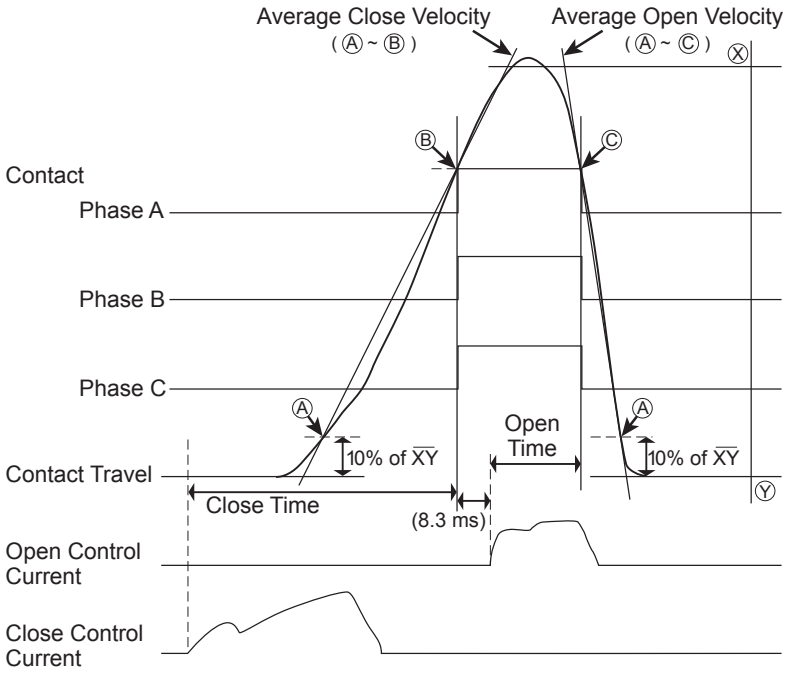


Fig. T.1-4 Close-Open Operation

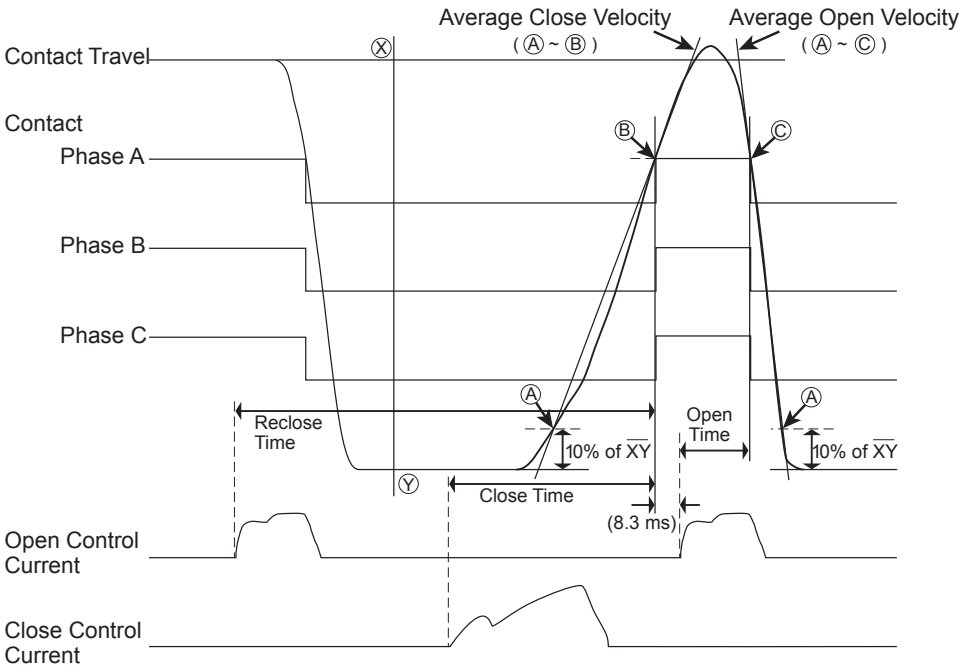


Fig. T.1-5 Open-Close Open Operation

U

Appendix U: SF_6 Gas Quality

The values listed in Table U-1 shall be used as a reference for determination of the SF_6 quality based on the condition of the gas when no other relevant industry standard is available. The values listed in the most recent revisions of IEC 60376 (new SF_6 gas) and IEC 60480 (used SF_6 gas) shall be used when available.

Table U-1 Maximum Acceptable SF_6 Gas Impurity Levels Based on Industry Standards

Impurity	New SF_6 Gas[1] (IEC 60376)	Used SF_6 Gas (IEC 60480)
Air	2000 ppm by weight [1% by volume]	3% by volume
CF_4	2400 ppm by weight [4000 ppm by volume]	3% by volume
H_2O	25 ppm by weight [200 ppm by volume or dew point of -36°C (-32.8°F)]	25 ppm by weight [200 ppm by volume or dew point of -36°C (-32.8°F)]
Mineral Oil	10 ppm by weight	10 ppm by weight
Total acidity expressed in hydrogen fluoride (HF)	1 ppm by weight (7.3 ppm by volume)	25 ppm by volume
Total reactive gaseous decomposition products	N/A	50 ppm by volume total or 12 ppm by volume (SO_2 + SOF_2)

Notes: [1]The amount of SF_6 in a container (measured in the liquid phase) should be higher than 99.7% for new SF_6 gas.

This page left blank intentionally.

Appendix W: Composite Insulators

These instructions cover the basic handling and cleaning requirements for composite insulators.

⚠ CAUTION

Composite insulators are susceptible to damage if handled in the same manner as conventional porcelain insulators. Do not wrap slings around the sheds of a composite insulator.

1. To avoid damaging the insulator, do not allow slings or other lifting equipment to come in contact with the sheds. Lift the bushing assembly by the flanges only. Lifting eyes may be installed in the insulator flanges to facilitate handling.
2. Installed bushing assemblies, spare bushing assemblies, and spare insulators are packaged for shipping and storage. Exercise caution when removing packaging material to avoid damaging the rubber sheds. Sharp tools may cut the insulator.
3. Clean the insulators in accordance with the following guidelines:

Table W-1 Cleaning Guidelines

Contamination Level	Cleaning Agent
Slight Contamination	5% Watery Solution of Detergent
Medium Contamination	Aliphatic Hydrocarbons such as Rivolta M.T.X. 100
Heavy Contamination	Acetone or Trichloraethylene

All cleaning has to be performed by applying the cleaning agent onto a cotton cloth and wiping the insulator.

Contact the insulator manufacturer for specific cleaning requirements with alternate solvents.

⚠ CAUTION

Cleaning composite insulators temporarily reduces the hydrophobicity of the insulating material. Do not energize the equipment for at least 24 hours after cleaning to allow sufficient time for the insulator to recover its hydrophobicity.

This page left blank intentionally.

Appendix Y: Replacing Rupture Disk

Rupture disks protect the tanks from excessive pressure. The rupture disks burst when the SF_6 gas pressure reaches 896 kPag (130 psig) ±5%. The SF_6 gas flows from the tanks until the gas pressure is equal to the atmospheric pressure of zero kPag (zero psig). Replace the rupture disk if it leaks, bursts, or is otherwise damaged.

