Service

DETROIT DIESEL CORPORATION

mtu

Automatic Transfer Switches

Models:

SCT/SCP/SBT/SBP

Power Switching Device:
Standard and Bypass/Isolation
30 to 4000 Amperes

Electrical Controls:
DXPower 1000™

MP-6127 9/02a

Product Identification Information

Product identification numbers determine service parts. Record the product identification numbers in the spaces below immediately after unpacking the products so that the numbers are readily available for future reference. Record field-installed kit numbers after installing the kits.

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Model Designation _____

Serial Number _____

Accessory Number	Accessory Description

x:in:007:001

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IMPORTANT SAFETY INSTRUCTIONS. Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained. To prevent accidents be aware of potential dangers and act safely. Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

This manual has several types of safety precautions and instructions: Danger, Warning, Caution, and Notice.

DANGER

Danger indicates the presence of a hazard that ***will cause severe personal injury, death***, or ***substantial property damage***.

WARNING

Warning indicates the presence of a hazard that ***can cause severe personal injury, death,*** or ***substantial property damage***.

CAUTION

Caution indicates the presence of a hazard that ***will*** or ***can cause minor personal injury*** or ***property damage***.

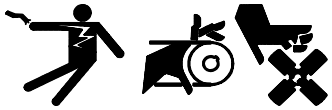
NOTICE

Notice communicates installation, operation, or maintenance information that is safety related but not hazard related.

Safety decals affixed to the equipment in prominent places alert the operator or service technician to potential hazards and explain how to act safely. The decals are shown throughout this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

Battery

WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

WARNING

Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery. Never connect the negative (-) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

Hazardous Voltage/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Welding the generator set. Can cause severe electrical equipment damage. Before welding the generator set perform the following steps: (1) Remove the battery cables, negative (–) lead first. (2) Disconnect all engine electronic control module (ECM) connectors. (3) Disconnect all generator set controller and voltage regulator circuit board connectors. (4) Disconnect the engine battery-charging alternator connections. (5) Attach the weld ground connection close to the weld location.

Installing the battery charger. Hazardous voltage can cause severe injury or death. An ungrounded battery charger may cause electrical shock. Connect the battery charger enclosure to the ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect it to the equipment grounding terminal or the lead on the battery charger. Install the battery charger as prescribed in the equipment manual. Install the battery charger in compliance with local codes and ordinances.

Connecting the battery and the battery charger. Hazardous voltage can cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Use adequate lifting capacity.
Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized.

Moving Parts

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

Notice

NOTICE

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

NOTICE

Foreign material contamination. Cover the transfer switch during installation to keep dirt, grit, metal drill chips, and other debris out of the components. Cover the solenoid mechanism during installation. After installation, use the manual operating handle to cycle the contactor to verify that it operates freely. Do not use a screwdriver to force the contactor mechanism.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

This manual provides service and parts information for DDC/MTU Power Generation Model SCT/SCP transfer switches and Model SBT/SBP Bypass/Isolation switches with DXPower 1000™ electrical controls. It includes operation, troubleshooting, repair, and maintenance procedures for the transfer switches and electrical controls.

A personal computer and Setup Program software are essential for troubleshooting the transfer switch. The DXPower™ Setup Program Software Operation and Installation Manual part number is shown in Figure 1.

The information included in this manual is intended solely for use by trained and qualified service personnel of authorized service distributors/dealers.

Information in this publication represents data available at the time of print. The manufacturer of DDC/MTU Power Generation products reserves the right to change this literature and the products represented without notice and without any obligation or liability whatsoever.

Read this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

The equipment service requirements are very important to safe and efficient operation. Inspect parts often and perform required service at the prescribed intervals. Obtain service from an authorized service distributor/dealer to keep equipment in top condition.

Figure 1 lists the part numbers for related literature. Separate operation and installation manuals contain operation and installation information not provided in this manual. Refer to the parts catalog for instructions to obtain replacement parts.

Document	Document Part Number
Model SCT/SCP ATS Operation and Installation Manual	MP-6126
Model SBT/SBP Bypass/Isolation Switch Operation and Installation Manual	MP-6128
DXPower™ Setup Program Operation Manual	MP-6135
Model SCT/SCP/SBT/SBP Parts Catalog	MP-6158
Model SCT/SCP/SBT/SBP Wiring Diagram Manual	MP-6169

Figure 1 Related Literature

Service Assistance

For professional advice on generator power requirements and conscientious service, please contact your nearest DDC/MTU Power Generation distributor.

- Consult the Yellow Pages under the heading Generators—Electric
- Visit the DDC/MTU Power Generation website at ddcmtupowergeneration.com
- Look at the labels and stickers on your DDC/MTU Power Generation product or review the appropriate literature or documents included with the product

1.1 Introduction

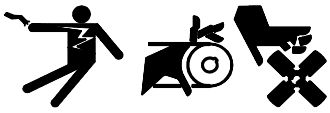
Regular preventive maintenance ensures safe and reliable operation and extends the life of the transfer switch. Preventive maintenance includes periodic testing, cleaning, inspecting, and replacing of worn or missing components. Section 1.4 contains a service schedule of recommended maintenance tasks.

A local authorized distributor/dealer can provide complete preventive maintenance and service to keep the transfer switch in top condition. Unless otherwise specified, have maintenance or service performed by an authorized distributor/dealer in accordance with all applicable codes and standards.

Keep records of all maintenance or service.

Replace all barriers and close and lock the enclosure door after maintenance or service and before reapplying power.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Servicing the transfer switch controls and accessories within the enclosure. Hazardous voltage can cause severe injury or death. Disconnect the transfer switch controls at the inline connector to deenergize the circuit boards and logic circuitry but allow the transfer switch to continue to supply power to the load. Disconnect all power sources to accessories that are mounted within the enclosure but are not wired through the controls and deenergized by inline connector separation. Test circuits with a voltmeter to verify that they are deenergized before servicing.

NOTICE

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

1.2 Inspection and Service

1.2.1 General Inspection

External Inspection. Inspect the transfer switch weekly.

- Look for any signs of vibration, leakage, excessive noise, high temperature, contamination, or deterioration.
- Remove accumulations of dirt, dust, and other contaminants from the transfer switch's exterior with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and damage the switch.*
- Replace any worn, missing, or broken external components with manufacturer-recommended replacement parts. Contact a local authorized distributor/dealer for part information and ordering.
- Tighten loose external hardware.

Contact an authorized distributor/dealer to inspect and service the transfer switch when any wear, damage, deterioration, or malfunction of the transfer switch or its components is evident or suspected.

1.2.2 Internal Inspections and Maintenance

Internal Inspection. Have an authorized distributor/dealer perform an annual inspection of the transfer switch. Inspect the switch more frequently if it is located in a dusty or dirty area or when any condition noticed during an external inspection may have affected internal components. Disconnect all power sources, open the transfer switch enclosure, and inspect internal components. Look for:

- Accumulations of dirt, dust, moisture, or other contaminants
- Signs of corrosion
- Worn, missing, or broken components
- Loose hardware
- Wire or cable insulation deterioration, cuts, or abrasions
- Signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor
- Other evidence of wear, damage, deterioration, or malfunction of the transfer switch or its components

Cleaning. Use a vacuum cleaner or a dry cloth or brush to remove contaminants from internal components. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and damage the switch.*

Lubrication. Maintain the transfer switch lubrication. If the transfer switch is subject to extremely dusty or abnormal operating conditions, relubricate all movements and linkages yearly. Relubricate the solenoid operator if the TS coil is replaced. Do not use oil; order the lubrication kit shown in the Parts Catalog.

Disconnect power and manually operate the transfer switch mechanism to verify that it operates smoothly without binding. If lubricating the outer mechanism of the transfer switch does not eliminate binding, replace the transfer switch assembly.

Periodically oil the enclosure door locks and screws.

Part Replacement and Tightening. Replace worn, missing, broken, deteriorated, or corroded internal components with manufacturer-recommended replacement parts. Contact a local authorized distributor/dealer for part information and part ordering. Tighten loose internal hardware.

Terminal Tightening. Loose connections on the power circuits can lead to overheating or explosion. Tighten all lugs to the torque values on the label on the switch. See Figure 1-1 for a typical label.

Tighten engine start, input/output, and auxiliary connections to the torque indicated on the decals affixed to the unit.

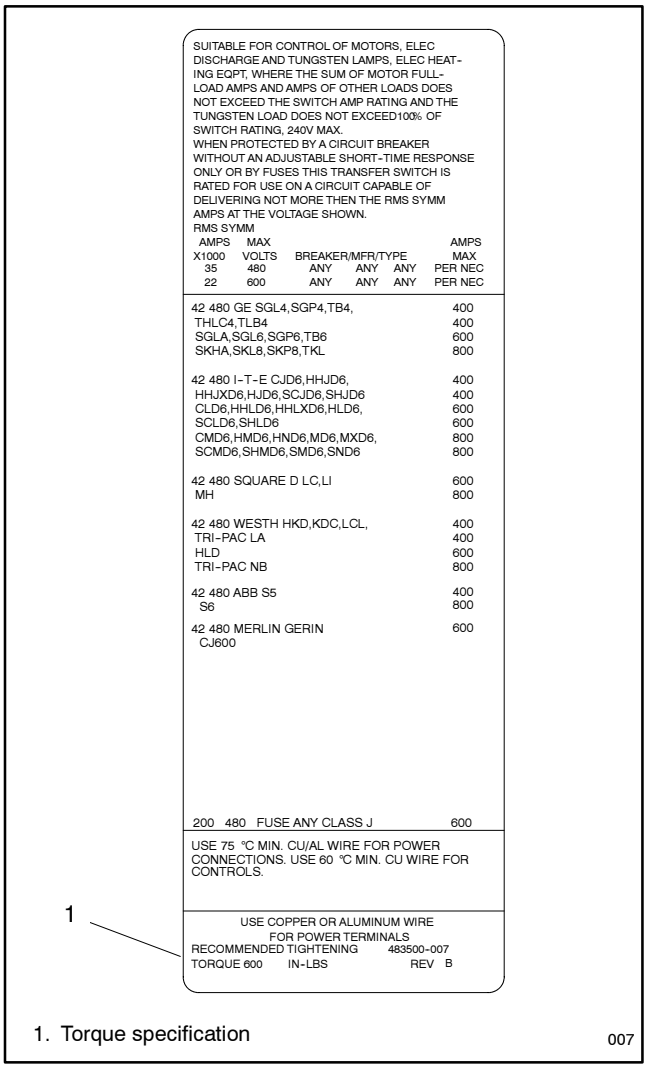


Figure 1-1 Typical Rating/Torque Label

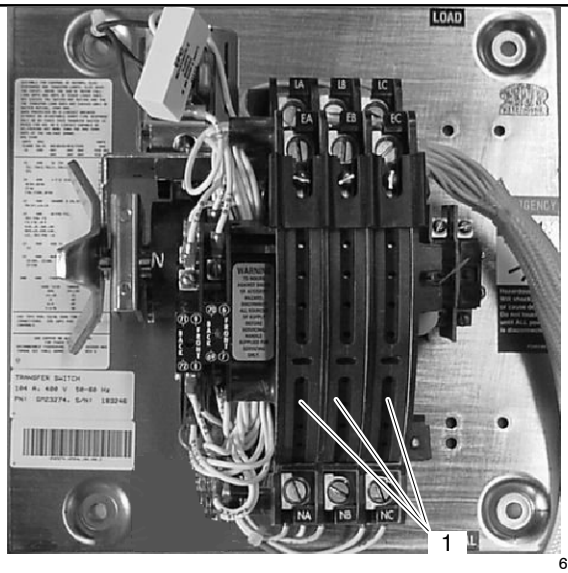
Signs of Overheating. Replace components damaged by overheating and locate the cause of the overheating. Overheating could be caused by loose power connections, overloading, or a short circuit in the system. After tightening the power terminals, perform a millivolt drop test to locate areas with high contact resistance. See Section 1.3.3. Check the line circuit breakers in the system to be sure that they do not allow the load to exceed the switch rating. Use the controller troubleshooting and schematics to locate a control circuit short.

Wire Repair or Replacement. Replace wiring when there is any doubt about its condition, or when there is extensive damage or deterioration. If the damaged or deteriorated wires are part of a wiring harness, replace the entire wiring harness.

Power Circuit Wiring. Have damage to line voltage and power circuit wiring evaluated and repaired or replaced by a qualified electrician.

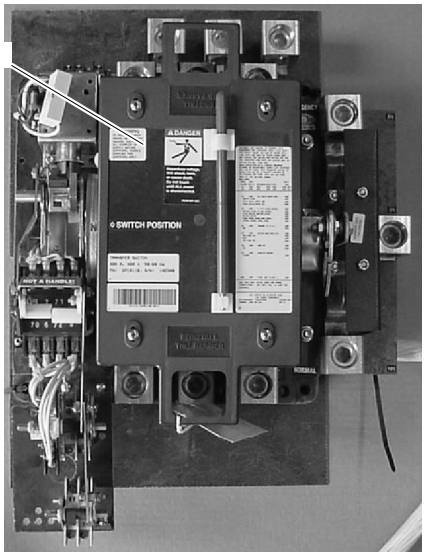
Control Circuit Leads. Repair minor damage to leads in low power and control circuits operating up to 250 volts. Carefully splice and insulate the connections. Tape minor control circuit wire insulation cuts or abrasions. Repair moderately damaged leads, where conductors are cut or insulation is damaged over sections shorter than about 100 mm (4 in.) or less than about 25% of the length of the wire, by cutting out the damaged section and splicing in wire of the same type. Use UL-listed insulated (250 V minimum) connectors and follow the connector manufacturer's instructions. Fabricate new leads using the same type of wire and UL-listed insulated (250 V minimum) connectors and follow the connector manufacturer's instructions.

Transfer Switch Inspection. Remove the arc chute assemblies or covers at the front of the transfer switch and inspect the main contacts inside the transfer switch. See Figure 1-2 and Figure 1-3. Remove surface deposits with a clean cloth. *Do not use an emery cloth or a file.* Discoloration of the contact surface does not affect performance. If the contacts are pitted, show signs of overheating, or are worn, replace the contacts. The contacts are worn if the contact surface material, a layer of silvery-colored metal, is worn through to the metal below. Check the condition of the arc chutes. If the arc chutes show signs of disintegration, replace the arc chute assembly.



1. Arc chute assemblies

Figure 1-2 150 Amp Model Transfer Switch



1. Barrier/pole cover

Figure 1-3 400 Amp Model Transfer Switch

1.3 Testing

Periodic testing is important in any transfer switch application. It helps to ensure that the generator set will start and the transfer switch mechanisms and control circuits will operate when needed.

1.3.1 Weekly Generator Set Exercise

Use the plant exerciser to start and run the generator set once a week to maximize the reliability of the emergency power system. See the transfer switch operation and installation manual for additional information about the exerciser.

1.3.2 Monthly Automatic Operation Test

Test the transfer switch's automatic control system monthly. See Section 3.5 or the transfer switch operation and installation manual for the test procedure. Verify that the expected sequence of operations occurs as the switch transfers the load to the emergency source when a normal source failure occurs or is simulated. After the switch transfers the load to the emergency source, end the test and verify that the expected sequence of operations occurs as the transfer switch retransfers to the available normal source and signals the generator set to shut down after a cooldown period.

Note: The ATS will not transfer the load during the test sequence if the Test DIP switch is set to the unloaded position.

1.3.3 Other Tests

Every Year

Measure the voltage drop to help locate high-resistance contacts in the ATS. The test procedure measures the voltage drop across a contact and the current in the circuit, then uses those measured values to find the contact resistance.

The purpose of the test is to locate any contact that has significantly higher resistance than others. An unusually high voltage across one set of contacts may signal unacceptably high resistance in the contacts.

Run the test with the ATS under a moderate and balanced load. Use the following procedure to take voltage measurements and calculate resistances for each phase of both Source N and Source E.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Millivolt Drop Test Procedure

1. Apply a balanced load of at least 10% of the switch rating. (Currents of 10 amps or greater will give more accurate results than lower currents.)

2. Carefully measure the voltage on each phase of both sources from the source lug to the load lug. Take several readings to ensure accuracy. The readings may be erratic because of the small voltage measured, load fluctuations, and meter circuit contact resistances.

   Note: To obtain accurate readings, keep the meter as far as possible from current-carrying conductors and the meter leads as short, direct, and at right angles to current-carrying conductors as possible. This minimizes the effect of induced voltages (transformer effect) in the vicinity of the current-carrying conductors.

3. Use an ammeter to measure the current flow through the circuit.

4. Calculate the contact resistance using the following formula:

$$R = V \div I$$

Where:

V = measured voltage in *millivolts*
I = measured current in amps
R = calculated resistance in milliohms

Compare the calculated values for resistance (R) to the values in the table in Figure 1-4. If the calculated resistance is significantly higher (2 times larger or more) than the value shown in the table, disconnect power, check the connections and lug torques, and repeat the test. If the second measurement also indicates that the resistance is too high, replace the contact. See the ATS MPParts Catalog for replacement part ordering information. Refer to the Table of Contents in the front of this manual to locate the contact replacement procedure for your switch.

Transfer Switch Rating, Amps	Maximum Contact Resistance, Milliohms (mΩ)
30–200	0.250
225–400	0.200
600–800	0.175
1000–1200	0.085
1600–3000	0.050

Figure 1-4 Maximum Contact Resistance

Every Three Years

Test the wire insulation. Use the following procedure to check for insulation breakdown and replace any faulty components.