⚠ WARNING

De-energize the breaker and disconnect the controls from the DC power source. Check that the SF_6 pressure is zero in the tanks. If not zero, reclaim the gas according to Appendix E: Filling, Removal, and Leak Detection of SF_6. Exercise extreme caution when handling new rupture disks. Make sure the surface has no dings, nicks, or scratches. Handle carefully and clean with solvent, if required.

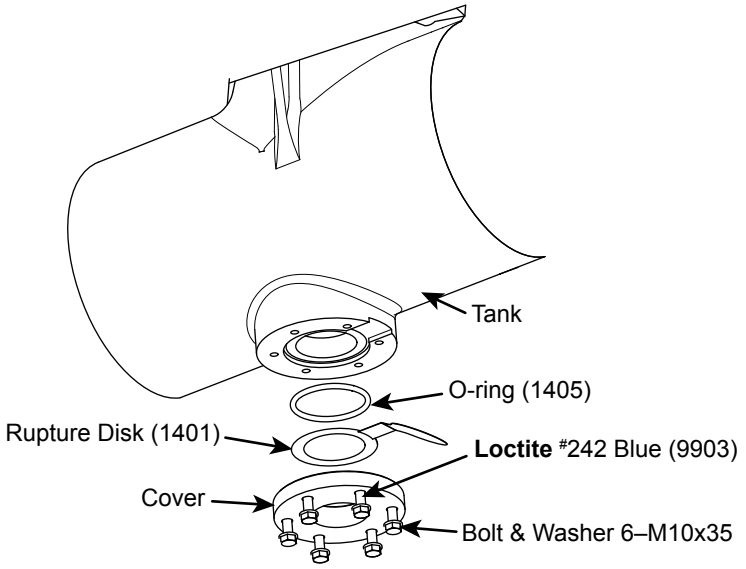


Fig. Y-1 Rupture Disk Assembly

Remove the six M10x30 bolts, washers, rupture disk retainer, and rupture disk.

Remove the O-ring. Use plastic scrapers to remove the old gas sealant from the O-ring groove, rupture disk retainer, and the surrounding area on the tank boss. Clean the parts with **Scotch-Brite** and denatured alcohol to remove solvent residue.

Apply gas sealant, according to Appendix A: SF_6 Gas Seals, to the O-ring groove and the face of rupture disk well between the O-ring and the outside edge of the O-ring groove. Insert the new O-ring.

Insert the rupture disk. Replace the rupture disk retainer and cover making sure disk is centered in counterbore. Install the nameplate if not attached to the rupture disk assembly. Torque the M10 bolts to 280 kg-cm (20 lb-ft) (refer to Appendix B: Torquing of Bolts).

Discard the original adsorbent and replace with fresh adsorbent per Appendix D.

Evacuate and fill the breaker with SF_6 gas per the procedure outlined in Appendix E: Filling, Removal, and Leak Detection of SF_6.

Manually jack the breaker, perform appropriate tests, and return the breaker to service.

Appendix AA: Bushing Maintenance and Replacement

AA

AA.1 Maintenance

Maintenance requirements for bushings on Mitsubishi circuit breakers are usually limited to cleaning the insulator surface when contamination becomes excessive, examination for physical damage, and cleaning and torquing high voltage terminal connections

AA.2 Bushing Replacement

Use the following procedure when necessary to remove a bushing from an assembled circuit breaker.

⚠ CAUTION

The electrical performance of the circuit breaker requires that the interior and insulating parts be clean and dry. Do not expose the interior of the tanks to inclement weather conditions. Use temporary coverings when the tanks are open to prevent exposure to dust, dirt, and moisture. Observe the following detailed precautions.

1. De-energize the breaker and apply grounds to the breaker terminals.
2. Make sure that the breaker is in the open position and that the closing spring is discharged.
3. Open switches to the breaker DC and AC control and auxiliary circuits.
4. Insert the close and trip prevention pins, except as required for inspection and tests.
5. Do not operate the breaker when SF_6 pressure is below lockout, except by the manual jack.
6. Do not open tanks in rain, very high humidity (>80%), or high winds (>10m/sec. (20 mph)).
7. Pure SF_6 gas (less than 20% oxygen) does not support life. Arced SF_6 gas may contain toxic products. Do not enter any tank that previously contained SF_6 gas that does not have thorough ventilation. Refer to Section 3.2 Sulfur Hexafluoride (SF_6) Gas for precautions when dealing with arced SF_6 gas.

Connect gas servicing equipment to the circuit breaker gas fill valve and remove all SF_6 gas from the tanks. Refer to Section 5.5.2 SF_6 Gas Removal and Filling of this instruction book for additional details.

Introduce dry air or nitrogen into the tanks to equalize the tank pressure with atmospheric pressure.

DANGER	A tank with a high concentration of SF_6 can be hazardous, causing asphyxiation from lack of oxygen. Before entering, ventilate the tanks and clean the interior of powders. A continuous flow of dry, fresh air improves personnel conditions and helps keep the atmosphere air from entering the tanks. Refer to Section 3.2 Sulfur Hexafluoride (SF_6) Gas for precautions when working in an SF_6 environment.

Remove the tank rear cover and ventilate the tank with air to eliminate residual SF_6 gas. Remove any gray powder from the area with a vacuum cleaner.

A shipping cover protects internal components of the bushing assemblies. To minimize the risk of introducing contaminants into the tanks, do not attempt bushing installation during adverse weather conditions.

Note: Do not remove the bushing assembly shipping covers or the circuit breaker rear covers until just before assembling the bushings to the breaker. Debris or excessive moisture trapped inside the tank compromises the high-voltage withstand capabilities of the circuit breaker and may cause failure when the breaker is energized.

AA.2.1 Removing the Rear Cover

To remove the rear cover from the stationary contact end of the tank:

- Remove the top bolt and install a guide pin to support the cover.
- Remove all bolts from the cover.
- Remove washers from under the head of the jack bolt and screw the jack bolt into the threaded hole in the cover to pry the cover loose from the flange.
- Set the rear cover aside and cover with a plastic sheet to prevent contamination.

AA.2.2 Removing the Bushing

To remove the bushing:

Porcelain and Composite

- Wrap a lifting strap around the body of the top fixing flange and fasten tightly to prevent slipping.

CAUTION	Do not put lifting straps or ropes on rubber sheds as this could put bending stress on the sheds severe enough to break the rubber housing.

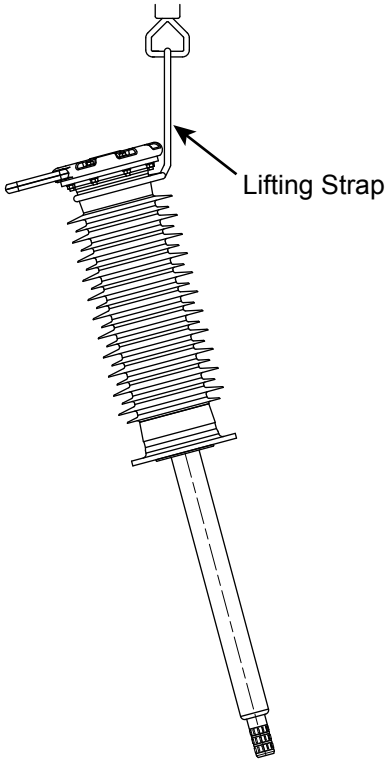


Fig. AA.2-1 Lifting of Porcelain or Composite Bushing

- Attach the sling to a crane and position the crane for a straight vertical pull directly above the lifting point.
- Remove the slack from the sling.
- Loosen all mounting bolts around the bottom flange of the bushing to be removed.
- Remove all except four of the mounting bolts. The remaining bolts should be diagonally opposite each other and have an approximately 5 mm (0.2 in) gap under the head. Verify that there is sufficient thread engagement to retain the bushing assembly when the seal is broken.
- Install guide pins in two of the bushing bolt holes 180° apart.
- Apply tension to the sling to break the seal between the bushing and the adapter plate on the tank. A plastic wedge driven into the joint may be necessary to break this seal.
- After the bushing is broken loose from the mounting, relieve the tension on the sling and reposition the crane, if necessary, to support the weight of the bushing assembly.
- Remove the remaining bushing mounting bolts.
- Slowly lift the bushing assembly off of the breaker. Keep the bushing centered to prevent damage to the conductor and the voltage shield.