Wire Insulation Breakdown Test Procedure

1. Disconnect all power sources by opening upstream circuit breakers or switches to the transfer switch. Disconnect the load from the transfer switch by opening circuit breakers or switches leading from the transfer switch. Disconnect the transfer switch wiring harness from the controller at connector P1.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

2. Use a hi-pot tester or meggar to check the insulation resistance phase-to-phase and phase-to-neutral, and phase-to-ground if neutral and ground are isolated. For a hi-pot tester, the maximum potential is 500 VAC and the maximum test time is 1 second.

3. Verify that the measured insulation resistance exceeds 1.24 megohms (MΩ).

4. If the hi-pot tester indicates wire insulation breakdown or if the measured resistance is less than 1.24 MΩ, isolate the leakage current using an instrument designed for this purpose. Replace the faulty components.

   Note: You may need to disconnect power conductors from the lugs to isolate the problem. If you disconnect the power conductors, see the transfer switch operation and installation manual for reconnection instructions.

Every Five Years

Check the normal and emergency source setpoint calibration according to the procedures in Section 3.9, System Settings.

1.4 Service Schedule

Follow the service schedule below for the recommended service intervals. The transfer switch operator can perform tasks marked by an X. Have an authorized distributor/dealer inspect the switch annually and perform all service marked by a D.

System Component or Procedure	See Section	Visually Inspect	Check	Adjust, Repair, or Replace	Clean	Test	Interval
ELECTRICAL SYSTEM							
Check for signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor.	1.2.2	X	X				Y
Check the transfer switch's external operating mechanism for cleanliness. Clean and relubricate if dirty.*	1.2.2	X		D	D		Y
Check wiring insulation for deterioration, cuts, or abrasion. Repair or replace wiring to regain the properties of the original wiring.	1.2.2	X					Y
		D	D	D			Y
Check the transfer switch's main power switching mechanisms' mechanical operation and integrity.	1.2.2	D	D			D	Y
Tighten control and power wiring connections to specifications.	1.2.2		D	D			Y
Check the transfer switch's main power switching contacts' condition. Clean or replace the main contacts or replace the transfer switch assembly as necessary.	1.2.2	D		D	D		Y
Perform a millivolt drop test to check for high contact resistances on power circuits. Tighten connections, clean main contacts, or adjust or replace main contacts or transfer switch assembly to eliminate high contact resistances.	1.3.3		D	D	D	D	Y
Test wire and cable insulation for electrical breakdown.	1.3.3					D	Every 3 Years
Check calibration of voltage-sensing circuitry and setpoints, and recalibrate circuitry as necessary.	1.3.3		D			D	Every 5 Years
CONTROL SYSTEM							
Exercise the generator set without load.	1.3.1, O/I/M					X	W
Test the transfer switch's automatic control system.	O/I/M	X				X	M
Test all LED indicators, time delays, and remote control systems for operation.	O/I/M	D	D	D		D	Y
GENERAL EQUIPMENT CONDITION							
Inspect the outside of the transfer switch for any signs of excessive vibration, leakage, high temperature, contamination, or deterioration.*	1.2.1	X			X		M
Check that all external hardware is in place, tightened, and not badly worn.	1.2.1	X	X	X			M
Inspect the inside of the transfer switch for any signs of vibration, leakage, noise, high temperature, contamination, or deterioration. Check for metal discoloration, melted plastic, or a burning odor.*	1.2.2	X					M
		D	D		D		Y
Check that all internal hardware is in place, tightened, and not badly worn.	1.2.2	X					M
		D	D				Y

***** Service more frequently if the ATS operates in extremely dusty or dirty areas.

See Section: Read these sections carefully for additional information before attempting maintenance or service.

Visually Inspect: Examine these items visually.

Check: Requires physical contact with or movement of system components, or the use of nonvisual indications.

Adjust, Repair, or Replace: Includes tightening hardware and lubricating the mechanism. May require replacement of components depending upon the severity of the problem.

Clean: Remove accumulations of dirt and contaminants from external transfer switch's components or enclosure with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and cause damage.*

Test: May require tools, equipment, or training available only through an authorized distributor/dealer.

Symbols used in the chart:

O/I/M=See the transfer switch operation/installation manual.
X=The transfer switch operator can perform these tasks.
D=An authorized distributor/dealer must perform these tasks.
W=Weekly
M=Monthly
Q=Quarterly
S=Semiannually (every six months)
Y=Yearly (annually)

Notes

2.1 Introduction to Troubleshooting

Use a personal computer running the DXPower Setup Program as a troubleshooting tool. The program's event log and system setting displays are useful tools for identifying the cause of most problems. Refer to the Setup Program Operation Manual for instructions throughout this Troubleshooting section.

Refer to the wiring diagrams provided with the switch or the Wiring Diagram Manual when troubleshooting the transfer switch and controller.

Disconnect power to the transfer switch before opening the enclosure to connect a personal computer. Read and follow all safety precautions.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

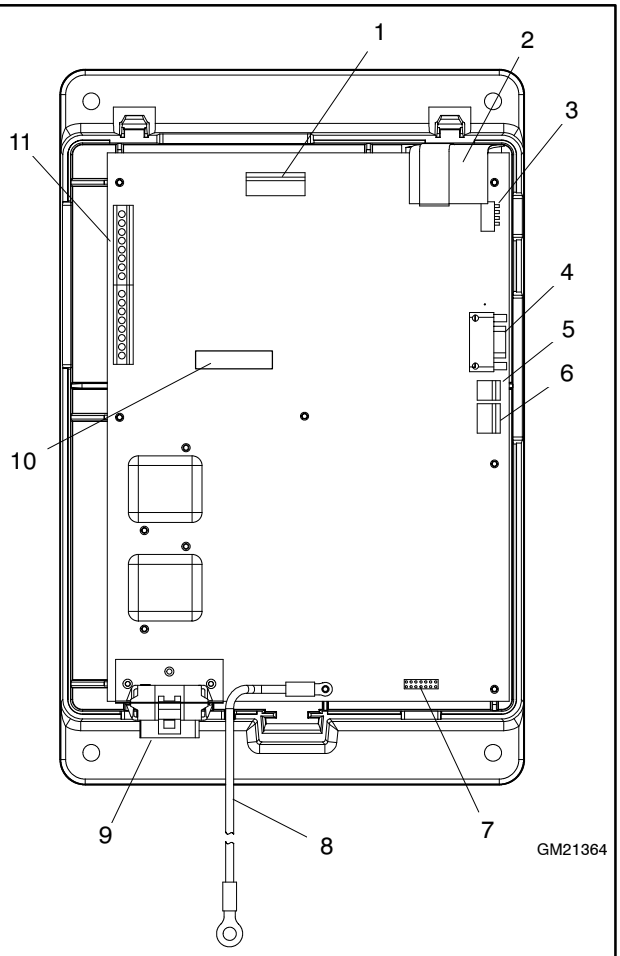
Only authorized personnel should open the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

2.2 PC Connection

Refer to the Setup Program Operation Manual for hardware requirements and communication information. Use a null modem cable to connect a personal computer (PC) to the controller's serial port, P6. See Figure 2-1.



1. I/O board connection (P3)
2. User interface connections
3. DIP switches
4. Serial port for PC connection (P6)
5. Preferred source switch connection (P7)
6. Supervised transfer switch connection (P8)
7. Programmed-transition interface board (PTIB) connection (factory connection) (P9)
8. Ground wire
9. Transfer switch harness connection
10. Serial number decal
11. Terminal strip (inputs, output, Modbus connections) (TB1)

Figure 2-1 Controller Board Component Locations (cover removed)

Note: The controller must have power in order to communicate with the PC. A cable to power the controller through a 120 VAC wall outlet is available. See Section 3.3.3.

To verify that the controller is communicating with the PC, open the Source Information window in the Setup Program and check the source voltages. If no voltage is shown, there is no communication. Verify that the controller has power and that "Connect" has been toggled on in the Setup Program. Check the COM port used by the computer. If necessary, select a different COM port and check for voltage readings again, and repeat until communication is established. Refer to MP-6135, Setup Program Operation Manual, for more information.

Note: Do not start a transfer test with the enclosure door open.

Before starting a test sequence, disconnect the PC from the controller or bring the null modem cable out of the enclosure at the bottom of the door. [Use a straight 9-pin extension cable, if necessary, to a maximum length of 15 m (50 ft.)] Close and lock the door. Tighten the door screws, checking to make sure that the communication cable is not pinched by the door. See Section 3.5 for test procedures. Follow all safety precautions when running a test.

2.3 Event History

Use the DXPower Setup Program to view the event history log. The log lists the 100 most recent transfer switch events, including transfers and DIP switch setting changes as well as faults and alarms. Refer to MP-6135, Setup Program Operation Manual, for instructions to view the event history.

The following tables list the faults and alarms that may be included in the event history log, the possible causes for each problem, and suggested procedures to identify and correct the source of the problem. The event history log also lists transfers and other normal events not shown in these tables.

The event history log can be saved to an electronic file. Refer to the Setup Program Operation Manual for instructions to save the event log to a file.

System Events and Faults		
Fault or Event Message	**Possible cause**	**Check**
Overfrequency, Underfrequency	Frequency settings	Check that the system frequency setting matches the actual source frequency (50 or 60 Hz).
		Check the over/underfrequency pickup and dropout settings. See Section 3.9.3 and the Setup Program Operation Manual.
		Check that the frequency debounce setting is long enough to prevent nuisance faults caused by brief frequency variations.
	Source availability, stability	Check that the source frequency matches the nominal system frequency and stays within the range of the pickup and dropout settings.
	Source connections	Check for loose connections. Check wiring.
Overvoltage, Undervoltage	Voltage settings	Check that the system voltage setting matches the actual source voltage.
		Check the over/undervoltage pickup and dropout settings. See Section 3.9.3 and the Setup Program Operation Manual.
		Check that the voltage debounce setting is long enough to prevent nuisance faults caused by brief voltage dips or spikes.
	Source availability, stability	Check that the source voltage matches the nominal system voltage and stays within the range of the pickup and dropout settings.
	Source connections	Check for loose connections. Check wiring.
	Calibration error	Check the ATS meter calibration. See MP-6135, Setup Program Operation Manual
Loss of Phase	Single/three phase setting	Check that the controller single/three phase setting matches the source.
	One phase of the source has been lost	Check that all phases of the source are available.
	Source connections	Check for loose connections.
Phase Rotation Error	Phase rotation setting	Check that the controller phase rotation setting matches the source phase rotation (ABC or CBA). Check the source connections to the transfer switch and verify that A,B, and C are connected to the appropriate lugs. Change the controller phase rotation setting or rewire the source connections if necessary.

Fault or Event Message	Possible cause	Check
Failure to Transfer	Source not available	Check source voltage, frequency, stability.
	Controller does not recognize an available source	Check switches, circuit breakers for open circuit.
		Check voltage and frequency settings (see above) and compare to measured source parameters.
		Check source connections to the ATS.
	Transfer switch mechanism problem	See Section 4.1, Transfer Switch Troubleshooting.
Auxiliary Switch Fault or Auxiliary Switch Open	Controller cannot determine the transfer switch position	Check wiring and connections to position microswitches. See the schematic drawing for connections.
		Test position microswitch operation. Replace microswitch if necessary.
		Transfer switch in intermediate position. Manually operate the transfer switch, following safety precautions and instructions in the ATS Operation/Installation manual. Check the control contact operation. Inspect for signs of coil damage or overheating and replace coil if necessary. See the Table of Contents for coil and control contact test procedures for your unit.
Failure to Acquire Standby	Generator set did not start	See “Failure to Start Generator Set,” below.
	Open circuit breaker	Check and close ATS source and generator set circuit breakers.
	ATS does not recognize the standby source	Check source voltage, frequency, phase rotation settings and compare to actual values.
		Check for loose source connections.
		Check for open switch or circuit breaker.
		Check ATS meter calibration.
Failure to Start Generator Set	Generator set master switch not in AUTO	Move generator set master switch to the AUTO position.
	Loose engine start connection	Check connections.
	No engine start command from ATS	See Section 3.6.
	Other generator set problem	Troubleshoot the generator set. See generator set service manual.
I/O Module Not Found	The controller does not detect an I/O module at the expected address	Check I/O module connections and address DIP switch settings. See Section 2.5.6.
I/O Module Not Installed	Controller detects a connected I/O module that has not been set up through the setup program	Use the Setup Program to check the number of I/O modules configured. Check the I/O module address DIP switches. See Section 2.5.6.
I/O Module Comms Lost	Communication to an installed I/O module has been lost	Check I/O module connections. See Section 2.5.6.
Low Battery Voltage	Low generator set engine starting battery	Check battery voltage and connections. See generator set manuals.

Figure 2-2 Event History

2.4 Troubleshooting Transfer Switch Operation

Problem	Possible Cause	Check
Generator set engine does not start	Engine start time delay is running	Check the time delay LED on the user interface. Wait for time delays to expire. Check time delay settings. See Section 3.11.
	Loose engine start connection	Check connections. Tighten connections and/or replace wiring if necessary.
	No engine start signal from the ATS	Normal source available.
		Exerciser inhibited.
		Maintenance DIP switch enabled (see Section 3.8).
	Generator set master switch not in the AUTO position	Move generator set master switch to the AUTO position.
	Other generator set problem	Troubleshoot the generator set. See the generator set Operation and Service Manuals.
Generator set engine runs when it should not	ATS does not recognize the Normal source	Check connections, voltage and frequency settings, phase rotation, calibration. Check for open switches or circuit breakers.
	ATS not in the expected position	Check the ATS position LEDs. Check the position of the preferred source selector switch, if equipped.
	Exerciser is running	Check the Exercise LED on the controller user interface. Push the Exercise button to end an exercise run.
	A test sequence is running	Check the Test LED on the controller user interface. Push the Test button to end a test sequence.
	Engine cooldown time delay operating	Check the Time Delay LEDs on the ATS controller user interface and the active time delay window. Check the ATS controller engine cooldown time delay setting. See Section 3.11.
		Check generator set controller engine cooldown setting. See the generator set controller Operation Manual.
	Engine start connection closed	Check wiring and connections. Also see Section 3.6.
	Generator set master switch not in AUTO	Move the generator set master switch to the AUTO position.
	Other generator set problem	Disconnect the engine start leads from the ATS. If the engine continues to run, troubleshoot the generator set. See the generator set Operation and Service Manuals.
Inphase monitor does not operate	Inphase monitor function not enabled	Check that the inphase monitor option on the ATS controller is selected. See the Setup Program Operation and Installation Manual.
	Transfer angle setting	Check the transfer angle setting. See the Setup Program Operation and Installation Manual.
	Inphase monitor option not available (programmed-transition models)	Not available on programmed-transition models. Center-OFF position makes the inphase monitor option unnecessary.

Problem	Possible Cause	Check
Exerciser does not start generator set	Exerciser not set	Press exercise button to set time. Check exercise mode and calendar settings.
	Check that exercise run duration is not set to zero	Use the Setup Program to check exerciser settings.
	Loose or open engine start connection	Check wiring and connections
	Engine start problem	See “Generator set engine does not start,” in this table. Also see Section 3.6.
Exerciser does not run regularly or at all	Exerciser not set	Press exercise button to set time. Check exercise mode and calendar settings.
	Exercise DIP switch #3 set to disable	Check and change DIP switch setting.
	Exercise interval different than expected	Check 1 week/2 week DIP switch and calendar settings
ATS does not transfer	Unloaded test or exercise	Check DIP switch positions
	Pre-transfer load control time delays operating	Check Time Delay and Load Control Active LEDs and Active Time Delay window in the Setup Program. Check the time delay settings.
	Supervised transfer control switch (optional) in manual position	Move to Transfer or AUTO position. See the ATS Operation Manual, MP-6126.
	Maintenance DIP switch enabled	Check DIP switch position. See Section 3.8.
	Connected source available	Check the Source Available LEDs.
	Preferred source switch (optional) in emergency position and emergency available	Check the position of the preferred source switch and the Source Available LEDs.
	Supervised transfer control switch (optional) in the manual position	Check the position of the supervised transfer control switch, if equipped. Move the switch to the TRANSFER or AUTO position, as appropriate for the application. See the transfer switch operation and installation manual for more detailed information.
	Transfer switch problem	Troubleshoot the transfer switch. See Section 4 for instructions.
No LEDs illuminated	No power to the controller	Check that the transfer switch harness is connected to the controller.
	No power to the transfer switch	Check source connections.
		Check that source switches or circuit breakers are closed.
		Check that one source is available.
	One or more faulty LEDs	Press the Lamp Test button to check the operation of all LEDs. Replace the controller if one or more LEDs do not light. If no LEDs light, troubleshoot power and connections to the controller.
	Controller needs resetting	Reset the controller and then press Lamp Test. See Section 3.4.

Problem	Possible Cause	Check
Source available LED off when Source is available	Malfunctioning LED	Press the Lamp Test button to check the operation of all LEDs. Replace the controller if one or more LEDs do not light. If no LEDs light, troubleshoot power and connections to the controller.
	Source settings do not match actual source parameters	Check settings. See Section 3.9.
	Incorrect ATS meter calibration	Check calibration. See Section 3.10.
Position LED not lit	Position microswitch malfunction	Check the operation of the position microswitches.
	Transfer switch in intermediate position	Manually operate the transfer switch and check the position LED operation. Follow the safety precautions and instructions in the ATS Operation/Installation Manual. Check the control contact operation; See the Table of Contents for control contact test procedures for your unit. Check for evidence of solenoid coil damage. Replace the coil if necessary. See the Table of Contents to locate coil replacement procedures for your model transfer switch.
	LEDs not functioning	See “No LEDs illuminated” in this table.