AA.2.3 Cleaning

- Remove and discard O-rings using plastic scrapers.

Note: Do not use metal tools as damage to the sealing surfaces will result.

- Remove all gas sealant residue from flange surfaces using **Scotch-Brite**, plastic scrapers, and denatured alcohol.
- Thoroughly clean the interior of the tank with a vacuum cleaner and visually inspect using a bright flashlight.
- Cover all tank openings with plastic sheets to prevent dirt and moisture from entering.
- Use water or denatured alcohol to clean porcelain bushing exteriors. Refer to Appendix W for composite bushing cleaning instructions.
- Store composite bushings indoors when not in use.

AA.3 Preparing the Bushing Assemblies

Position the sling to lift the bushing assembly with the proper terminal orientation. Lift the assembly to the upright position with a crane and remove the shipping cover from the bottom of the bushing. Remove the bag of adsorbent taped to the conductor. Clean the bottom bushing flange with denatured alcohol and **Scotch-Brite**. Clean the conductor with denatured alcohol. For applications employing contact assemblies, verify that the assemblies are not damaged and that the retaining rings are seated. Inspect the contact assembly at the bottom of the conductor and verify that the contact surface is not damaged.

AA.3.1 Lifting Composite Bushings

- See Fig. AA.3-1 for lifting composite bushings from their crates.
- Install eye-bolts in both end flanges and lift with ropes or slings.
- If required, lift vertically from the top flange as detailed in Fig. AA.3-1.

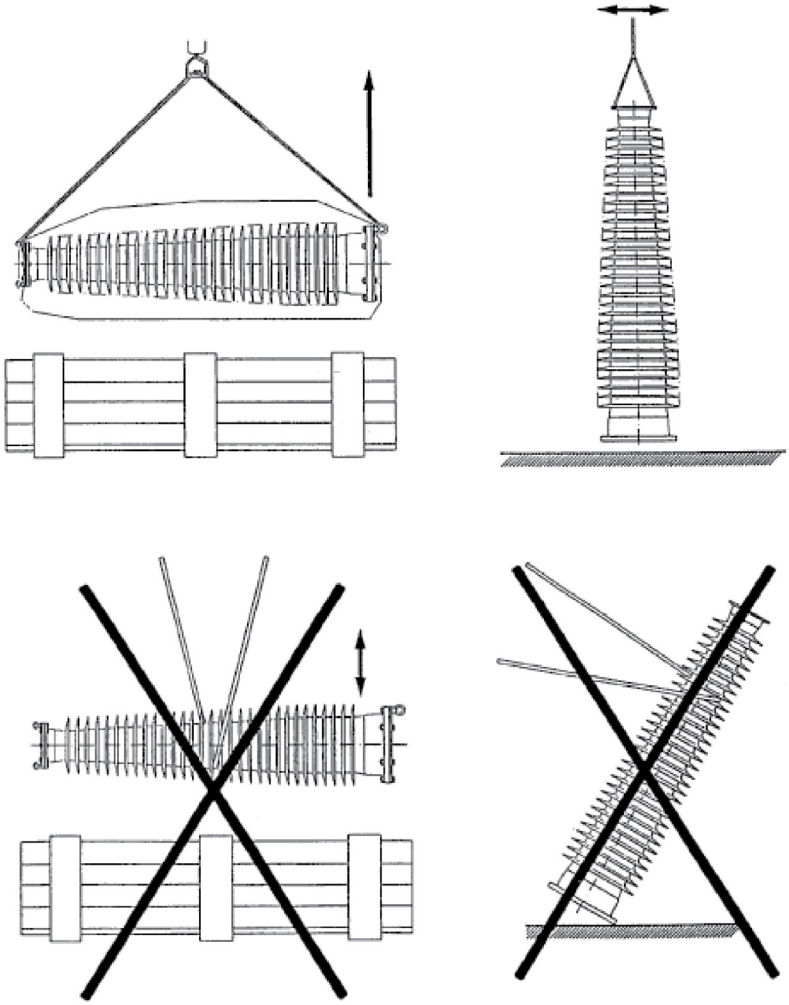


Fig. AA.3-1 Lifting Composite Bushings

AA.4 Preparing Gas Seals

Remove the plastic sheet covering the flange where the first bushing assembly is to be installed. Follow the procedure outlined in Appendix A: SF_6 Gas Seals to prepare the top flanges of the tank for the O-ring and gas sealant. Thoroughly clean the tank, bushing flanges, O-ring groove, and O-ring with solvent. Apply a thin coat of gas sealant to the flange in the areas indicated in Fig. A.5-1 Application Procedure for Gas Sealant and seat the O-ring in the groove.

AA.5 Bushing Installation

CAUTION

Breakers shipped with the bushings removed have the bushings numbered and match-marked along with the bushing adapter plate and tank nozzle. Bushings installed in field must be aligned with the original match-mark. This does not apply to replacement bushing assemblies.

Install three guide pins into bushing mounting bolt holes that are equally spaced around the bushing entrance. Check the position of the bushing high voltage terminal pad relative to the installation drawings. Guide the bushing assembly carefully while lowering it into the tank. Visually guide the bushing conductor located closest to the cabinet into the contact assembly by sighting through the rear cover opening. The conductor of the bushing located closest to the rear cover is guided into the contact assembly by reaching into the tank through the opening where the rear cover is installed. Maintain the proper angle to prevent damage to the interrupter assembly and the bushing conductor. Align the bottom end of the bushing conductor with the contact assembly in the interrupter. Check that the O-ring is in its groove and set the bushing in place. Torque the bushing mounting bolts to the value indicated in Appendix B: Torquing of Bolts. Repeat the installation process for the remaining bushings.

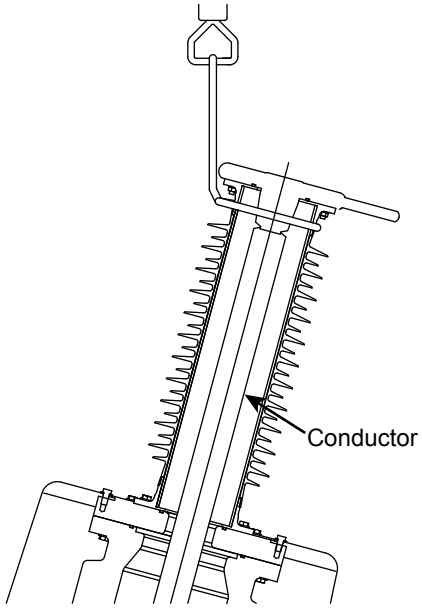


Fig. AA.5-1 Installing Porcelain or Composite Bushing Assembly

AA.6 Closing the Tank

Inspect and clean the tanks, removing all debris. Clean insulating supports for the interrupter assembly with solvent and clean, lint-free wipes. Do not clean insulating materials with wipes that have been in contact with metal surfaces.

Note: Do not expose adsorbent to air for extended periods of time. Evacuating the breaker must be started within one hour of replacing the adsorbent. Keep adsorbent in an air-tight container until bushings are installed and the breaker tanks are ready to be closed.

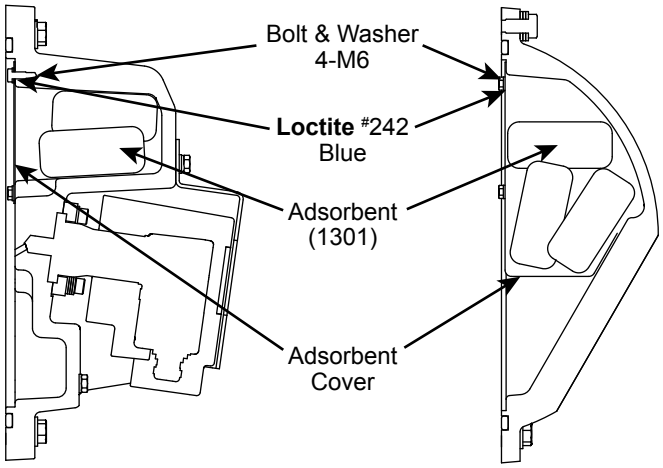


Fig. AA.6-1 Replacing Adsorbent

Begin closing the tanks by replacing the adsorbent in the containers on the inside of the rear covers according to Appendix D: Adsorbent Application or Replacement. Clean and prepare the tank flanges and rear covers for the gas sealant and O-ring according to Appendix A: SF_6 Gas Seals. Torque the mounting bolts to the value indicated in Appendix B: Torquing of Bolts.

Note: If the gas system is common to all three poles, remove all three rear covers and replace the adsorbent in each. If the gas system is independant, only the adsorbent in the opened tank is required to be replaced.

AA.7 Evacuating

Refer to Appendix E: Filling, Removal, and Leak Detection of SF_6.

AA.8 SF_6 Gas Filling

Fill the tanks to their normal SF_6 operating pressure. Add sufficient gas to reset the pressure switch. Follow the procedure identified in Appendix E to verify that gas does not leak through the seals at the bushing and rear mounting flanges.

AA.9 Weather Sealing

Seal all joints with weather sealant to prevent moisture from entering the joints, causing corrosion and deterioration of the gasket and seal surfaces. Apply the sealant as described in Appendix F: Weather Sealing to the bottom bushing flanges, BCT covers, and tank rear covers.

AA.10 Manual Operation of Circuit Breaker

Manually close and open the circuit breaker before electrical operation. Refer to Section 5.6.1 Manual Jack Assembly for instructions regarding the manual jack assembly.

This page left blank intentionally.

Appendix AB: Trip and Close Coil Replacement

AB

Tools Required

Wrenches	8, 10, 17 & 19 mm
Allen head wrench	3 mm
Torque wrench	60 kg-cm (4.3 lb-ft)
Torque wrench	280 kg-cm (20.3 lb-ft)
Pliers	
Screwdriver	
Feeler gauges	0.05 to 5.5 mm (0.002 - 0.217 in)
Loctite	#242 Blue
Roll pin	qty. 1

AB.1 Trip Coil Assembly Replacement Procedure for BM-1 Mechanism Circuit Breakers when Coil with Magnetic Circuit Assembly is Available

⚠ CAUTION

De-energize and isolate the breaker. Ground the high voltage terminals. Keep clear of moving parts in the mechanism and linkage when operating the circuit breaker.

AB.1.1 Discharge the Close Spring

Refer to Fig. AB.1-1 Trip Coil Assembly when using the following procedure.

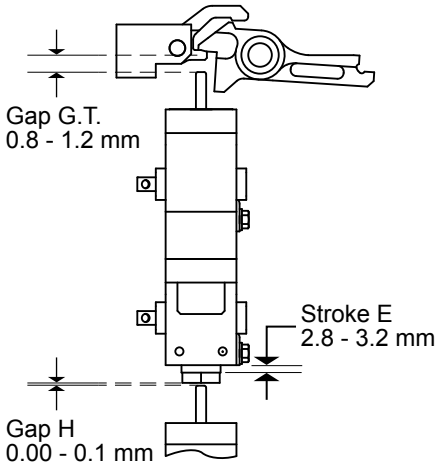


Fig. AB.1-1 Trip Coil Assembly

- Verify that the trip and close prevention pins are removed and that the breaker is filled to the proper gas pressure.
- Remove voltage from the spring charge motor circuit. Electrically close the breaker. If the spring charge motor cannot be easily isolated from the close circuit, de-energize the DC control circuit and manually jack the breaker closed.

⚠ CAUTION Keep clear of moving parts in the mechanism and linkage when closing the breaker.

- De-energize the close and trip circuits to the breaker.
- Insert the trip prevention pin.

Note: The close prevention pin can be installed when the breaker is in either the open or closed position while the trip prevention pin can only be installed when the breaker is in the closed position.

- Verify that the breaker is in the closed position, the spring charge indicator shows that the close spring is discharged, and the trip prevention pin is installed.

AB.1.2 Remove Trip Coil Assembly

- Note the location of wiring connections to the trip coil. Remove the wires to the trip coil terminals.

⚠ CAUTION	Note the location and quantity of shims installed between the trip coil and the mechanism frame. Account for all the shims while removing and replacing the trip coil assembly.

- Note the orientation of the coil assembly.
- Loosen the two M10 bolts that attach the trip coil assembly to the mechanism frame. Remove the trip coil assembly and any shims between the trip coil assembly and the mechanism frame.

AB.1.3 Reassembly of Trip Coil

- Verify that the coil assembly is orientated as it was prior to disassembly.
- Attach the trip coil assembly and shims to the mechanism frame with the M10 bolts. Make sure that the location and quantity of shims are consistent with what was noted during the disassembly procedure.

AB.1.4 Adjustments

- Measure the trip coil gap (G.T.). This dimension should be between 0.8 and 1.2 mm (0.031 and 0.047 in).
- Adjust gap (G.T.) by removing or adding shim washers between the coil assembly and the mechanism frame at the M10 mounting bolts.
- Torque the two primary coil assembly mounting bolts to 280 kg-cm (20.2 lb-ft).

- If the breaker has two trip coils, measure the gap (H) between the primary and secondary coil plungers. This measurement should be between 0.0 and 0.1 mm (0.0 and 0.004 in). Insert or remove shim washers between the primary and secondary trip coil assemblies to bring this measurement into the specified range.
- Torque the secondary trip coil mounting bolts (two M12 hex head bolts) to 480 kg-cm (34.7 lb-ft).

AB.1.5 Wiring

- Reconnect the wiring to the trip coil terminals as it was prior to disassembly.
- Verify that the coil terminals have not been bent into a position that could cause an electrical short circuit.

AB.1.6 Operational Test

- Remove the trip prevention pin.
- Energize the control circuits to the breaker. The motor should operate to charge the close spring.
- Electrically open and close the breaker.
- Return the breaker to service.