Figure 2-3 Transfer Switch Troubleshooting

2.5 Faults

This section describes transfer switch faults indicated by the Service Required LED on the controller's user interface. Refer to the table in Section 2.3 for recommendations for correcting the faults described below.

2.5.1 Service Required LED

The following faults cause the Service Required LED to flash, indicating that immediate service is required:

- Auxiliary switch fault
- Auxiliary switch open
- Failure to acquire standby source
- Failure to transfer
- Phase rotation fault
- Input/output module faults

Find and correct the cause of the fault before trying to reset the controller. The cause of the fault may be shown by the other LEDs on the user interface; check the Source Available, Position, Load Control, Time Delay, Exercise, and Test LEDs to diagnose the cause of the faults. If the LEDs do not reveal the cause of the fault condition, connect a PC to the controller and use the Setup Program to view the event history. The event history lists fault conditions and transfers. See the software operation manual for more information and instructions.

After correcting the fault condition, press the Lamp Test button for approximately 5 seconds until the LEDs flash twice to clear the Service Required LED.

2.5.2 Auxiliary Switch Faults

An Auxiliary Switch Fault occurs if the controller cannot determine the transfer switch switch position. The Service Required LED flashes.

Check the transfer switch position and compare it to the position LED indicators on the controller's user interface.

The fault clears when the controller can detect the switch position. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

2.5.3 Failure to Acquire Standby Source

A fault occurs if the unit attempts to start the generator set but the standby source does not appear after the Acquire Standby Source to Failure time delay. The Service Required LED illuminates. Some conditions that may cause this fault are failure of the generator set to start, no voltage output from the generator, or an error in sensing the voltage output from the generator set.

The fault clears when the system acquires a standby source. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

2.5.4 Failure to Transfer

If the unit fails to transfer on command, the controller waits 1 second and then initiates another 200 msec attempt to transfer. If the in-phase monitor is operating, the system waits 1 second and then begins monitoring the source phases in preparation for transfer. When the sources are in phase, the system attempts to transfer. After three unsuccessful attempts to transfer, the system stops attempting to transfer and generates a fault. The Service Required LED illuminates.

The fault clears when the transfer switch transfers successfully. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

2.5.5 Phase Rotation Faults

A fault occurs if the phase rotation of an input channel does not match the system's phase rotation direction setting (ABC or CBA). The unit will not transfer to a source if the source's phase rotation does not match the system setting. If the system detects a phase rotation fault in the connected source, it attempts to transfer to an alternate source that has the correct phase rotation. The controller logs phase rotation faults in the event history.

If the system detects phase rotation faults on both sources, the Service Required LED lights. The system does not transfer from the connected source.

2.5.6 I/O Module Faults and Diagnostics

When power is applied to the system, the controller attempts to initiate communication with each connected I/O board. The following faults may occur on powerup if the I/O modules are not correctly installed, addressed, or configured in the setup software. Check the LED on each I/O module for diagnostic information in the case of a fault.

Diagnostic LED. Each I/O module has a diagnostic LED that lights or flashes to indicate the I/O board status as described in the table in Figure 2-4.

I/O Module Not Found. If the system does not detect an I/O module at an expected address, the Service Required LED flashes and the software logs the message, “I/O Module Not Found”. Check that the number of I/O modules installed matches the number expected by the setup program. Check that the I/O modules are connected and the address DIP switches are set correctly. Check the diagnostic LED to verify that the module is receiving power and communicating with the controller.

I/O Module Not Installed. If the software detects an I/O module that is connected but not expected by the setup program, the Service Required LED flashes and the software logs the message, “I/O Module Not Installed.” The system ignores the board if it does not find the setup definition. Check that the number of I/O modules expected in the Setup Program matches the number of modules installed on the transfer switch. Check that the I/O module address DIP switches are set correctly. Check the diagnostic LED.

I/O Module Communications Lost. If communication to an I/O module that was previously installed and working is lost, the Service Required LED flashes and the software logs the message “I/O Module Communications Lost.” Check the I/O module connections and diagnostic LED.

I/O board Status	Diagnostic LED
Unpowered	Off
Operating correctly	On, Steady
Power but no communication with control board	Quick Flash (2 Hz)
No defined program at I/O module address	Slow Flash (0.5 Hz)

Figure 2-4 I/O Module Diagnostic LED

Notes

3.1 Initial Tests

Perform these initial tests to check the ATS controller operation.

Figure 3-2 shows the locations of the pushbuttons and LEDs on the controller's user interface.

3.1.1 Lamp Test

If no LEDs on the controller's user interface are illuminated, press the LAMP TEST button. If the controller has power, all LEDs on the user interface will light when the button is pressed.

If no LEDs light when the LAMP TEST button is pressed, proceed to Section 3.3.1 to check for power to the transfer switch and controller.

3.1.2 Service Required Reset

Hold the LAMP TEST button for approximately 5 seconds until the LEDs flash to reset the Service Required LED.

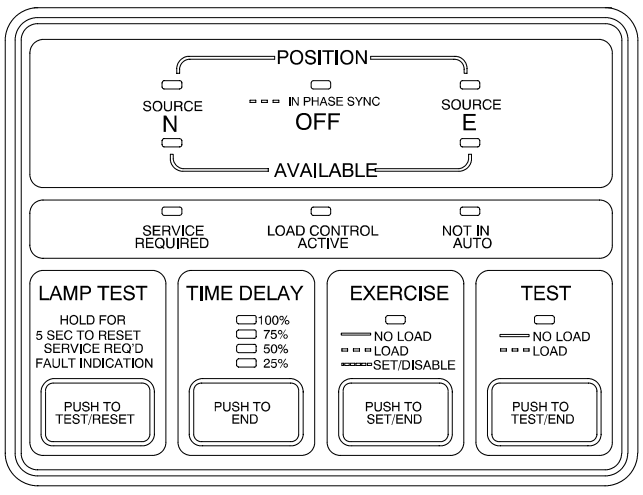
3.2 Controller LEDs

Check the Service Required LED for fault indication. See Figure 3-1. To reset the service required LED, press and hold the LAMP TEST button until all LEDs flash, which takes approximately 5 seconds.

Use the LEDs on the controller's user interface to check the status of the transfer switch. Watch the LEDs during test and exercise sequences to track the transfer switch operation. See Figure 3-3.

Service Required LED Illumination	Fault (See Section 2.5)
Flashing	Auxiliary Switch Fault
	Auxiliary Switch Open
	Failure to Acquire Standby Source
	Failure to Transfer
	I/O Module Communications Lost
	I/O Module Not Installed
	I/O Module Not Found
	Phase Rotation Fault
	Remote Common Fault
Steady	External Low Battery

Figure 3-1 Service Required LED



1. User interface panel location, typical

GM211077A

Figure 3-2 User Interface Panel

LED Indicator	Color	LED Illumination
Exercise	Amber	**Steady:** Unloaded exercise is running. **Slow Flash:** Loaded exercise is running. **Rapid Flash:** When EXERCISE button is pressed and held, rapid flashing indicates the exercise has been started and set. Rapid flashing at any other time indicates that the exercise is inhibited by the Exerciser Disable/Enable DIP switch setting.
Load Control Active	Amber	**Steady:** Pre/post-transfer load control or peak shave functions are operating.
Not in Auto	Red	**Rapid Flash:** ATS is not set for automatic operation or a load shed (forced transfer to OFF) sequence is active.
Position N	Red	**Steady:** Transfer switch is in Normal position.
Position E	Red	**Steady:** Transfer switch is in Emergency position.
Position Off/ In-Phase Sync	Amber	**Steady:** Transfer switch is in Off position (programmed-transition models only). **Rapid Flash:** In-phase monitor is operating (open-transition models only).
Service Required	Red	**Steady**: Fault. Non-emergency is maintenance required. **Rapid Flash:** Fault. Immediate maintenance is required
Source N Available	Green	**Steady:** Source N is available.
Source E Available	Green	**Steady**: Source E is available.
Test	Red	**Steady:** Unloaded test is running. **Slow Flash:** Loaded test is running.
Time Delay LED Bar	Amber	**LEDs step down** to indicate time remaining in an active time delay or exercise period.

Figure 3-3 User Interface LED Indicators

3.3 Power Supply

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

3.3.1 Transfer Switch Power

If no LEDs light when the LAMP TEST button is pressed, check for power to the controller and the transfer switch. Verify that the transfer switch wiring harness is connected to the controller. See Figure 3-4. Check for open circuit breakers or switches. Follow the voltage check procedure in Section 3.9.2, Voltage, Frequency, and Phase Rotation Checks, to check voltage at the Source N (normal) or Source E (emergency) lugs.

1. Transfer switch harness connection to controls, controller connector P1

Figure 3-4 Transfer Switch Harness Connection to Control Board, Typical

3.3.2 Controller Power Supply

Check for voltage to the controller using the following procedure:

Procedure to Check Voltage to the Controller

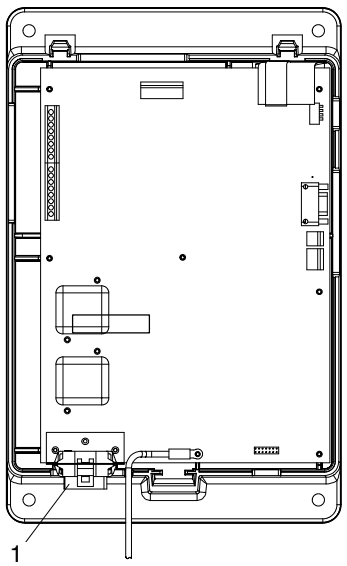
1. Disconnect power to the transfer switch by opening circuit breakers or switches.
2. Disconnect the transfer switch wiring harness from the controller at the 24-pin connector.
3. Reapply power to the transfer switch.
4. Check for voltage across the wiring harness pins. Observe all Safety Precautions when checking the voltage.
   a. If Source N is available, check for line voltage across pins 4 and 12 of the transfer switch wiring harness connector.
   b. If Source E is powering the transfer switch, check for line voltage across pins 6 and 7 of the connector.

If there is no power to the pins checked in step 4, check the wiring harness and replace it if necessary.

3.3.3 Powering the Controller Directly (Service Kit GM25479)

On occasion it is necessary to supply 120 VAC power directly to the controller for testing. Use the cable in Service Kit GM25479 to supply power to the controller from a 120 VAC wall outlet. Disconnect the controller from the transfer switch and connect cable GM25481 to the controller's P1 connector. See Figure 3-5. Plug the cable into a 120 VAC wall outlet to power the controller during testing.

Note: Do not connect 120 VAC power to any other location on the controller.



1. Service kit power cable connection location (controller connector P1)

Figure 3-5 120 VAC Connection Location (P1)

3.4 Controller Reset

If the controller is not responding and you have verified that there is power to the transfer switch controller, try resetting the controller. The controller can be reset without disconnecting power. Use the following procedure.

Controller Reset Procedure

1. Hold the LAMP TEST button until the LEDs flash. Do not release the button.
2. Continue to hold the LAMP TEST button in and press the End Time Delay button. The LEDs will flash when the controller resets.

3.5 Test Sequence

Use the following procedure to run a test to check the transfer switch operation. Watch the LEDs on the controller's user interface as the time delays run and Source E becomes available when the generator set starts. The TEST LED flashes to indicate a loaded test, or lights steadily to indicate a test without load. For a loaded test, watch the position LEDs to verify that the ATS transfers the load.

To set the TEST DIP switch for a loaded or unloaded test, refer to Section 3.8 for instructions on setting the controller DIP switches.

To monitor the individual time delays during the test, connect a personal computer running the Setup Program. Close and lock the transfer switch door before initiating a test sequence. Use the Active Time Delay window to monitor the time delays as they run. See the Setup Program Operation Manual for further instructions.

The test sequence simulates a loss of the normal source, starts the generator set, and transfers the load to the emergency source (if the TEST DIP switch is set for a loaded test), executing all time delays that are set up to operate during a loss of the normal source. When the test is ended in step 8 of the procedure, the transfer switch transfers the load back to the normal source and removes the engine start signal, executing all programmed time delays.

Refer to Figure 3-6 and Figure 3-7 for flowcharts showing the test sequence of operation without and with load.

Note: If the standby source fails during a test, the ATS will immediately attempt to transfer to the preferred source.

Optional Switches. If the ATS is equipped with a preferred source switch, check the switch position before proceeding with the automatic operation test. The test procedure assumes that Source N is the preferred source.

If the transfer switch is equipped with a supervised transfer switch, verify that it is set to the Auto position.

See the transfer switch Operation and Installation Manual for more information about optional switches.

Note: Close and lock the enclosure door before starting the test procedure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Automatic Operation Test Procedure

1. Close and lock the transfer switch enclosure door. Tighten the door screws.
2. Check the controller LED indicators to verify that the Position N and Source N Available indicators are lit.
3. Press the lamp test button and check that all controller LEDs illuminate.
4. Verify that the generator set master switch is in the AUTO position.
5. Press the TEST button on the controller to start the test. The TEST LED flashes to indicate that the ATS controller is set up to transfer the load during the test. (If the TEST LED lights steadily, the ATS controller is set up to run the test without transferring the load. The test sequence will start the generator set but will not transfer to Source E.)
6. Verify that the generator set starts after the engine start delay times out. Check that the Source E Available LED lights.
7. Verify that the switch transfers the load to Source E.
   a. Open-Transition Models: After the preferred-to-standby time delay, verify that the Position N LED goes out and the Position E LED lights, indicating that the switch has transferred the load to Source E.
   b. Programmed-Transition Models: After the preferred-to-off time delay, verify that the Position N LED goes out and the Position OFF LED lights. After the off-to-standby time delay, check that the Position E LED lights, indicating that the switch has transferred the load to Source E.
8. Push the Test button to end the test.

9. Verify that the switch transfers the load back to Source N.

   a. Open-Transition Models: After the standby-to-preferred time delay, verify that the Position E LED goes out and the Position N LED lights, indicating that the switch has transferred the load to Source N.

   b. Programmed-Transition Models: After the standby-to-off time delay, verify that the Position E LED goes out and the Position OFF LED lights. After the off-to-preferred time delay, check that the Position N LED lights, indicating that the switch has transferred the load to Source N.

   Note: The generator set may have an engine cooldown time delay that causes the generator set engine to run after the transfer switch engine start signal is removed.

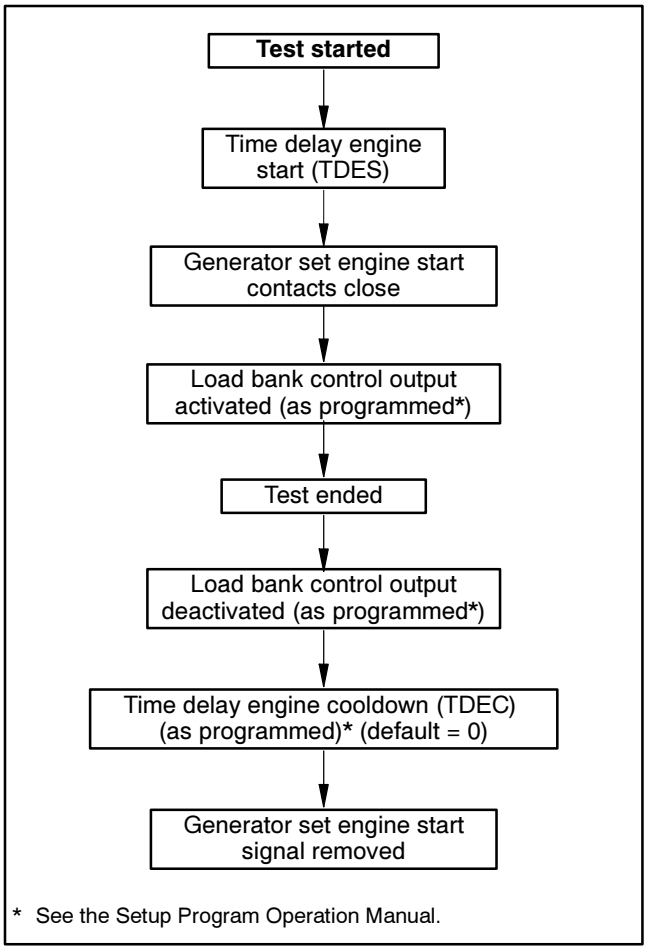


Figure 3-6 Test Without Load Sequence

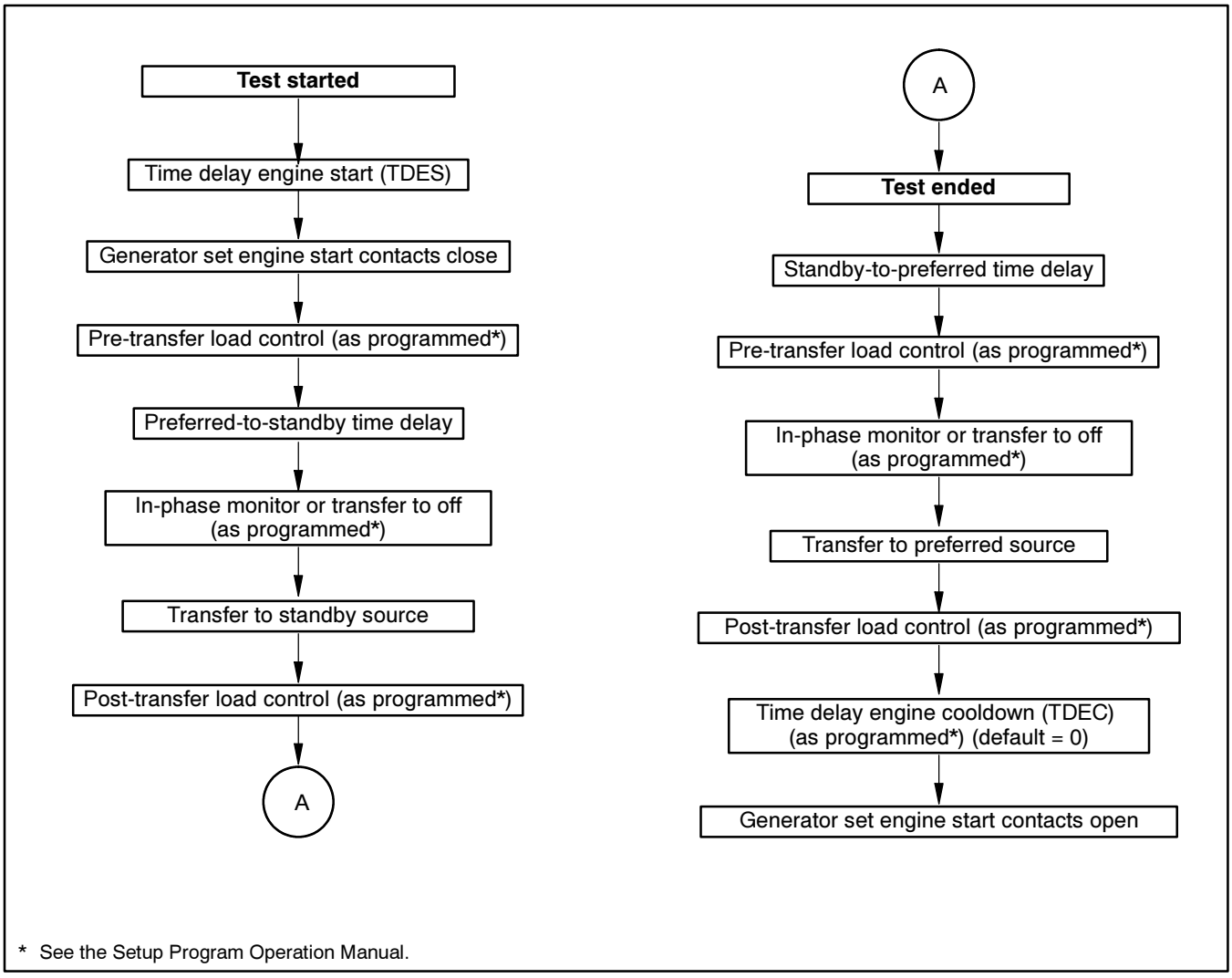


Figure 3-7 Test with Load Sequence

3.6 Engine Start

Check for continuity across the engine start contacts during a test or exercise sequence. Refer to the transfer switch schematic diagram provided with the unit or to the Wiring Diagram Manual. Refer to the flowcharts in Figure 3-6 through Figure 3-10 for the test and exercise operation sequences. Allow time for the engine start and engine cooldown time delays (if not set to zero) during the test.

Start with the transfer switch in the Source N position.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

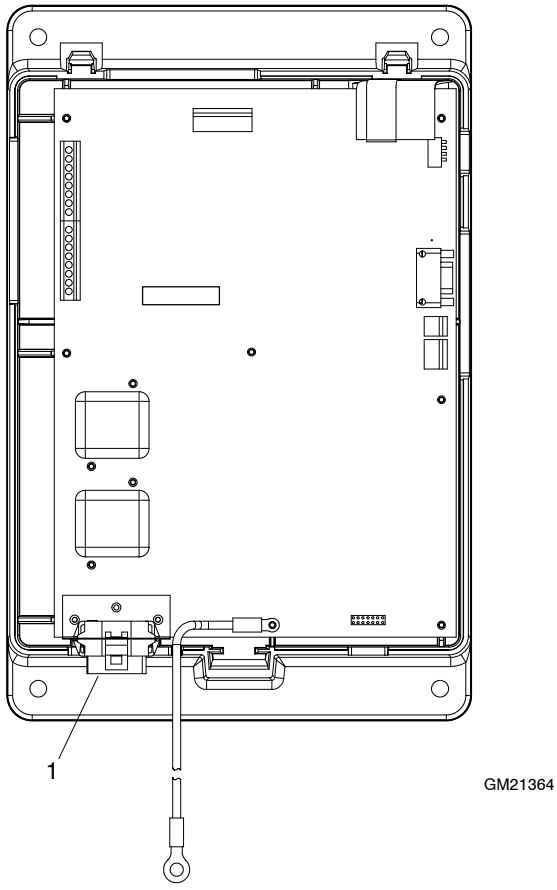
Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Engine Start Test Procedure

1. Connect an ohmmeter or test lamp across pins 8 and 9 of connector P1 (the transfer switch harness-to-controller connection). See Figure 3-8.
2. Verify that the engine start contacts are open before starting the test.
3. Press the Test button to initiate a test sequence and verify that the engine start contacts close after the engine start time delay.
4. Press the Test button again to end the test. Verify that the engine start contacts open after the engine cooldown time delay (if not set to zero).
5. Press the EXERCISE button to initiate an exercise run and verify that the engine start contacts close.
6. Press the EXERCISE button again to end the exercise run. Verify that the engine start contacts open.

If the ATS engine start contacts do not close during the Engine Start Contact Test Procedure, replace the ATS controls.

If the generator set engine does not start, check the engine start connections to the generator set. Verify that the generator set master switch is in the AUTO position. Troubleshoot the generator set if the engine start connections are good but the engine does not start.



1. Transfer switch harness connection, P1

Figure 3-8 Transfer Switch Harness-to-Controller Connection, P1

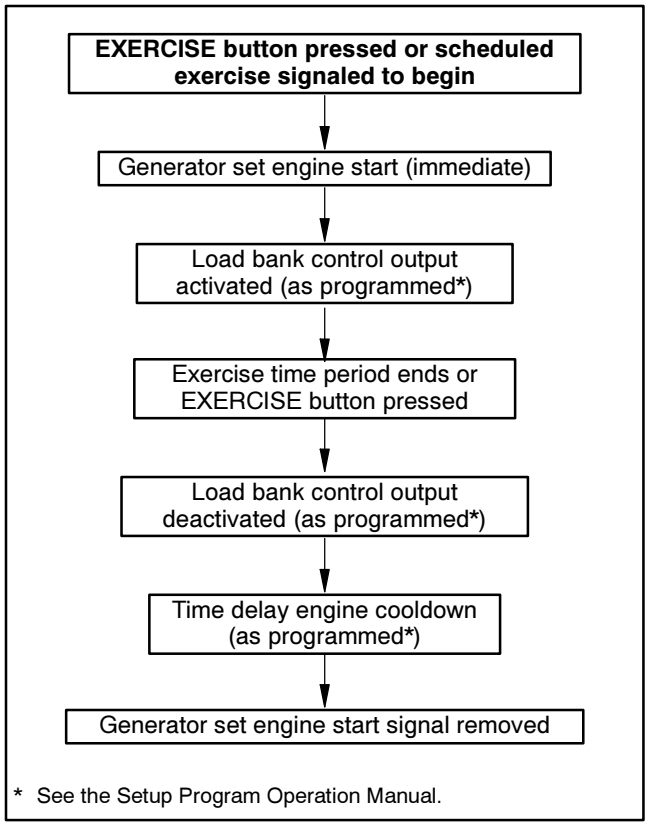


Figure 3-9 Exercise without Load Sequence

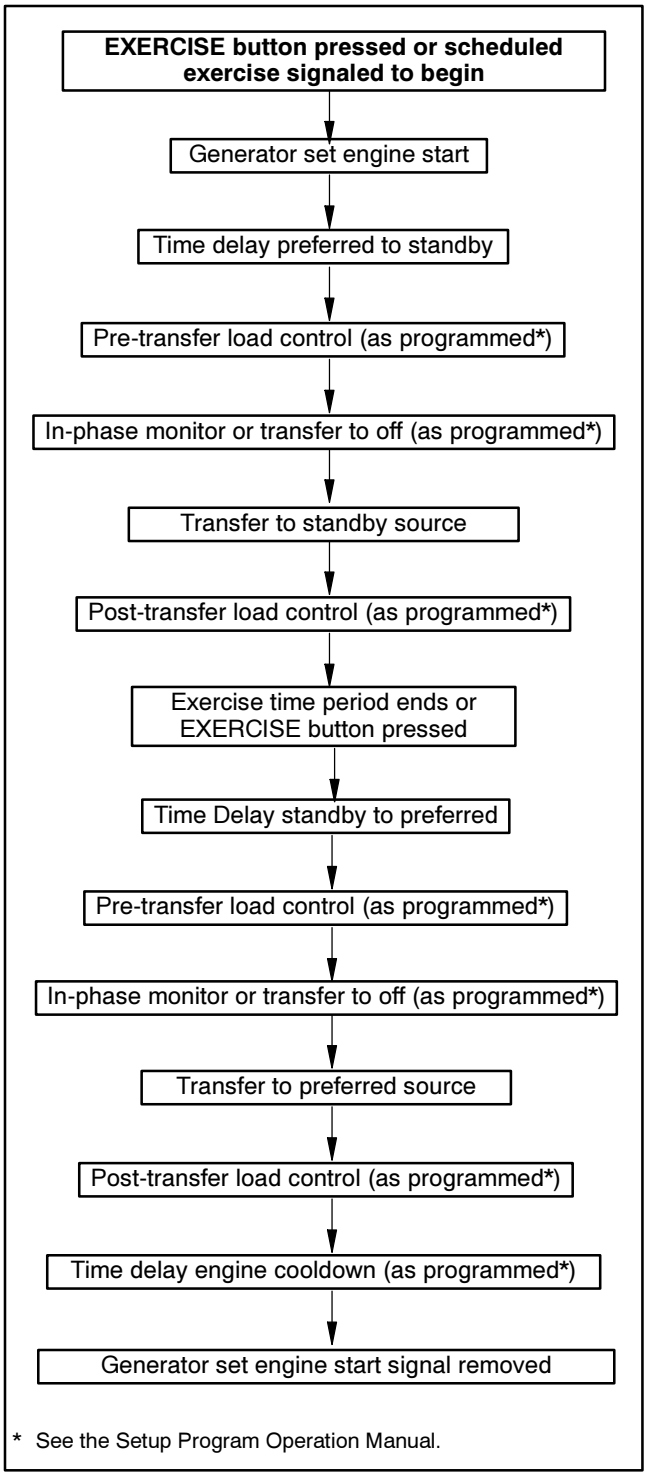
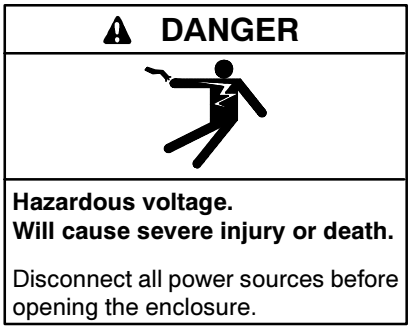


Figure 3-10 Exercise with Load Sequence

3.7 Position Microswitch Test

Disconnect power to the transfer switch and use an ohmmeter or test lamp to check the operation of the position microswitches. Manually operate the switch and check for continuity across pins 10 and 13 of the connector P1 for Source E and pins 10 and 14 for Source N.

3.8 DIP Switch Positions



DIP switches on the main logic board control the test and exercise functions. The factory settings for the DIP switches are shown in Figure 3-11.

The Maintenance DIP switch inhibits transfer during ATS service.

Before opening the transfer switch enclosure to check or change the DIP switch settings, open the circuit breakers to disconnect the power to the transfer switch.

The DIP switches are located on the controller's main logic board on the inside of the enclosure door. Figure 3-18 shows the locations of the switches on the controller circuit board. A decal on the logic assembly housing shows the DIP switch positions and settings (see Figure 3-11). It is not necessary to remove the logic assembly cover to see or adjust the DIP switches. Check the DIP switch settings and adjust if necessary for the application.

Note: Changing the position of the 1 week/2 week exercise DIP switch after the exerciser has been set does not change the time of the *next* scheduled exercise. The new DIP switch setting becomes effective *after* the next scheduled exercise. See the ATS Operation and Installation Manual for more information about the exerciser.

Close and lock the enclosure door before energizing the transfer switch.

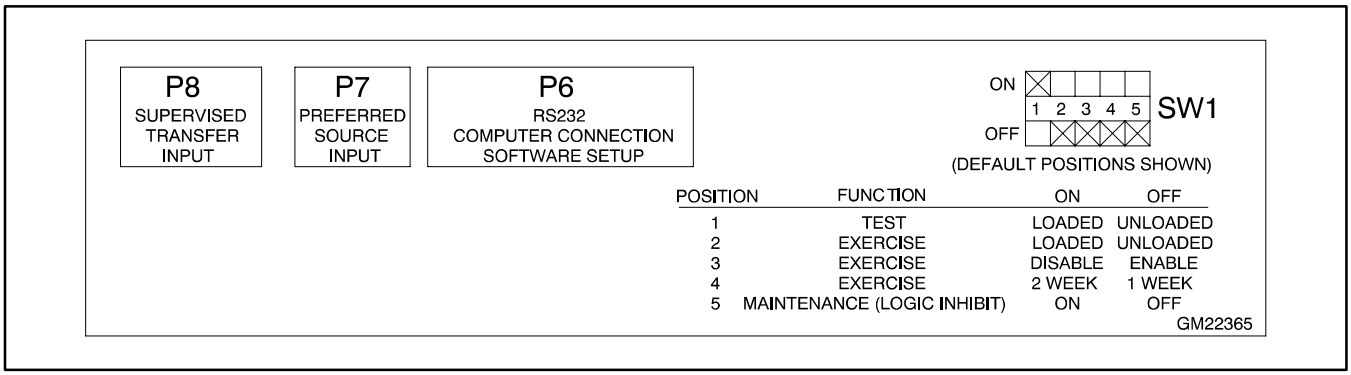


Figure 3-11 Logic Assembly Decal Showing DIP Switch Settings

3.9 System Settings

If the ATS does not recognize the source, check that the source voltage and frequency settings on the controller match the actual source parameters.

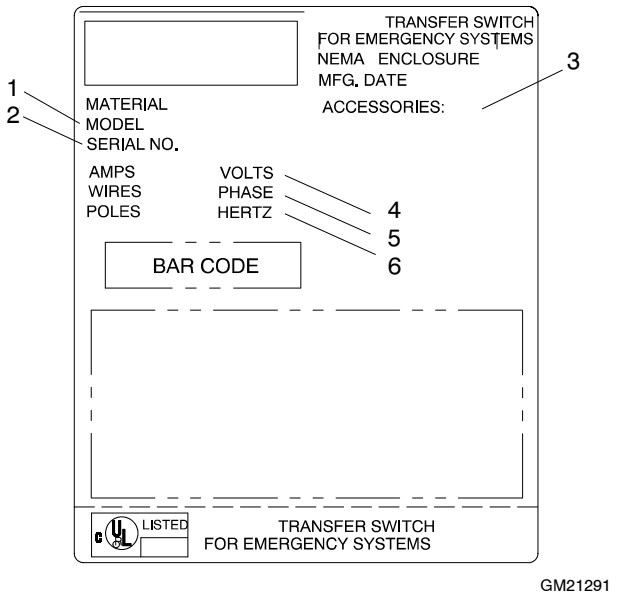
Compare the controller settings to the ratings on the ATS nameplate and to the measured source parameters using the following instructions.

3.9.1 Controller Source Settings

Use a personal computer running the Setup Program to check the controller's source voltage, frequency, and phase settings in the Source Information window. See MP-6135, Software Operation and Installation Manual, for instructions.

Check the controller settings and compare them to the voltage rating, frequency rating, and number of phases shown on the ATS nameplate. The nameplate is attached to the cover of the controller assembly, which is mounted on the inside of the transfer switch door. See Figure 3-12 for an illustration of the nameplate.

Note: The system voltage and frequency shown on the ATS nameplate must match the Source N and Source E voltage and frequency settings. Do not enter settings that do not match the nameplate ratings of the ATS.



1. Model designation
2. Serial number
3. Factory-installed accessory numbers
4. Voltage rating
5. Frequency rating
6. Number of phases (single or three)

Figure 3-12 Typical Transfer Switch Nameplate

Use the procedure in the next section to measure the source voltage, frequency, and phase rotation, and compare the measured values to the controller settings. Follow the instructions in the Software Operation and Installation manual to change the controller settings if they do not match the measured source parameters.

3.9.2 Voltage, Frequency, and Phase Rotation Checks

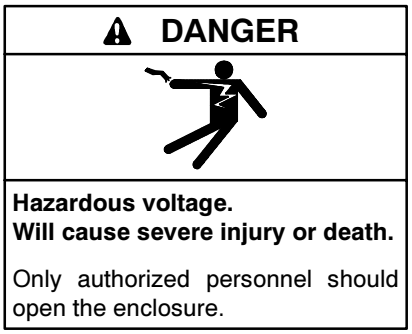
The voltage, frequency, and phasing of the transfer switch and the power sources must be the same to avoid damage to loads and the transfer switch. Compare the voltage and frequency ratings of the utility source, transfer switch, and generator set, and verify that the ratings are all the same.