AB.2 Trip Coil Assembly Replacement Procedure for BM-1 Mechanism Circuit Breakers when Coil without Magnetic Circuit Assembly is Available

⚠ CAUTION	De-energize and isolate the breaker. Ground the high-voltage terminals. Keep clear of moving parts in the mechanism and linkage when operating the circuit breaker.

AB.2.1 Discharge the Close Spring

Refer to Fig. AB.1-1 Trip Coil Assembly for the following procedure.

- Verify that the trip and close prevention pins are removed and that the breaker is filled to the proper gas pressure.
- Remove voltage from the spring charge motor circuit. Electrically close the breaker. If the spring charge motor cannot be easily isolated from the close circuit, de-energize the DC control circuit and manually jack the breaker closed.

⚠ CAUTION	Keep clear of moving parts in the mechanism and linkage when closing the breaker.

- De-energize the close and trip circuits to the breaker.
- Insert the trip prevention pin.

Note: The close prevention pin can be installed when the breaker is in either the open or the closed position while the trip prevention pin can only be installed when the breaker is in the closed position.

- Verify that the breaker is in the closed position, that the spring charge indicator shows that the close spring is discharged, and that the trip prevention pin is installed.

AB.2.2 Remove Trip Coil Assembly

- Note the location of wiring connections to the trip coil. Remove the wires to the trip coil terminals.

⚠ CAUTION	Note the location and quantity of shims between the trip coil and the mechanism frame. Account for all the shims while removing and replacing the trip coil assembly.

- Note the orientation of the coil assembly.

- Loosen the two M10 bolts that attach the trip coil assembly to the mechanism frame. Remove the trip coil assembly and any shims between the trip coil and the mechanism frame.
- Loosen the shoulder bolt that retains the trip coil plunger. Remove the plunger and spring.
- Note the orientation of the coil terminals and the coil retaining plate in the coil assembly.
- Remove the two M5 hex head bolts and washers that attach the coil retaining plate to the coil assembly.
- Remove the coil from the assembly.
- Repeat this part of the procedure for the second trip coil, if appropriate.

AB.2.3 Reassembly of Trip Coil

- Insert the new coil in the assembly. Verify that the coil's wiring terminals are oriented as they were prior to disassembly.
- Verify the orientation of the coil retaining plate and attach it to the assembly with bolts and washers previously removed. Apply one drop of **Loctite** #242 Blue to each screw when installing the retaining plate. Position the plunger and spring in the coil.
- Install the shoulder bolt to retain the plunger. Torque to 140 kg-cm (10.1 lb-ft).
- Verify that the coil assembly is oriented as it was prior to disassembly.
- Repeat this part of the procedure for the second trip coil, if appropriate.
- Attach the trip coil assembly and shims to the mechanism frame using the M10 bolts. Torque bolts after adjusting. Make sure that the location and quantity of shims are consistent with what was noted during the disassembly procedure.

AB.2.4 Adjustments

- Measure the trip coil gap (GT). This dimension should be between 0.8 and 1.2 mm (0.031 and 0.047 in).
- Adjust gap (GT) by removing or adding shim washers between the coil assembly and the mechanism frame at the M10 mounting bolts.
- Torque the two primary coil assembly mounting bolts to 280 kg-cm (20.2 lb-ft).

- If the breaker has two trip coils, measure the gap (H) between the primary and secondary coil plungers. This measurement should be between 0.0 and 0.1 mm (0 and 0.004 in). Insert or remove shim washers between the primary and secondary trip coil assemblies to bring this measurement into the specified range.
- Torque the secondary trip coil mounting bolts (two M12 hex head bolts) to 480 kg-cm (34.7 lb-ft).

AB.2.5 Wiring

- Reconnect wiring to the trip coil terminals as it was prior to disassembly.
- Verify that coil terminals have not been bent into a position that could cause an electrical short circuit.

AB.2.6 Operational Test

- Remove the trip prevention pin.
- Energize the control circuits to the breaker. The motor should operate to charge the close spring.
- Electrically open and close the breaker.
- Return the breaker to service.

AB.3 Close Coil Assembly Replacement Procedure for BM-1 Mechanism Circuit Breakers when Coil with Magnetic Circuit Assembly is Available

⚠ CAUTION	De-energize and isolate the breaker. Ground the high-voltage terminals. Keep clear of moving parts in the mechanism and linkage when operating the circuit breaker.

AB.3.1 Discharge the Close and Trip Springs

Refer to Fig. AB.3-1 Close Coil Assembly when using the following procedure.

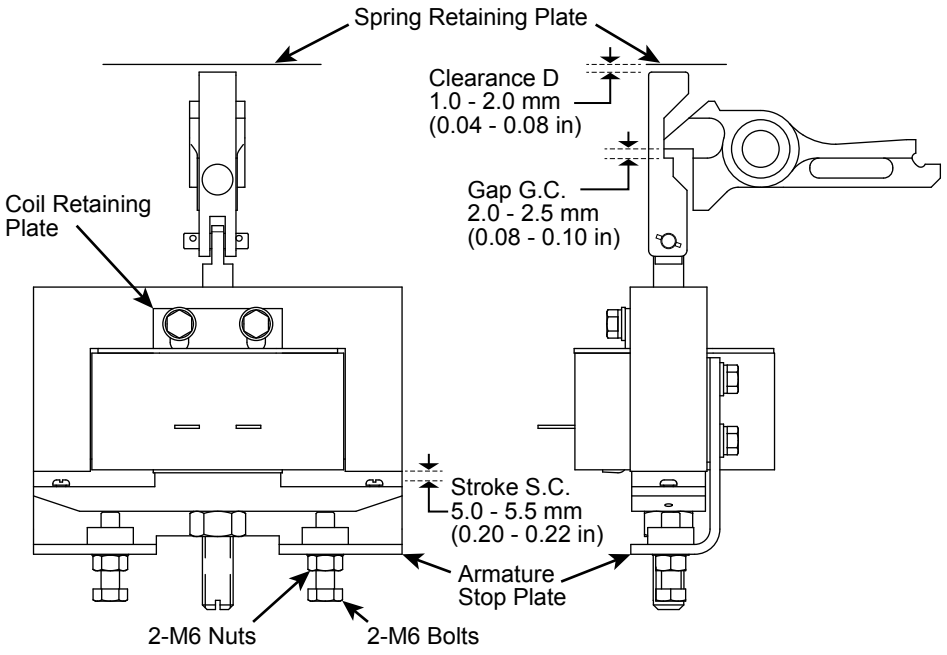


Fig. AB.3-1 Close Coil Assembly

- Verify that the trip and close prevention pins are removed and that the breaker is filled to the proper gas pressure.
- Remove voltage from the spring charge motor circuit. Electrically close the breaker. If the spring charge motor cannot be easily isolated from the close circuit, de-energize the DC control circuit and manually jack the breaker closed.

⚠ CAUTION

Keep clear of moving parts in the mechanism and linkage when closing the breaker.

- With the spring charge motor circuit still de-energized, electrically open the breaker. Again, if the spring charge motor circuit cannot be easily isolated from the trip circuit, de-energize the DC control circuit and manually jack the breaker open.

CAUTION

Keep clear of moving parts in the mechanism and linkage when closing the breaker.

- De-energize the close and trip circuits to the breaker.
- Insert the close prevention pin.