Read and understand all instructions on installation drawings and labels on the switch. Note any optional accessories that have been furnished with the switch and review their operation.

Note: Source N is the source connected to the normal side of the transfer switch. Source E is the source connected to the emergency side of the transfer switch.

The voltage check procedure requires the following equipment:

- A digital voltmeter (DVM) with electrically insulated probes capable of measuring the rated voltage and frequency
- A phase rotation meter



Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Voltage, Frequency, and Phase Rotation Measurement Procedure

Note: Perform voltage checks in the order given to avoid damaging the transfer switch.

1. Verify that the generator set master switch is in the OFF position and both power sources are disconnected from the transfer switch.
2. Disconnect the power switching device and controller wiring harnesses at the inline disconnect plug, if they are connected.
3. Manually operate the transfer switch to position E. See the Transfer Switch Operation and Installation Manual for manual operation instructions.
4. If Source N is a generator set, move the generator set master switch to the RUN position. The generator set should start.
5. Close the Source N circuit breaker or switch.
6. Use a voltmeter to check the Source N (normal) phase-to-phase and phase-to-neutral (if applicable) terminal voltages and frequency.
   a. If Source N is the utility and the measured input does not match the voltage and frequency shown on the transfer switch nameplate, *STOP!* The transfer switch does not match the application—order the correct transfer switch.
   b. If Source N is a generator set and the generator set output voltage and frequency do not match the nominal system voltage and frequency shown on the transfer switch nameplate, follow the manufacturer's instructions to adjust the generator set. The automatic transfer switch will only function with the rated system voltage and frequency specified on the nameplate.
7. Use a phase rotation meter to check the phase rotation at the Source N (normal) terminals. Rewire the transfer switch Source N terminals to obtain the correct phase sequence if necessary.

   Note: The default setting for the phase rotation on the controller is ABC. If the application uses a phase rotation of CBA, use the Setup Program to change the phase rotation setting on the controller.
8. If the source is a generator set, stop the generator set by moving the master switch to the OFF position.
9. Disconnect Source N by opening upstream circuit breakers or switches.
10. Manually operate the transfer switch to position N.
11. Repeat steps 4 through 8 for Source E. Then proceed to step 12.
12. Disconnect both sources to the transfer switch by opening the circuit breakers or switches.
13. Connect the power switching device and controller wiring harnesses together at the inline disconnect plug.

    Note: Do not connect or disconnect the controller wiring harness when the power is connected.
14. Close and lock the transfer switch enclosure door.
15. Reconnect both power sources by closing the circuit breakers or switches.
16. Move the generator set master switch to the AUTO position.

    Note: If the engine cooldown time delay setting is not set to zero (default setting), the generator set may start and run until the Time Delay Engine Cooldown (TDEC) ends.

3.9.3 Voltage and Frequency Pickup and Dropout Settings

Figure 3-13 illustrates the relative values of the voltage pickup and dropout settings. Typical frequency pickup and dropout settings relate to the nominal source frequency in a similar way.

If the source voltage rises above the overvoltage dropout setting or falls below the undervoltage dropout setting for a time longer than the debounce time, the controller will consider the source as failed. The source voltage must return to a level within the range of the pickup values for the controller to recognize the source as restored.

Choose pickup and dropout settings that allow a tolerable variation in the source parameters to prevent nuisance transfers caused by small changes in the source voltage and frequency.

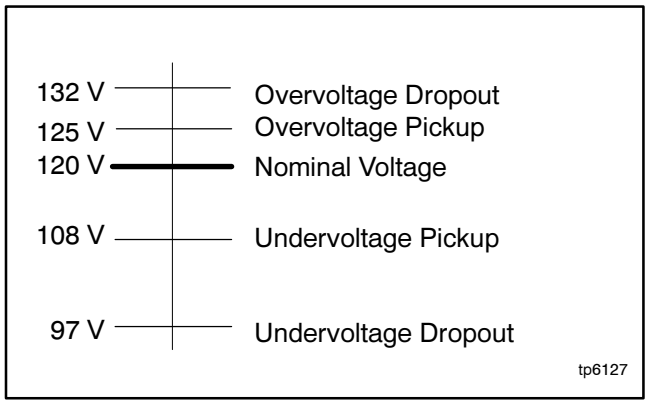


Figure 3-13 Relationship Between Voltage Pickup and Dropout Settings (default settings shown)

Parameter	Default	Adjustment Range
Overvoltage dropout	110% of nominal	105%–135% of nominal
Overvoltage pickup	95% of dropout	95%–100% of dropout
Undervoltage pickup	90% of nominal	85%–100% of nominal
Undervoltage dropout	90% of pickup	75%–98% of pickup
Voltage dropout time	0.5 sec.	0.1–9.9 sec.

Figure 3-14 Voltage Settings

Parameter	Default	Adjustment Range
Overfrequency dropout	101% of pickup	101%–105% of pickup
Overfrequency pickup	110% of nominal	105%–120% of nominal
Underfrequency pickup	90% of nominal	80%–95% of nominal
Underfrequency dropout	99% of pickup	95%–99% of pickup
Frequency dropout time	3 sec.	0.1–15 sec.

Figure 3-15 Frequency Settings

3.10 Meter Calibration

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Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

The transfer switch controls are calibrated at the factory and should not require recalibration in the field. However, if recalibration is necessary, measure the source voltages as instructed in Section 3.9.2, record the measured values, and then enter the measured values into the appropriate spaces in the Meter Calibration window in the Setup Program. See MP-6135, Software Operation and Installation Manual, for more information about using the Setup Program.

3.11 Time Delays

Check the time delays when troubleshooting problems with the transfer switch operation.

Use the Active Time Delay Window in the Setup Program and observe the time delay LEDs on the controller's user interface to identify which time delays are executing at any given time. Open the Active Time Delay window and then press the TEST button on the controller's user interface to initiate a test and observe as each programmed time delay executes. Compare the operation to the test sequence illustrated in the flowcharts in Figure 3-6 or Figure 3-7.

Some time delays run serially (one after another) and others run at the same time, so that the Time Delay LEDs on the controller interface may appear to reach zero and then start stepping down again to track another time delay.

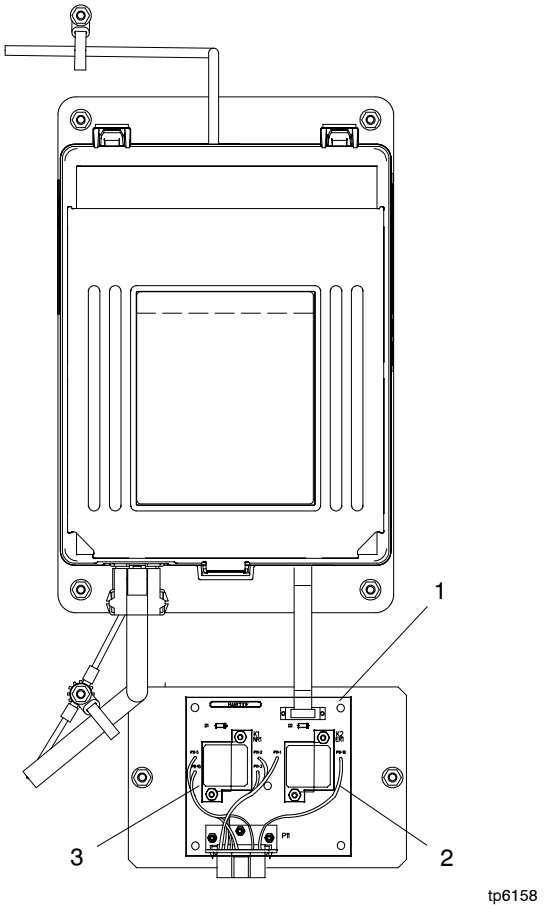
Use the Time Delay and Load Control Time Delay windows in the Setup Program to check the settings for the adjustable time delays. Figure 3-16 shows the factory settings and adjustment ranges for the adjustable time delays.

Adjustable Time Delays		
Time Delay	**Default**	**Adjustment Range**
Engine start	3 sec.	0-6 sec.*
Preferred to standby	1 sec.	0-60 min.*
Standby to preferred	15 min.	
Engine cooldown	0 min.	
Failure to acquire standby source	1 min.	
Pretransfer to preferred signal	3 sec.	
Pretransfer to standby signal	3 sec.	
Post-transfer to preferred signal	0 sec.	
Post-transfer to standby signal	0 sec.	
Off to standby (programmed-transition only)	1 sec.	
Off to preferred (programmed-transition only)	1 sec.	
* Adjustable in 1 second intervals		

Figure 3-16 Factory Settings, Time Delays

3.12 Programmed-Transition Interface Board

The programmed-transition interface board (PTIB) contains two replaceable 10-amp relays, K1 (NR1) and K2 (ER1). See Figure 3-17. Refer to the operation sequence diagrams in Section 4.5 and to the schematic diagram provided with the transfer switch to troubleshoot the relays.



1. Programmed-Transition Interface Board (PTIB)
2. K2 (ER1) Relay
3. K1 (NR1) Relay

Figure 3-17 Programmed-Transition Interface Board

3.13 Controller Replacement

Always check for open switches or circuit breakers, loose connections, or faulty wiring before replacing any parts. Reset the controller as described in Section 3.4 before replacing it. Replace the controller only if the troubleshooting and test procedures in this manual indicate conclusively that the controller is damaged or inoperative.

Replace the entire controller assembly and plastic housing. Controller parts are not offered separately. Save the old controller's plastic cover, which includes the transfer switch nameplate, for use with the new controller.

New controllers are shipped with the factory default settings for the system settings, including voltage, frequency, number of phases, phase rotation, and other user-adjustable settings. After installing a new controller, use a personal computer running the Setup Program to change the settings, if necessary. Refer to the Setup Program Operation and Installation Manual for instructions.

Disconnect power to the transfer switch before starting to disconnect the controller. Observe the following safety precautions to avoid injury or equipment damage.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

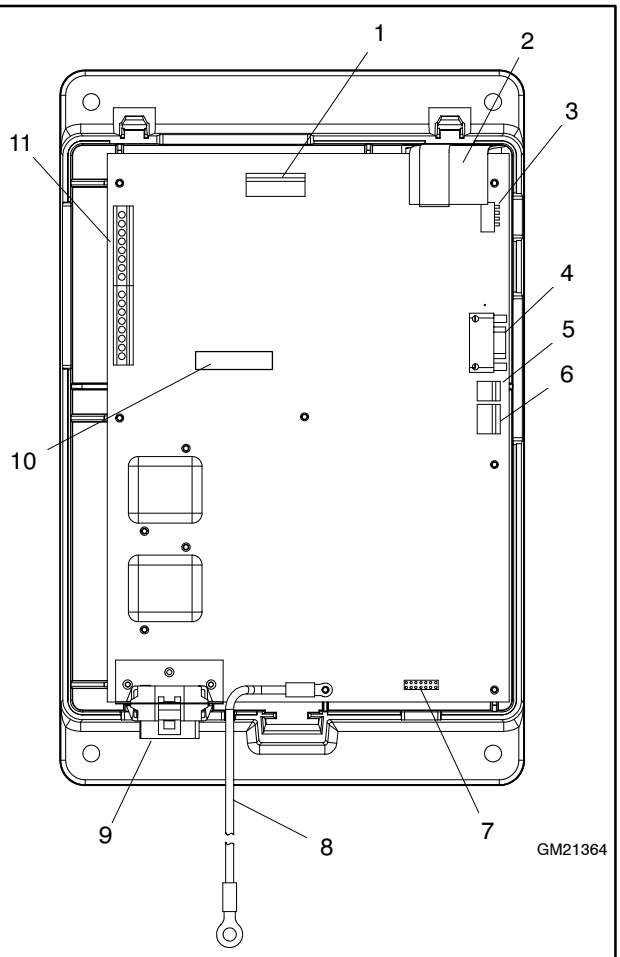
Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Controller Replacement Procedure

1. Move the generator set master switch to the OFF position.
2. Disconnect the generator set engine starting battery, negative (-) lead first.
3. Disconnect power to the transfer switch by opening switches or circuit breakers to the switch.
4. Open the transfer switch enclosure.
5. Check the voltage at the source connections to verify that the power is off.
6. Disconnect the transfer switch harness at the connector on bottom of the controller. See Figure 3-18.
7. Disconnect the programmed-transition board, if equipped, from the controller at connector P9.
8. Label each input/output lead connected to the main logic board terminal strip and then disconnect the I/O leads.
9. Disconnect I/O modules (if equipped) at connector P3.
10. Disconnect the preferred source switch and supervised transfer switch (if equipped) from the controller board connectors P7 and P8.
11. Disconnect the controller ground wire at the ring terminal on the enclosure door.
12. Support the controller assembly and remove four nuts at the corners.



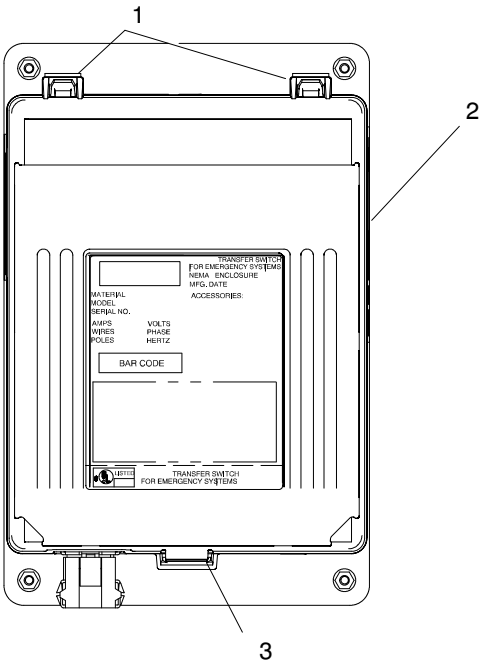
1. I/O board connection (P3)
2. User interface connections
3. DIP switches
4. Serial port for PC connection (P6)
5. Preferred source switch connection (P7)
6. Supervised transfer switch connection (P8)
7. Programmed-transition interface board (PTIB) connection (factory connection) (P9)
8. Ground wire
9. Transfer switch harness connection
10. Serial number decal
11. Terminal strip (inputs, output, Modbus connections) (TB1)

Figure 3-18 Controller Board Component Locations (cover removed)

13. Carefully remove the controller assembly, including the user interface panel, which is part of the assembly.

14. Remove the plastic cover from the old controller and save it to install on the new controller assembly. To remove the cover, depress the latch at the bottom of the cover. Swing the cover open on its hinges and lift it off. See Figure 3-19.

    Note: The old cover includes the transfer switch nameplate, which must remain with the transfer switch.



1. Hinges
2. Access openings to DIP switches and PC connection
3. Latch

Figure 3-19 Controller Housing Cover

15. Replace the entire assembly with a new controller. Secure the four nuts at the corners and tighten them to no more than 6.8 Nm (5 ft. lbs. or 60 in lbs.) torque.

16. Connect the controller ground wire at the ring terminal on the enclosure door.

17. Connect the programmed-transition board, if equipped, to the controller at connector P9.

18. Connect the I/O leads to the main logic board terminal strip, using the labels attached in step 8 to connect the leads to the appropriate terminals.

19. Connect I/O modules (if equipped) at connector P3.

20. Connect the preferred source switch and supervised transfer switch (if equipped) to the controller board connectors P7 and P8.

21. Connect the transfer switch harness to the connector on bottom of the controller.

22. Check the controller's DIP switch settings and adjust them if necessary.

23. Remove the plastic cover from the new controller and replace it with the cover from the old assembly.

24. Connect the controller communication ribbon cable to controller serial port P6 and bring the other end of the cable out the door through the bottom of the enclosure.

25. Close and lock the transfer switch enclosure door.

26. Reconnect power to the transfer switch by closing circuit breakers or switches.

    Note: Power to the controller is required in order to check and adjust the controller settings. If all the power sources are generator sets, reconnect the normal source generator set engine starting battery and move the generator set master switch to the AUTO position.

27. Connect a personal computer and use the Setup Program to check the system settings and adjust them, if necessary. Check the system voltage, frequency, number of phases, phase rotation, time delays, and other user-adjustable settings. Set up inputs/outputs and the in-phase monitor, if applicable. Refer to the Setup Program Operation and Installation Manual for instructions.

28. Disconnect power to the transfer switch by opening circuit breakers or switches.

29. Open the enclosure door and remove the communications cable.

30. Close and lock the enclosure door. Tighten any screws that secure the door.

31. Reconnect the generator set engine starting battery, negative (–) lead last.

32. Move the generator set master switch to the AUTO position.

33. Reconnect power to the transfer switch.

34. Press the LAMP TEST button on the front of the controller and verify that all LEDs light.

35. If the calendar mode exerciser is not being used, press the EXERCISE button on the controller user interface to set the exercise time and start an exercise run. The generator set should start. Refer to the transfer switch Operation and Installation Manual for more information about the exerciser.

Notes

4.1 Transfer Switch Troubleshooting

When troubleshooting the transfer switch mechanism, always check for simple causes first: broken or loose wires, corroded contacts, exposure to dirt or foreign material, etc.

Check the time delays, source settings, and other system parameters as described in Sections 2 and 3 before concluding that there is a mechanical problem with the transfer switch. Many transfer problems can be traced to inappropriate controller settings.

Verify that the voltage on the nameplate matches the actual nominal source voltage. Use the procedure in Section 3.9.2, Voltage, Frequency, and Phase Rotation Checks, to measure the source voltage. Observe all Safety Precautions when taking voltage measurements. Verify that the measured voltage matches the transfer switch rated voltage.