Note: The close prevention pin can be installed when the breaker is in either the open or the closed position while the trip prevention pin can only be installed when the breaker is in the closed position.

- Verify that the breaker is in the open position and the spring charge indicator shows that the close spring is discharged.

AB.3.2 Remove Close Coil Assembly

- Note the location of the wiring connections to the close coil. Remove the wires to the close coil terminals.
- Loosen the two M10 bolts on the spring retaining plate.
- Remove the spring retaining plate and the spring. Note that the spring is compressed. Do not to misplace the spring while removing it from the mechanism.

CAUTION

Note the location and quantity of shims between the close coil and the mechanism frame. Account for all the shims while removing and replacing the close coil assembly.

- Loosen the two bolts that attach the close coil assembly to the mechanism frame. Remove the coil assembly and the shims.

AB.3.3 Remove Trigger Lever

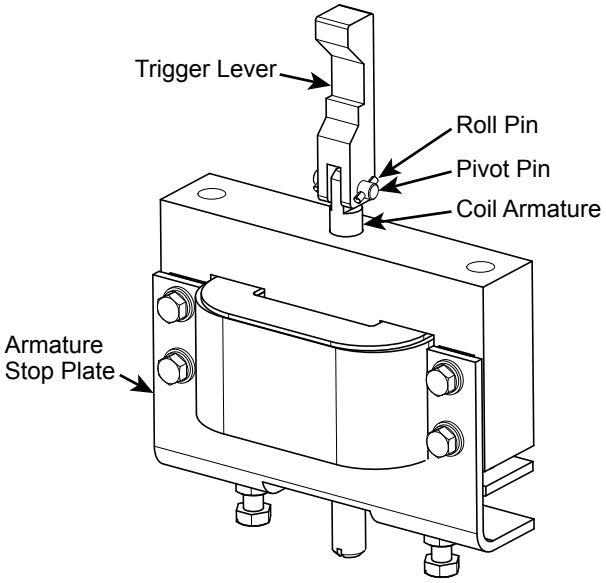


Fig. AB.3.3-1 Close Coil Trigger Removal

- Note the orientation of the trigger lever that is attached to the coil armature.
- Remove one roll pin from the pivot pin that attaches the trigger lever to the coil armature. Discard the roll pin, but save the pivot pin and lever for reuse.

AB.3.4 Reassembly of Close Coil

- Connect the trigger lever to the new close coil assembly with the pivot pin. Verify that the lever is oriented as it was prior to disassembly.
- Insert a new roll pin to secure the pivot pin to the coil assembly.
- Attach the close coil assembly and shims to the mechanism frame using the M10 bolts. Make sure that the location and quantity of shims are consistent with what was noted during the disassembly procedure.
- Position the spring and spring retaining plate on the assembly. Torque the two M10 bolts to 280 kg-cm (20.2 lb-ft).

AB.3.5 Adjustments

- Adjust the stroke (A) of the close coil armature into the specified range using the bolts (D). After adjustment, apply **Loctite** #242 Blue and lock the bolts into position using the locknuts.
- Adjust the gap (B) by removing or adding shim washers between the coil assembly and the mechanism frame at the M10 mounting bolts.
- If gap (B) is greater than the maximum and no more shim washers are left to remove, adjust by loosening the lock nut and turning the plunger into the armature by one full turn. Loosen the M10 mounting bolts and remove the coil assembly from the mechanism frame to turn the plunger into the armature. After completing this adjustment, torque the lock nut to 280 kg-cm (20.2 lb-ft).
- Torque the two coil assembly mounting bolts to 280 kg-cm (20.2 lb-ft).

AB.3.6 Wiring

- Reconnect wiring to the close coil terminals as it was prior to disassembly.
- Verify that coil terminals have not been bent into a position that could cause an electrical short circuit.

AB.3.7 Operational Test

- Remove the close prevention pin.
- Energize the control circuits to the breaker. The motor should operate to charge the close spring.
- Electrically close and open the breaker.
- Return the breaker to service.

AB.4 Close Coil Assembly Replacement Procedure for BM-1 Mechanism Circuit Breakers when Coil without Magnetic Circuit Assembly is Available

⚠ CAUTION	De-energize and isolate the breaker. Ground the high-voltage terminals. Keep clear of moving parts in the mechanism and linkage when operating the circuit breaker.

AB.4.1 Discharge the Close and Trip Springs

Refer to Fig. AB.3-1 Close Coil Assembly when using the following procedure.

- Verify that the trip and close prevention pins are removed and that the breaker is filled to the proper gas pressure.
- Remove voltage from the spring charge motor circuit. Electrically close the breaker. If the spring charge motor cannot be easily isolated from the close circuit, de-energize the DC control circuit and manually jack the breaker closed.

⚠ CAUTION	Keep clear of moving parts in the mechanism and linkage when closing the breaker.

- With the spring charge motor circuit still de-energized, electrically open the breaker. Again, if the spring charge motor circuit cannot be easily isolated from the trip circuit, de-energize the DC control circuit and manually jack the breaker open.

⚠ CAUTION	Keep clear of moving parts in the mechanism and linkage when actuating the trip coil in this manner.

- De-energize the close and trip circuits to the breaker.
- Insert the close prevention pin.

Note: The close prevention pin can be installed when the breaker is in either the open or the closed position while the trip prevention pin can only be installed when the breaker is in the closed position.

- Verify that the breaker is in the open position and the spring charge indicator shows that the close spring is discharged.

AB.4.2 Remove Close Coil Assembly

- Note the location of wiring connections to the close coil. Remove the wires to the close coil terminals.
- Loosen bolts on the spring retaining plate.
- Remove the spring retaining plate and spring. Note that the spring is compressed. Take care not to misplace the spring while removing it from the mechanism.

⚠ CAUTION	Note the location and quantity of shims between the close coil and the mechanism frame. Account for all the shims while removing and replacing the close coil assembly.

- Loosen the two M10 bolts that attach the close coil assembly to the mechanism frame. Remove the coil assembly and the shims.
- Note the orientation of the coil terminals, the trigger lever, the armature stop plate, and the coil retaining plate on the coil assembly.

- Remove the four M5 hex head bolts and washers that attach the armature stop plate to the coil assembly.
- Remove the two M5 hex head bolts and washers that attach the coil retaining plate to the coil assembly.
- Remove the coil from the assembly.

AB.4.3 Reassembly of Close Coil

- Insert the new coil in the assembly. Verify that the coil's wiring terminals are oriented as they were prior to disassembly.
- Verify the orientation of the coil retaining plate and attach it to the assembly with the bolts and washers previously removed. Apply one drop of **Loctite** #242 Blue to each screw when installing the retaining plate. Position the armature assembly in the coil and make sure that the lever is oriented as it was prior to disassembly.
- Verify the orientation of the armature stop plate and attach it to the coil assembly with the bolts and washers previously removed. Apply one drop of **Loctite** #242 Blue to each screw when installing the armature stop plate.
- Attach the close coil assembly and shims to the mechanism frame using the M10 bolts. Verify that the location and quantity of shims are consistent with those noted during the disassembly procedure.
- Position the spring and spring retaining plate on the assembly. Torque the two M10 bolts to 280 kg-cm (20.2 lb-ft).