4.2 Troubleshooting Table

Use the table in Figure 4-1 to diagnose transfer switch problems. See Sections 5 through 10 for transfer switch test and service procedures. Refer to the Table of Contents to find the transfer switch test and service procedures for your unit.

Condition	Possible Cause	Check for
Failure to transfer	Mechanical binding	Jammed or damaged solenoid.
		Faulty or worn core spring.
		Bent main contact shaft.
		Jammed main contacts. Check for foreign object.
		Contact lever or pushbutton jammed against solenoid counterweight. See the Table of Contents for control contact test procedures for your model transfer switch.
		Loose hardware.
		Accumulation of dirt or other foreign material.
	Electrical malfunction	Damaged or wrong coil. Check for signs of overheating.
		Damaged or wrong rectifier and/or snubber.
		Damaged or wrong resistor (not used on all models).
		Loose or broken wires.
		Corroded or fused contacts.
		Coil control contact operation. See the Table of Contents for control contact test procedures for your model transfer switch.
		Improperly wired harness
		Wrong voltage. Check system voltage, controller system voltage and over/undervoltage pickup and dropout settings, and controller meter calibration. See Sections 2 and 3.
Chattering noise when attempting to transfer	Coil control contact operation	See the Table of Contacts for test procedures for your model transfer switch.
	Low voltage	Check source voltage and connections.
	Incorrect spring	See the Table of Contents for coil replacement instructions for your model transfer switch.
	Wrong coil	Check coil voltage rating.

Figure 4-1 Transfer Switch Troubleshooting

4.3 Contacts

Use the millivolt drop test in Section 1.3.3 to identify damaged contacts. Replace contacts that have high resistance.

Refer to the Table of Contents to find the contact replacement procedures for your model transfer switch.

4.4 Solenoid Coil, Rectifier, and Snubber

4.4.1 Solenoid Coil

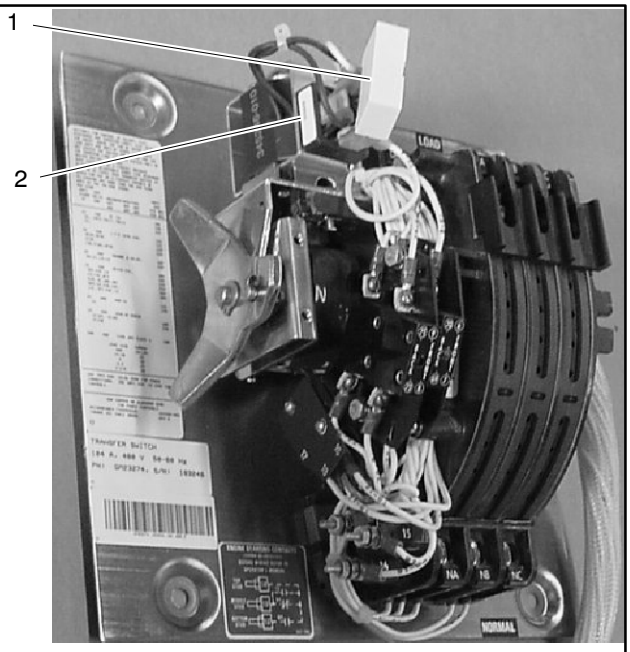
Measure the coil resistance to check for a damaged coil. Coil resistances are listed in Figure 4-4. Most damaged coils will result in an open circuit (very high resistance). Replace the coil if an open circuit or a resistance value significantly different from the resistance shown in the table is found. Replace the rectifier and snubber (if used) whenever the coil is replaced. See Section 4.4.2.

Refer to the Table of Contents to find the coil replacement procedures for your model transfer switch.

4.4.2 Rectifier and Snubber

Models rated over 240 volts include a snubber to protect the rectifier. See Figure 4-2 for the snubber location.

A damaged rectifier or coil probably indicates a damaged snubber as well. Replace the snubber whenever the rectifier is replaced. The snubber is included with the rectifier kit. On smaller models (240 volts and below) that were not originally equipped with a snubber, installation of the snubber included with the replacement rectifier kit is optional.



1. Snubber, typical
2. Rectifier, typical

tp6158

Figure 4-2 Snubber and Rectifier Locations (typical; 30–104 amp. model shown)

Type (ATS or Bypass Switch)	Type	Amps	Number of Poles and Type	Voltage	Coil DC Resistance (ohms) ±10% @ 20ºC
ATS	Open Transition	30–200	2-Pole	208	41.4
				240	67.8
				415	212
				480	256
				600	343
			3-Pole, Switched Neutral, Overlapping Neutral	208	25.7
				240	41.4
				415	133.7
				480	168.3
				600	256
	Programmed Transition	150/225/260/400	2-Pole	208	15.02
				240	25.7
				415	41.4
				480	102.3
				600	102.3
			3-Pole	208	15.02
				240	25.7
				415	41.4
				480	67.8
				600	102.3
			Switched Neutral, Overlapping Neutral	208	11.3
				240	25.7
				415	41.4
				480	67.8
				600	102.3
	Open Transition	225/260/400	2-Pole	208	15.02
				240	25.7
				415	41.4
				480	102.3
				600	102.3
			3-Pole	208	15.02
				240	15.02
				415	41.4
				480	67.8
				600	102.3
			Switched Neutral, Overlapping Neutral	208	11.3
				240	11.3
				415	41.4
				480	67.8
				600	102.3
	Open and Programmed Transition	600/800/1000/1200	2-Pole, 3-Pole, Switched Neutral, Overlapping Neutral	208	4.8
				240	6.6
				415	19
				480	28
				600	43
		1600/2000/3000	2-Pole, 3-Pole, Switched Neutral, Overlapping Neutral	208	2.2
				240	3.4
				415	8.5
				480	13.5
				600	21.3

Figure 4-3 Coil Resistances, Automatic Transfer Switches

Type (ATS or Bypass Switch)	Type	Amps	Number of Poles and Type (2), (3), (B3), (C3)	Voltage	Coil DC Resistance (ohms) ±10% @ 20ºC
Bypass/ Isolation Switch	Open Transition	150/225/260/400	2-Pole	208	15.02
				240	25.7
				415	41.4
				480	102.3
				600	102.3
			3-Pole	208	15.02
				240	15.02
				415	41.4
				480	67.8
				600	102.3
			Switched Neutral, Overlapping Neutral	208	11.3
				240	11.3
				415	41.4
				480	67.8
				600	102.3
	Programmed Transition	150/225/260/400	2-Pole	208	15.02
				240	25.7
				415	41.4
				480	102.3
				600	102.3
			3-Pole	208	15.02
				240	25.7
				415	41.4
				480	67.8
				600	102.3
			Switched Neutral, Overlapping Neutral	208	11.3
				240	25.7
				415	41.4
				480	67.8
				600	102.3
	Open and Programmed Transition	600/800	2-Pole, 3-Pole, Switched Neutral, Overlapping Neutral	208	9.8
				240	11.9
				415	37.4
				480	49.8
				600	84.4
		1000/1200/1600/2000/3000	2-Pole, 3-Pole, Switched Neutral, Overlapping Neutral	208	2.2
				240	3.4
				415	8.5
				480	13.5
				600	21.3

Figure 4-4 Coil Resistances, Bypass/Isolation Switches

4.5 Solenoid Operation

This section contains descriptions and diagrams of the solenoid coil operation. For complete diagrams, refer to the schematic diagrams provided with the transfer switch.

The ATS controller monitors the connected source and detects source failure, either a complete loss of the source or a source parameter that is outside the acceptable range. The controller starts the engine start time delay. If power is restored before the time delay ends, the controller resets the time delay and continues to monitor the source. If the source failure persists and the time delay ends, the controller closes the engine start contacts to signal the Source E generator set to start.

When Source E (or the standby source) becomes available, the controller starts the preferred-to-standby time delay (if not set to zero). When the time delay ends, relay K2 (ER) in the controller closes, applying power to the solenoid coil and initiating transfer.

Note: The K1 (NR) and K2 (ER) relays are energized for only 200 milliseconds to initiate transfer.

The solenoid power circuits vary for different ATS models. The following sections describe and illustrate the transfer sequence for the different models.

Control contacts (TS or CN and CE) control the amount of time that power is applied to the solenoid coil. The contacts open before the operating mechanism reaches Top Dead Center (TDC). Inertia carries the mechanism through TDC, and a spring in the solenoid assembly (or a second coil on some larger models) moves the mechanism into the Source E (or standby) position.

When Source N (or the preferred source) is restored, the controller starts the standby-to-preferred time delay. When the time delay ends, the controller's K1 (NR) relay closes, applying power to the solenoid coil and initiating transfer back to Source N (or the preferred source).

Programmed-transition models stop in the OFF position for a programmed length of time during transfer. The transfer-to-OFF sequence is controlled by the NR1 and ER1 relays on the programmed-transition interface interface board (PTIB).

The controller K1 and K2 relays and the PTIB relays are replaceable.

Note: Always check all wiring and connections before replacing parts.

Figure 4-5 explains the notation used in the solenoid operation diagrams in Figure 4-6 through Figure 4-17.

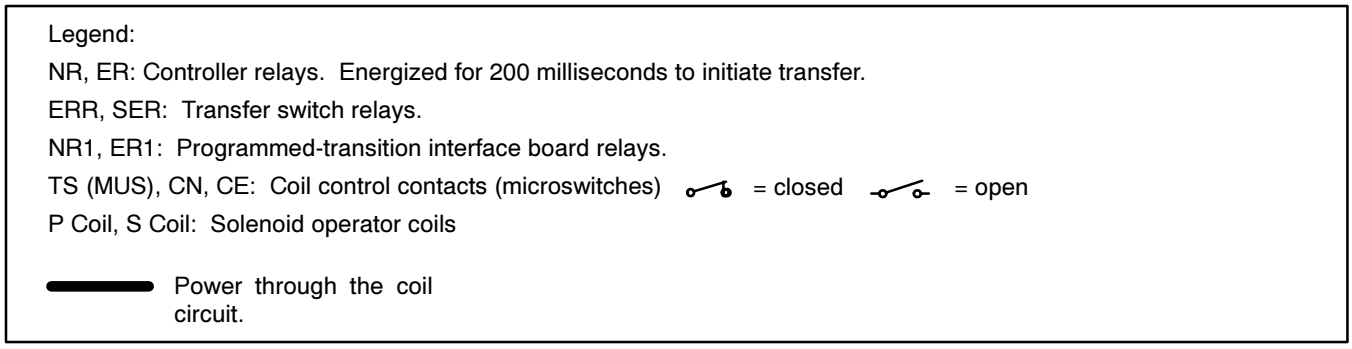
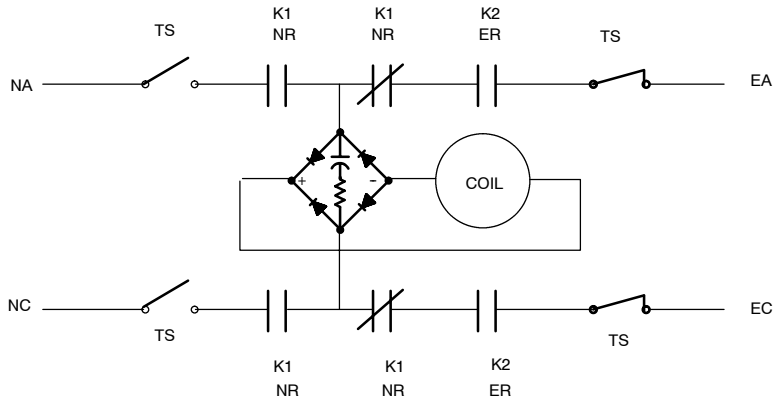


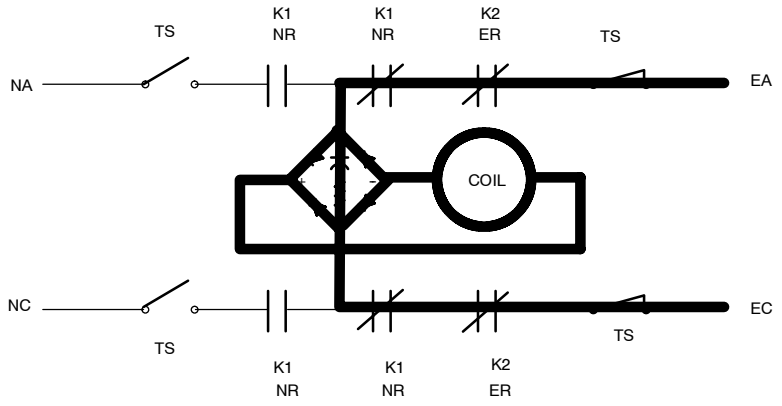
Figure 4-5 Legend for Solenoid Operation Diagrams

4.5.1 Open-Transition 30–1200 Amp and 4000 Amp Open Transition Models

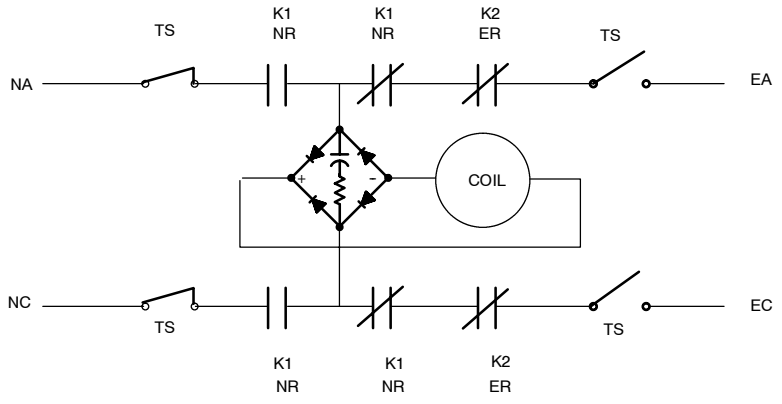
Source N position, Source N available. The solenoid coil is not energized.



Source N position, Source N lost. The coil is energized if Source E is available. The transfer switch is ready to transfer to Source E.



Source E position, Source E available. The solenoid coil is not energized.



Source E position, Source N available. The controller is calling for transfer to Source N. The coil is energized and the transfer switch will transfer to Source N.

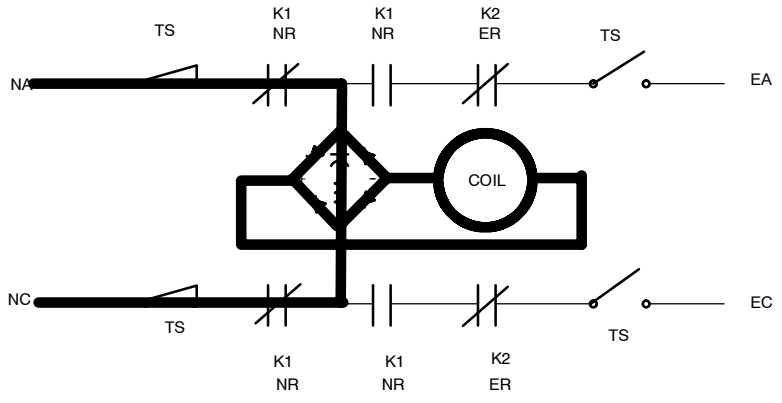


Figure 4-6 30–1200 Amp and 4000 Amp Open-Transition Models, Transfer to Source N and Transfer Back to Source E

4.5.2 1600–3000 Amp Open-Transition Models

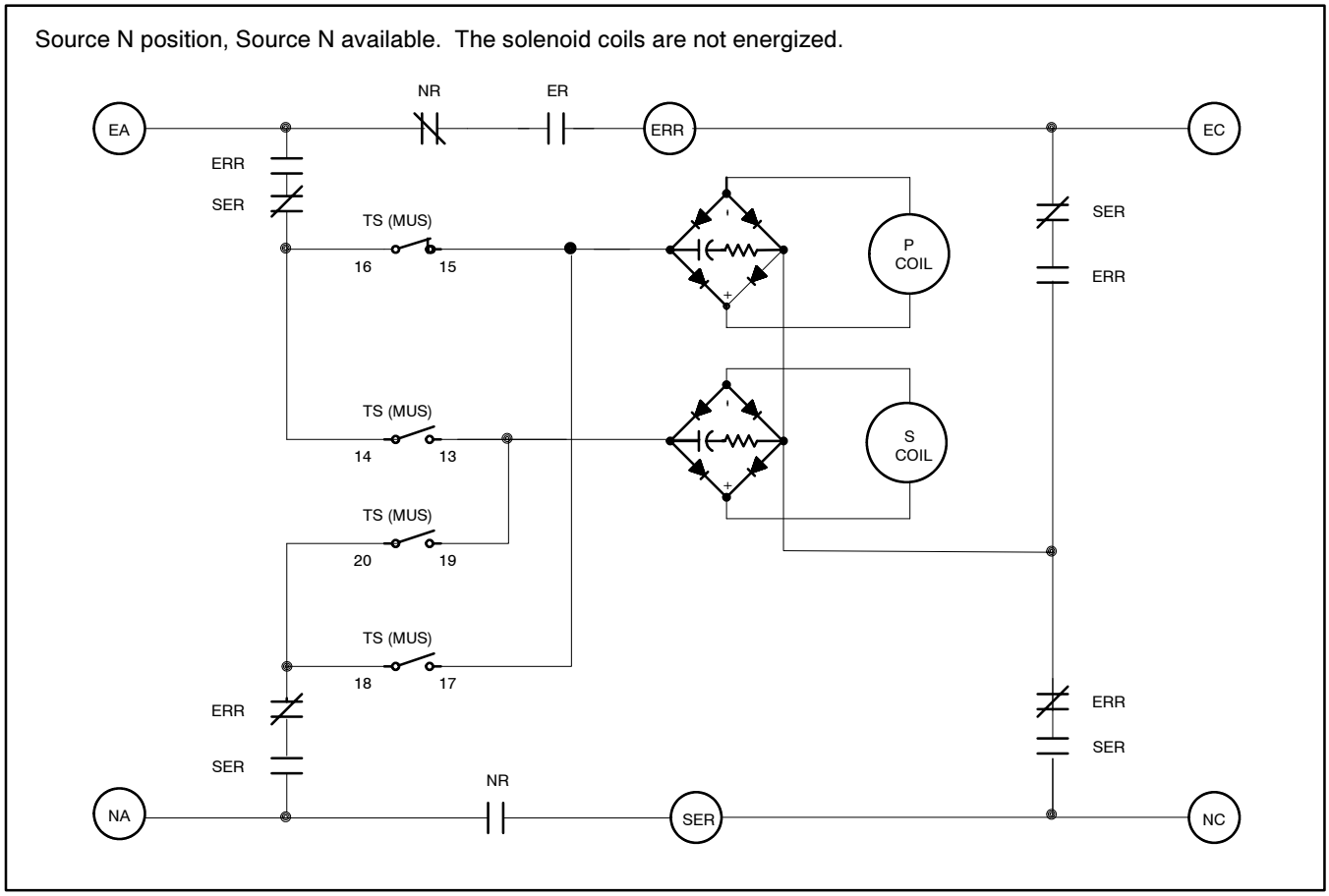
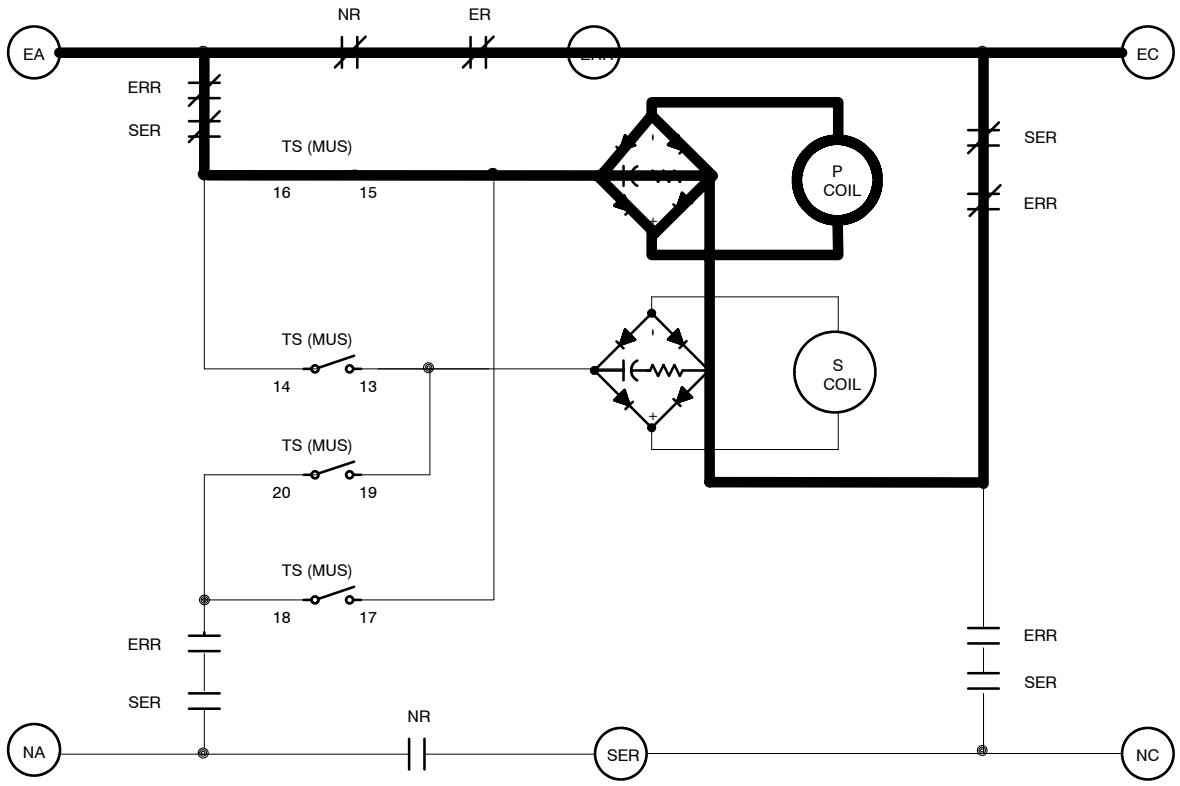


Figure 4-7 1600–3000 Amp Open-Transition Models, Source N Position

Transfer to Source E, step 1. Source N lost, Source E available. ERR is energized for 200 mseconds. TS 15-16 closes to energize the P coil. TS 15-16 reopens just before Top Dead Center (TDC).



Transfer to Source E, step 2. After Top Dead Center, TS 13-14 closes to energize the S Coil.

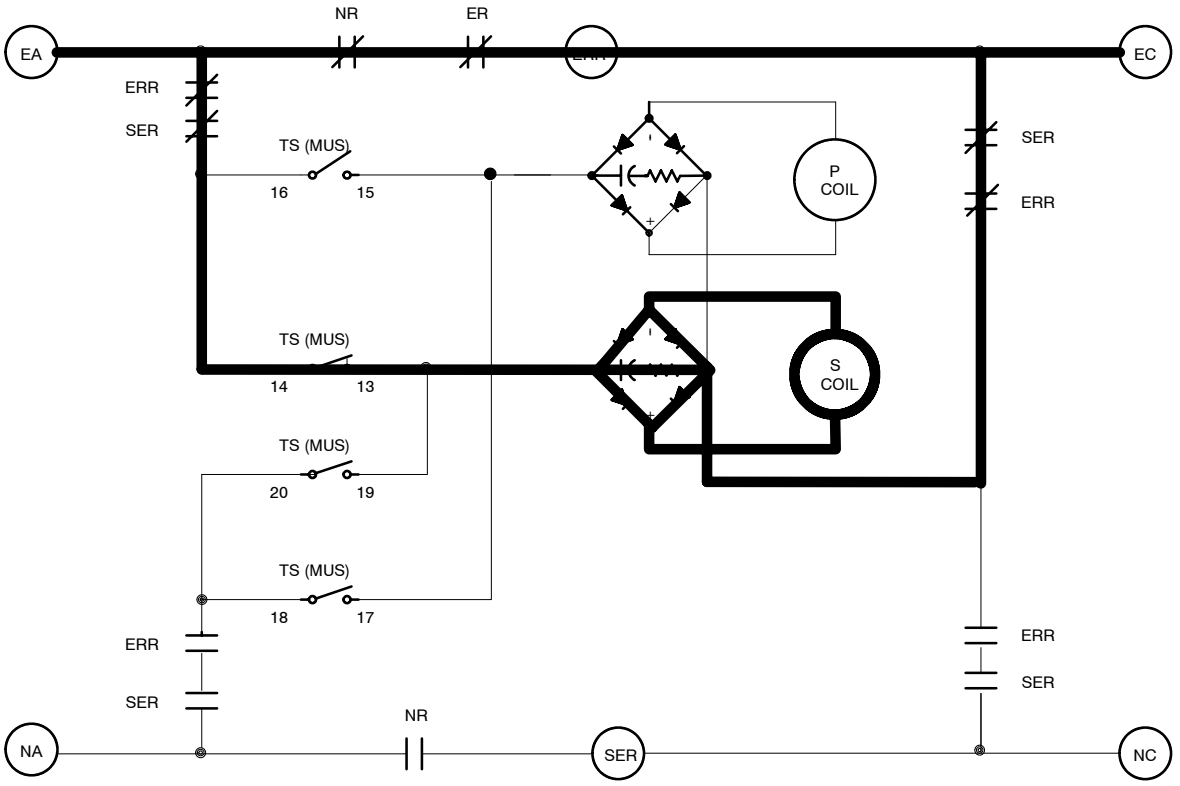


Figure 4-8 1600-3000 Amp Open-Transition Models, Transfer to Source E

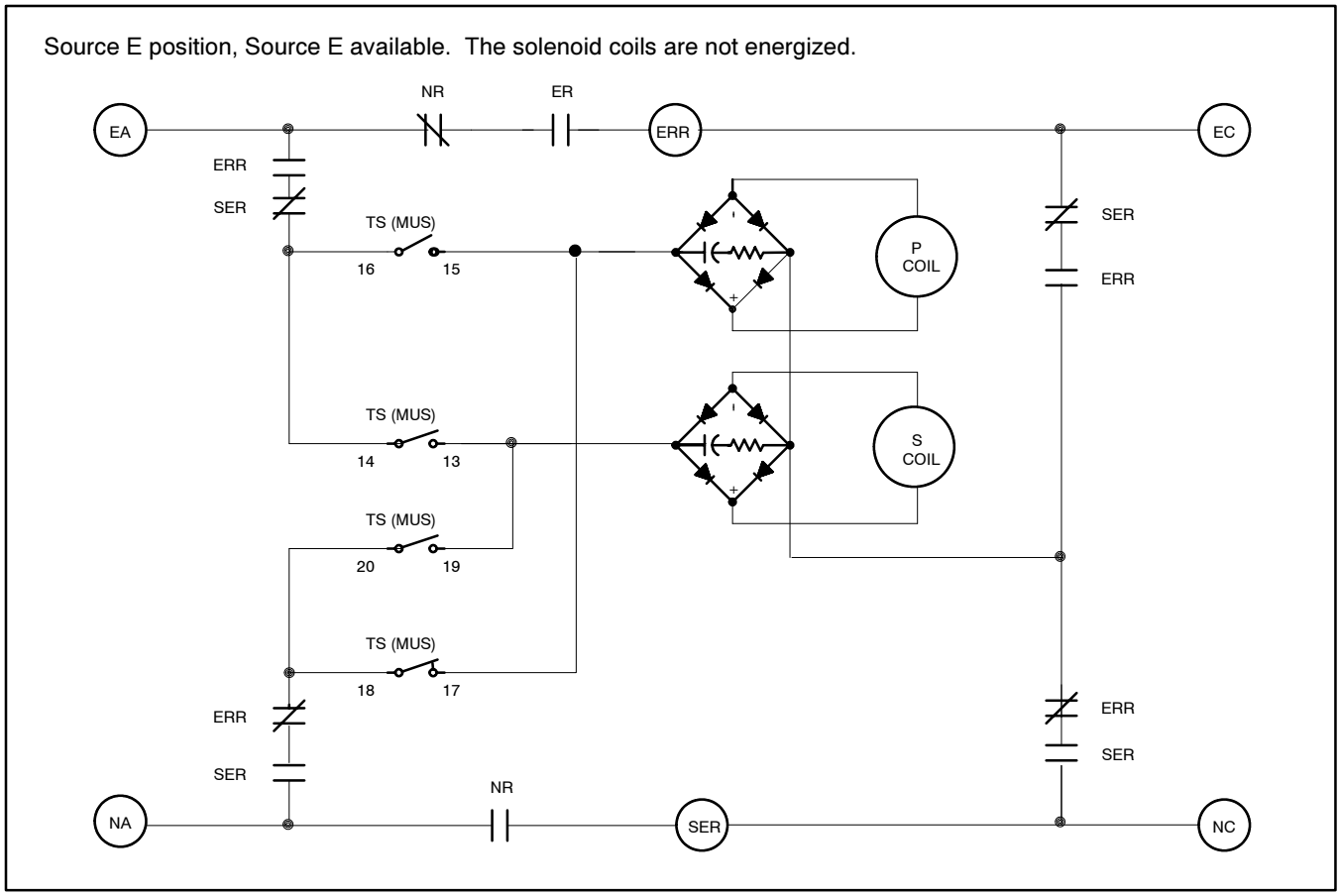
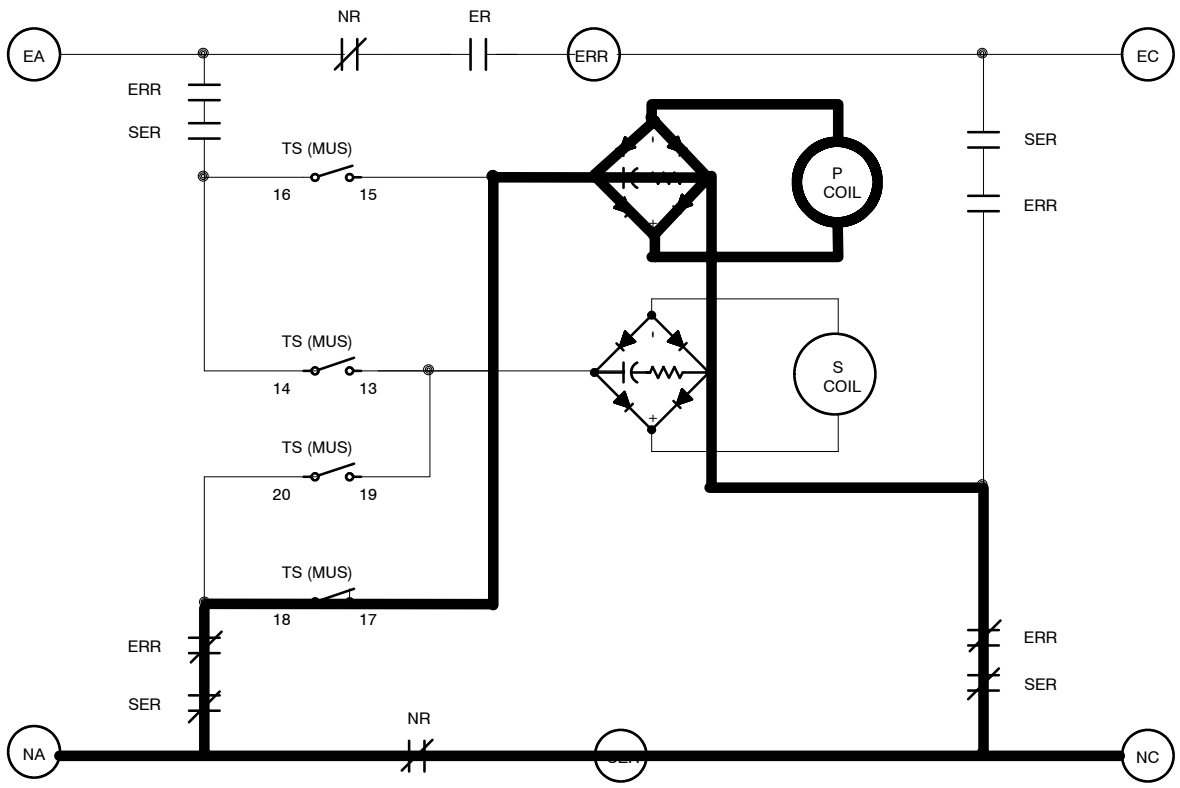


Figure 4-9 1600–3000 Amp Open-Transition Models, Source E Position, Source E Available

Transfer to Source N, step 1. Source N available. SER is energized for 200 mseconds. TS 17-18 closes to energize the P coil. TS 17-18 reopens just before Top Dead Center (TDC).



Transfer to Source N, step 2. After Top Dead Center, TS 19-20 closes to energize the S Coil.

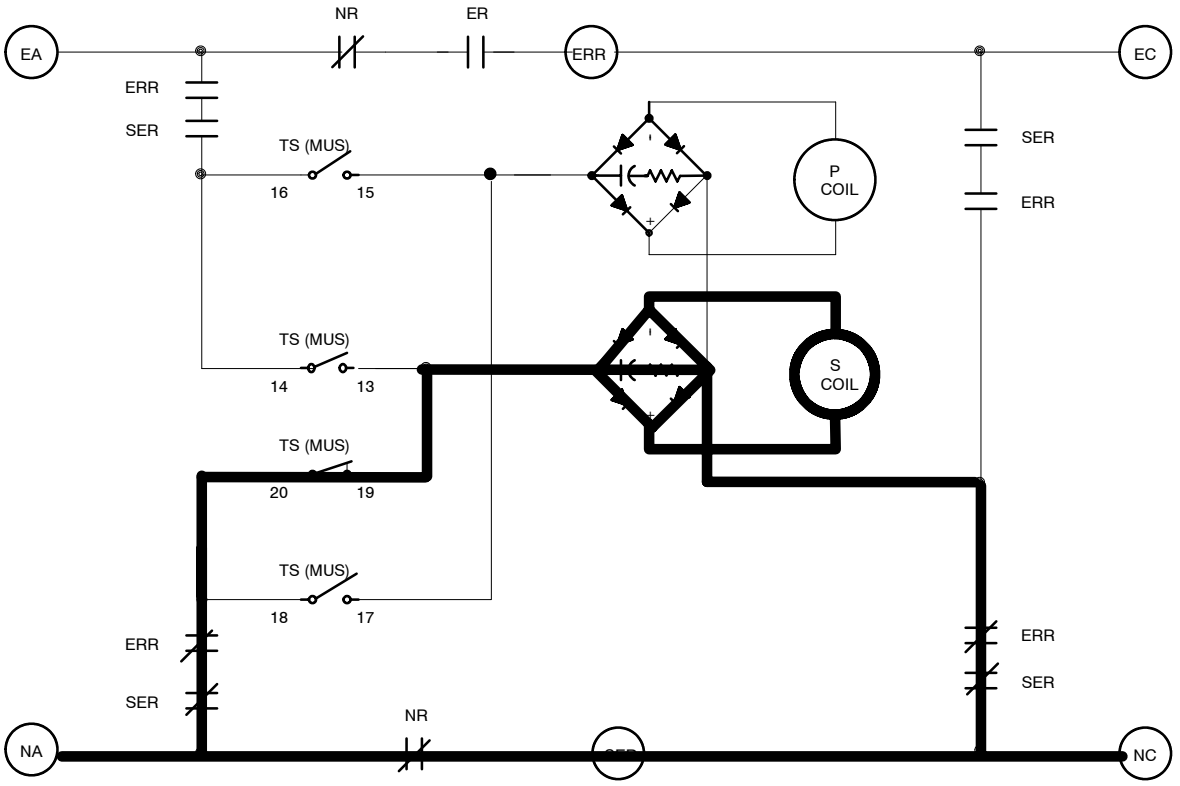


Figure 4-10 Open-Transition 1600-3000 Amp Models, Transfer to Source N

4.5.3 150–400 Amp 2- and 3-Pole Programmed-Transition Models

Replaceable relays ER1 and NR1 are mounted on the programmed-transition interface board (PTIB). Relays ER1 and NR1 are energized for only 200 msec during the transfer sequence.