AB.4.4 Adjustments

- Adjust the stroke (A) of the close coil armature into the specified range using the bolts (D). After adjustment, apply **Loctite** #242 Blue and lock the bolts into position using the locknuts.
- Adjust the gap (B) by removing or adding shim washers between the coil assembly and the mechanism frame at the M10 mounting bolts.
- If gap (B) is greater than the maximum and no more shim washers are left to remove, adjust by loosening the lock nut and turning the plunger into the armature by one full turn. Loosen the M10 mounting bolts and remove the coil assembly from the mechanism frame to turn the plunger into the armature. After completing this adjustment, torque the lock nut to 280 kg-cm (20.2 lb-ft).
- Torque the two coil assembly mounting bolts to 280 kg-cm (20.2 lb-ft).

AB.4.5 Wiring

- Reconnect the wiring to the close coil terminals as it was prior to disassembly.
- Verify that coil terminals have not been bent into a position that could cause an electrical short circuit.

AB.4.6 Operational Test

- Remove the close prevention pin.
- Energize the control circuits to the breaker. The motor should operate to charge the close spring.
- Electrically close and open the breaker.
- Return the breaker to service.

This page left blank intentionally.

Material Safety Data Sheet

Sulfur Hexafluoride

Section 1. Chemical product and company identification

Product name : Sulfur Hexafluoride

Supplier : AIRGAS INC., on behalf of its subsidiaries
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Product use : Synthetic/Analytical chemistry.

Synonym : Sulfur fluoride; OC-6-11; Elegas; SF6; Hexafluorure de soufre; UN 1080; Esaflon

MSDS # : 001048

Date of Preparation/Revision : **4/26/2010.**

In case of emergency : 1-866-734-3438

Section 2. Hazards identification

Physical state : Gas. [COLORLESS, ODORLESS GAS. [NOTE: SHIPPED AS A LIQUEFIED COMPRESSED GAS. CONDENSES DIRECTLY TO A SOLID UPON COOLING.]]

Emergency overview : WARNING!

MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA.
CONTENTS UNDER PRESSURE.

Do not puncture or incinerate container. May cause target organ damage, based on animal data.

Contact with rapidly expanding gases can cause frostbite.

Target organs : May cause damage to the following organs: upper respiratory tract.

Routes of entry : Inhalation

Potential acute health effects

Eyes : Contact with rapidly expanding gas may cause burns or frostbite.

Skin : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Acts as a simple asphyxiant.

Ingestion : Ingestion is not a normal route of exposure for gases

Potential chronic health effects : **CARCINOGENIC EFFECTS**: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.

Medical conditions aggravated by over-exposure : Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (section 11)

Section 3. Composition, Information on Ingredients

Name	CAS number	% Volume	Exposure limits
Sulfur Hexafluoride	2551-62-4	100	**ACGIH TLV (United States, 1/2009).** TWA: 5970 mg/m³ 8 hour(s). TWA: 1000 ppm 8 hour(s). **NIOSH REL (United States, 6/2009).** TWA: 6000 mg/m³ 10 hour(s). TWA: 1000 ppm 10 hour(s). **OSHA PEL (United States, 11/2006).** TWA: 6000 mg/m³ 8 hour(s). TWA: 1000 ppm 8 hour(s). **OSHA PEL 1989 (United States, 3/1989).** TWA: 6000 mg/m³ 8 hour(s).

Sulfur Hexafluoride

TWA: 1000 ppm 8 hour(s).

Section 4. First aid measures

No action shall be taken involving any personal risk or without suitable training.If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus.It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

Eye contact : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

Skin contact : In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Inhalation : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Ingestion : As this product is a gas, refer to the inhalation section.

Section 5. Fire-fighting measures

Flammability of the product : Non-flammable.

Products of combustion : Decomposition products may include the following materials:
sulfur oxides
halogenated compounds

Fire-fighting media and instructions : Use an extinguishing agent suitable for the surrounding fire.

Apply water from a safe distance to cool container and protect surrounding area. If involved in fire, shut off flow immediately if it can be done without risk.

Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions : Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment (section 8). Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Methods for cleaning up : Immediately contact emergency personnel. Stop leak if without risk. Note: see section 1 for emergency contact information and section 13 for waste disposal.

Section 7. Handling and storage

Handling : High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Storage : Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Sulfur Hexafluoride

Section 8. Exposure controls/personal protection

Engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Personal protection

Eyes : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.

Skin : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

The applicable standards are (US) 29 CFR 1910.134 and (Canada) Z94.4-93

Hands : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Personal protection in case of a large spill : Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

Product name

sulphur hexafluoride

ACGIH TLV (United States, 1/2009).
TWA: 5970 mg/m³ 8 hour(s).
TWA: 1000 ppm 8 hour(s).
NIOSH REL (United States, 6/2009).
TWA: 6000 mg/m³ 10 hour(s).
TWA: 1000 ppm 10 hour(s).
OSHA PEL (United States, 11/2006).
TWA: 6000 mg/m³ 8 hour(s).
TWA: 1000 ppm 8 hour(s).
OSHA PEL 1989 (United States, 3/1989).
TWA: 6000 mg/m³ 8 hour(s).
TWA: 1000 ppm 8 hour(s).

Consult local authorities for acceptable exposure limits.

Section 9. Physical and chemical properties

Molecular weight : 146.06 g/mole
Molecular formula : F6-S
Melting/freezing point : Sublimation temperature: -64.15°C (-83.5°F)
Critical temperature : 45.5°C (113.9°F)
Vapor pressure : 320 (psig)
Vapor density : 5.114 (Air = 1)
Specific Volume (ft ^{3}/lb) : 2.5994
Gas Density (lb/ft ^{3}) : 0.3847

Section 10. Stability and reactivity

Stability and reactivity : The product is stable.
Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Sulfur Hexafluoride

Section 11. Toxicological information

Toxicity data

Chronic effects on humans : May cause damage to the following organs: upper respiratory tract.

Other toxic effects on humans : No specific information is available in our database regarding the other toxic effects of this material to humans.

Specific effects

Carcinogenic effects : No known significant effects or critical hazards.

Mutagenic effects : No known significant effects or critical hazards.

Reproduction toxicity : No known significant effects or critical hazards.

Section 12. Ecological information

Aquatic ecotoxicity

Not available.

Environmental fate : Not available.

Environmental hazards : No known significant effects or critical hazards.

Toxicity to the environment : Not available.

Section 13. Disposal considerations

Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, local regulation.Return cylinders with residual product to Airgas, Inc.Do not dispose of locally.

Section 14. Transport information

Regulatory information	UN number	Proper shipping name	Class	Packing group	Label	Additional information
DOT Classification	UN1080	SULFUR HEXAFLUORIDE	2.2	Not applicable (gas).		**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 75 kg **Cargo aircraft** Quantity limitation: 150 kg
TDG Classification	UN1080	SULFUR HEXAFLUORIDE; OR SULPHUR HEXAFLUORIDE	2.2	Not applicable (gas).		**Explosive Limit and Limited Quantity Index** 0.125 **Passenger Carrying Road or Rail Index** 75

Sulfur Hexafluoride						
Mexico Classification	UN1080	SULFUR HEXAFLUORIDE	2.2	Not applicable (gas).		-

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Section 15. Regulatory information

United States

U.S. Federal regulations : **United States inventory (TSCA 8b):** This material is listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: sulphur hexafluoride
SARA 311/312 MSDS distribution - chemical inventory - hazard identification: sulphur hexafluoride: Sudden release of pressure

Clean Water Act (CWA) 307: No products were found.

Clean Water Act (CWA) 311: No products were found.

Clean Air Act (CAA) 112 accidental release prevention: No products were found.

Clean Air Act (CAA) 112 regulated flammable substances: No products were found.

Clean Air Act (CAA) 112 regulated toxic substances: No products were found.

State regulations : **Connecticut Carcinogen Reporting:** This material is not listed.
Connecticut Hazardous Material Survey: This material is not listed.
Florida substances: This material is not listed.
Illinois Chemical Safety Act: This material is not listed.
Illinois Toxic Substances Disclosure to Employee Act: This material is not listed.
Louisiana Reporting: This material is not listed.
Louisiana Spill: This material is not listed.
Massachusetts Spill: This material is not listed.
Massachusetts Substances: This material is listed.
Michigan Critical Material: This material is not listed.
Minnesota Hazardous Substances: This material is not listed.
New Jersey Hazardous Substances: This material is listed.
New Jersey Spill: This material is not listed.
New Jersey Toxic Catastrophe Prevention Act: This material is not listed.
New York Acutely Hazardous Substances: This material is not listed.
New York Toxic Chemical Release Reporting: This material is not listed.
Pennsylvania RTK Hazardous Substances: This material is listed.
Rhode Island Hazardous Substances: This material is not listed.

Canada

WHMIS (Canada) : Class A: Compressed gas.

CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

United States

Label requirements : MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA.
CONTENTS UNDER PRESSURE.

Canada

Label requirements : Class A: Compressed gas.

Sulfur Hexafluoride

Hazardous Material Information System (U.S.A.) :

Health	*	0
Flammability		0
Physical hazards		0

National Fire Protection Association (U.S.A.) :

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

MITSUBISHI ELECTRIC

30SFMT40E-B
30SFMT40HE-B
30SFMT40LE-B
70SFMT40E-B
70SFMT40HE-B
70SFMT40LE-B

Type SFMT Circuit Breaker
Spring Mechanism
Single Break SF_6 Puffer Type

Parts List
MEB0008

10/20

Mitsubishi Electric
Power Products, Inc.

520 Keystone Drive
Warrendale, PA 15086
(800) 624-7425

After Hours Support:
(866) 390-6487

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment are not claimed to be covered by these instructions. If further information is desired by the purchaser regarding the installation, operation, or maintenance of his particular equipment, the Mitsubishi Electric Power Products' Representative should be contacted.

PL

Parts List

To properly identify the parts ordered, specify:

1. Type of circuit breaker
2. Serial number and/or MEPPI order number
3. Parts List Number (or Instruction Book Number)
4. Part number and description
5. Quantity

   Refer also to the Instruction Book for the figure reference number.

When ordering electrical control components, identify the part by:

1. Control Schematic Number
2. Device and description of device
3. Type and rating

Note: Generic part numbers in this list are for general identification purposes. The breaker serial number is required for Mitsubishi Electric Power Products, Inc. to identify the actual inventory part number of the required component for the specific circuit breaker.

(Example of rating table. Consult your own schematic for the correct parts)

Device	Description	Manufacturers' Part Number
8D1	Knife Switch	CKS 2P 1SA 250VDC
8D2	Knife Switch	CKS 2P 1SA 250VDC
8M	Knife Switch	CKS 2P 1SA 250VDC
8SH	Knife Switch	CKS 2P 1SA 250VDC
8U	Knife Switch	CKS 2P 1SA 250VDC
11-52CT	Breaker Control Switch Close	Square D Type 9001
23SH	Thermostat	GRT-90
33hb	Mechanism Limit Switch	X-10GM2-B Closing Spring Charged Open Discharged Closed
42M	Motor Contactor	SD – K21 250 VDC
48T	Time Delay Relay Motor Failure	SRTD-KN 0.1-60SEC. (SET AT 30) 1255Ω
49M	Motor Over Current Relay	TH – K20 4-6A (SET AT 4.8 A)
49MX	49M Auxiliary Relay	SRD – K5 2a 3b 1485 Ω
52a	Breaker Auxiliary Contact	Type BMZ
52b	Breaker Auxiliary Contact	
52c	Close CGT1	

Example:

(Dwg)	(Device)	(Description)	(Manufacturers' Part Number)	(Qty)
H1A2419A	8D1	Knife Switch	CKS 2P 15A 250V	1
H1A2419A	52Y	Anti-pumping Relay	SRD-k5 2a 2b 1485 Ohm	1

Parts may be ordered from the local representative for Mitsubishi Electric Power Products, Inc.

PART NO.	DESCRIPTION	QUANTITY	I.B. & P.L.B. FIGURE NUMBER
1202	Rear Cover O-ring	3 x 1	3.4-1, 5.7-1
1203	Front Cover O-ring	3 x 1	3.4-1
1301	Adsorbent	3 x 1	5.7-1, 5.7-4, D.4-1, AA.6-1
1401	Rupture Disk	3 x 1	Y-1
1405	O-ring	3 x 3	Y-1
2013	Stationary Arcing Contact Assembly	3 x 1	3.4-1, 5.7-1, 5.7-2, 5.7-3
2040	Nozzle	3 x 1	3.4-1, 5.7-1
2041	Moving Arcing Contact	3 x 1	3.4-1, 5.7-1, 5.7-3
3010	Trip Coil Assembly	1	5.6-4, 5.6-6
3040	Close Coil Assembly	1	5.6-4, 5.6-7
3050	Trip Prevention Pin	1	3.6-1, 3.7-1, 5.6-1
3051	Close Prevention Pin	1	3.6-1, 3.7-1, 5.6-1
7001	Arcing Contact Inspection Tool Kit	1	
7011	- Nozzle Tool	1	5.7-1
7012	- Moving Arcing Contact Tool	1	5.7-1
7002	Manual Jack Assembly MD100246	1	5.6-1
7003	Manual Jack Assembly MD100577	1	5.6-1
7024	Adapter, Gas Filling, $^{9}/_{16}$" SAE	1	E.2-1
7025	Adapter, Evacuating $1^{5}/_{8}$" SAE	1	E.2-1
7026	Breaker Timing Adapter Assembly	1	T.1-1
	(for Doble transducer) consisting of:		
7027	- Rod	1	T.1-1
7028	- Mounting Plate	1	T.1-1
7029	- Rod End	1	T.1-1

Note: Quantity indicates number of parts per breaker ("3" denotes 3 phases).

PART NO.	DESCRIPTION	QUANTITY	I.B. & P.L.B. FIGURE NUMBER
7039	- Screws	4	T.1-1
7040	- Retaining Ring	1	T.1-1
7041	SF_6 Density Switch Test Plug-in	1	5.5.4.1
7042	SF_6 Density Switch Test Kit	1	5.5.4.2
9901	Gas Sealant, Shin-Etsu KE-44-W RTV (100g)		
9902	Weather Sealant, Shin-Etsu KE-45-T RTV (100g)		
9903	**Loctite** #242 Blue		
9904	Diamond #2 Low Temp Grease (50cc)		
9905	**Noxlub** Contact Grease		
9906	Darina #2 Contact Grease (50cc)		
9907	**Loctite** #277 Red		
9908	**Dow Corning** #111 Valve Lubricant		

Note: Quantity indicates number of parts per breaker ("3" denotes 3 phases).