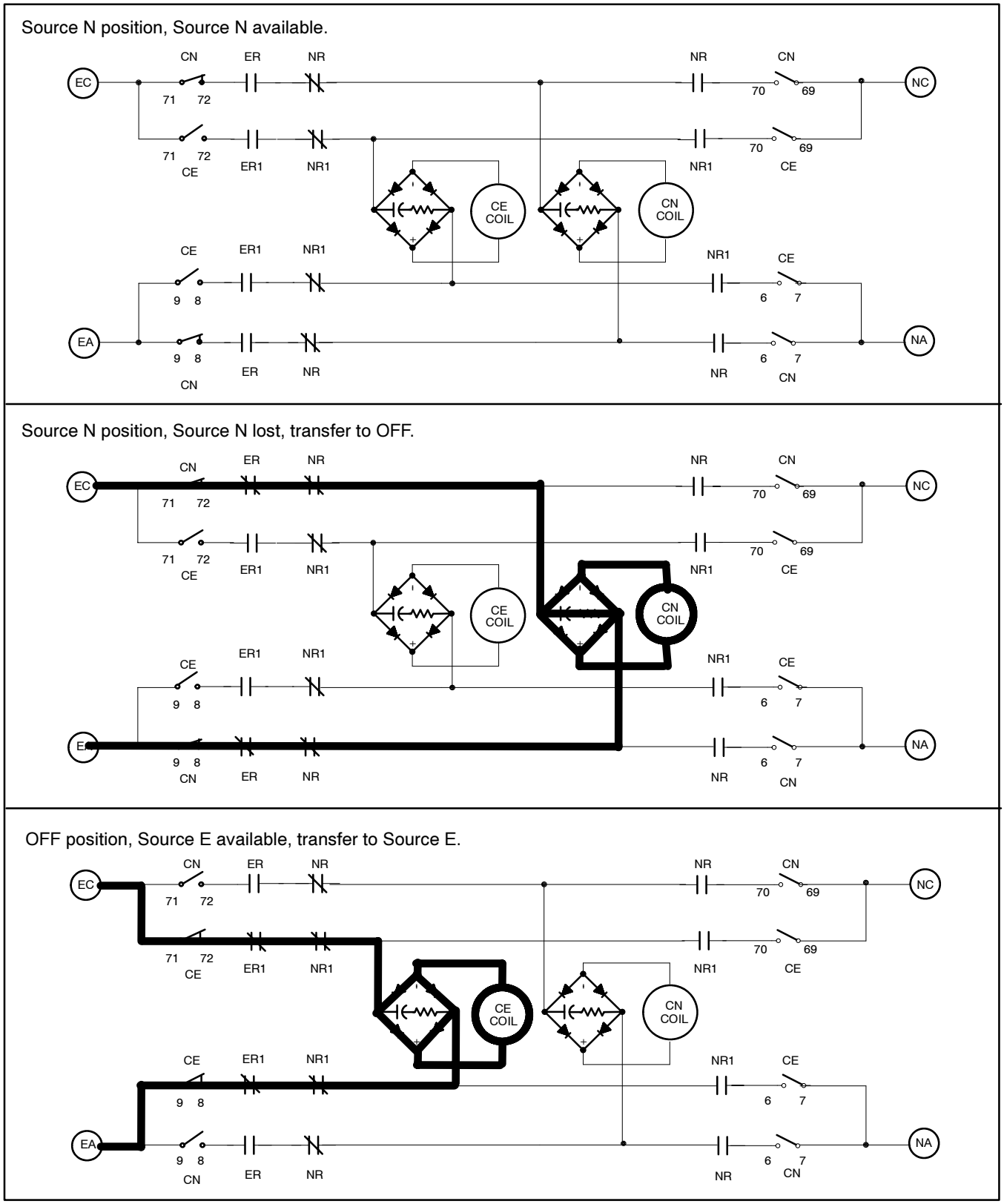


Figure 4-11 150–400 Amp 2- and 3- Pole Programmed-Transition Models, Transfer from Source N to Source E

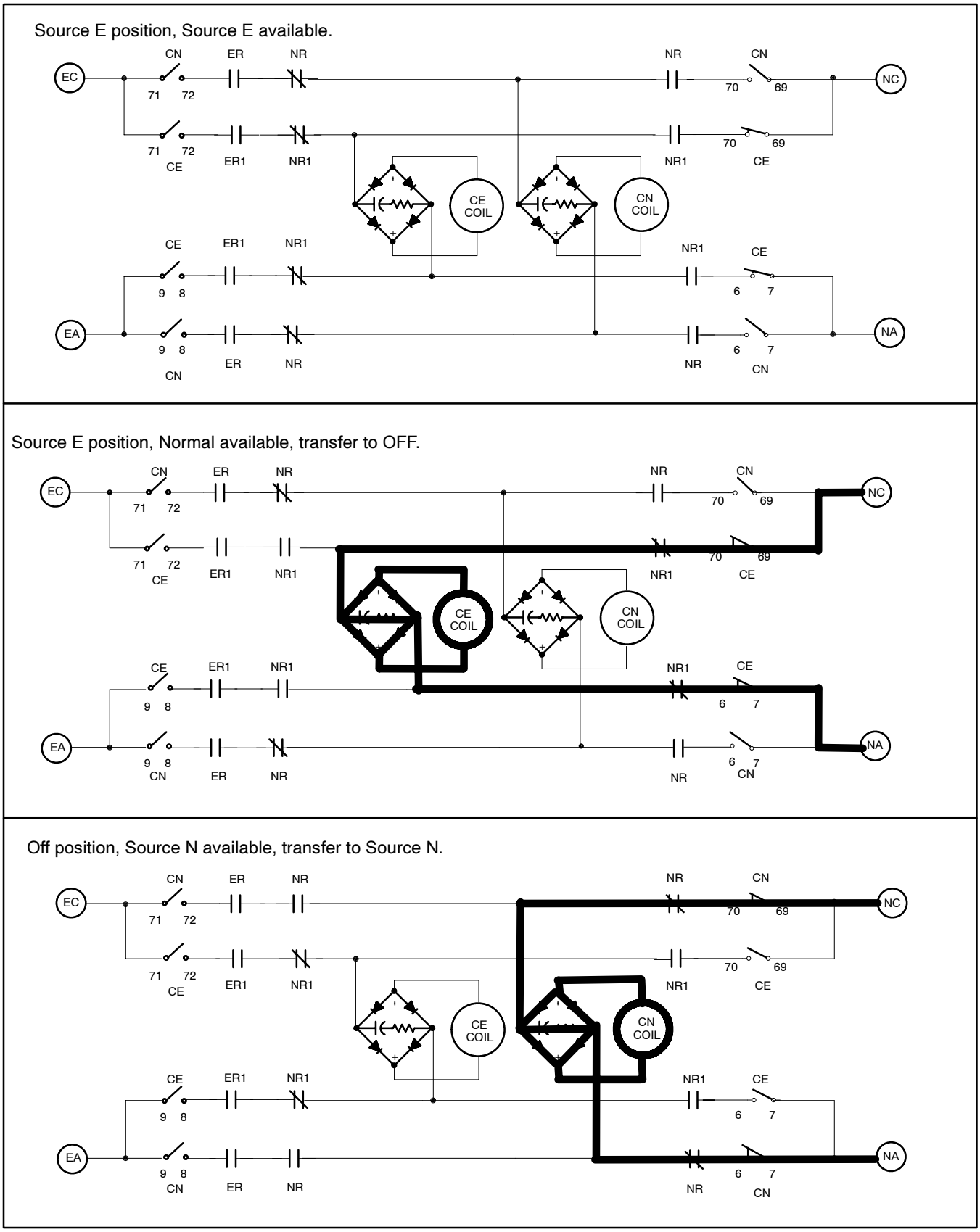


Figure 4-12 150–400 Amp 2- and 3- Pole Programmed-Transition Models, Transfer from Source E to Source N

4.5.4 150–400 Amp 4-Pole and 600–1200 Amp Programmed-Transition Models

Replaceable relays ER1 and NR1 are mounted on the programmed-transition interface board (PTIB). Relays ER1 and NR1 are energized for only 200 msec during the transfer sequence.

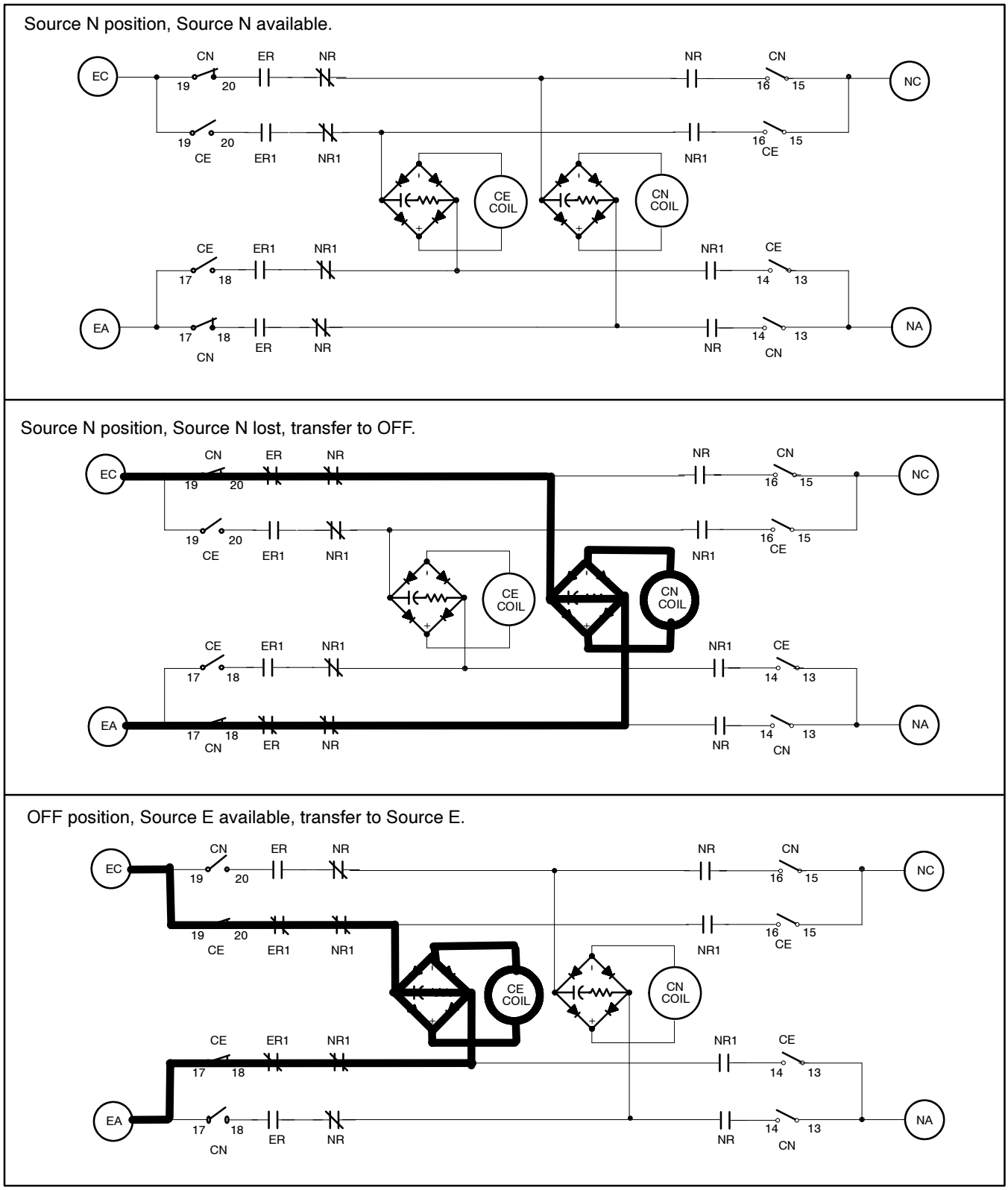


Figure 4-13 150–400 Amp 4-Pole and 600–1200 Amp Programmed-Transition Models, Transfer from Source N to Source E

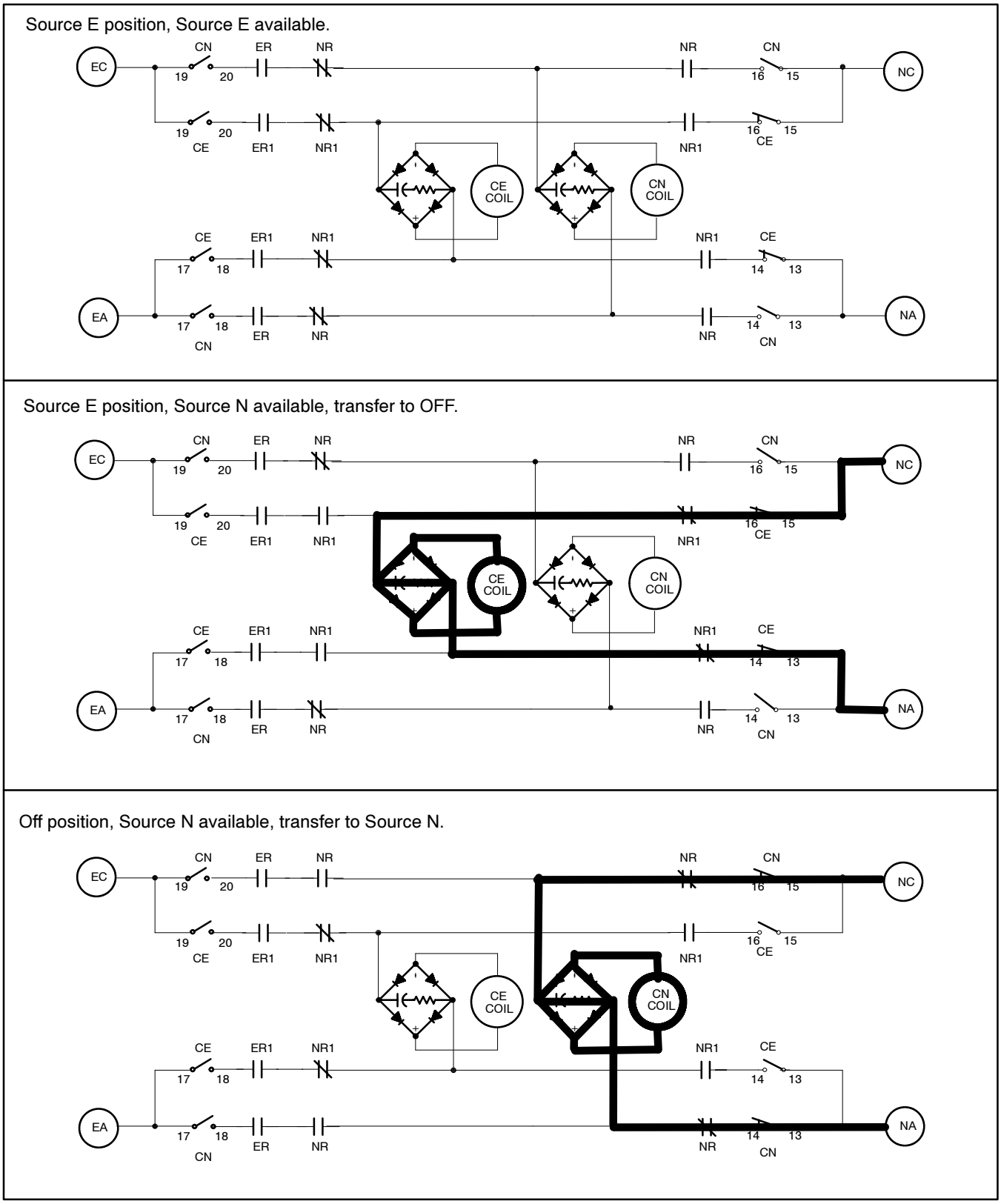


Figure 4-14 150–400 Amp 4-Pole and 600–1200 Amp Programmed-Transition Models, Transfer from Source E to Source N

4.5.5 1600–3000 Amp Programmed-Transition Models

The 1600–3000 amp programmed-transition models use two pairs of solenoid coils. Only the P coil is energized during transfers to the OFF position. During transfers from OFF to either source, the two coils in the pair are energized in sequence, the P coil first and then the S coil after the weight passes through top dead center (TDC).

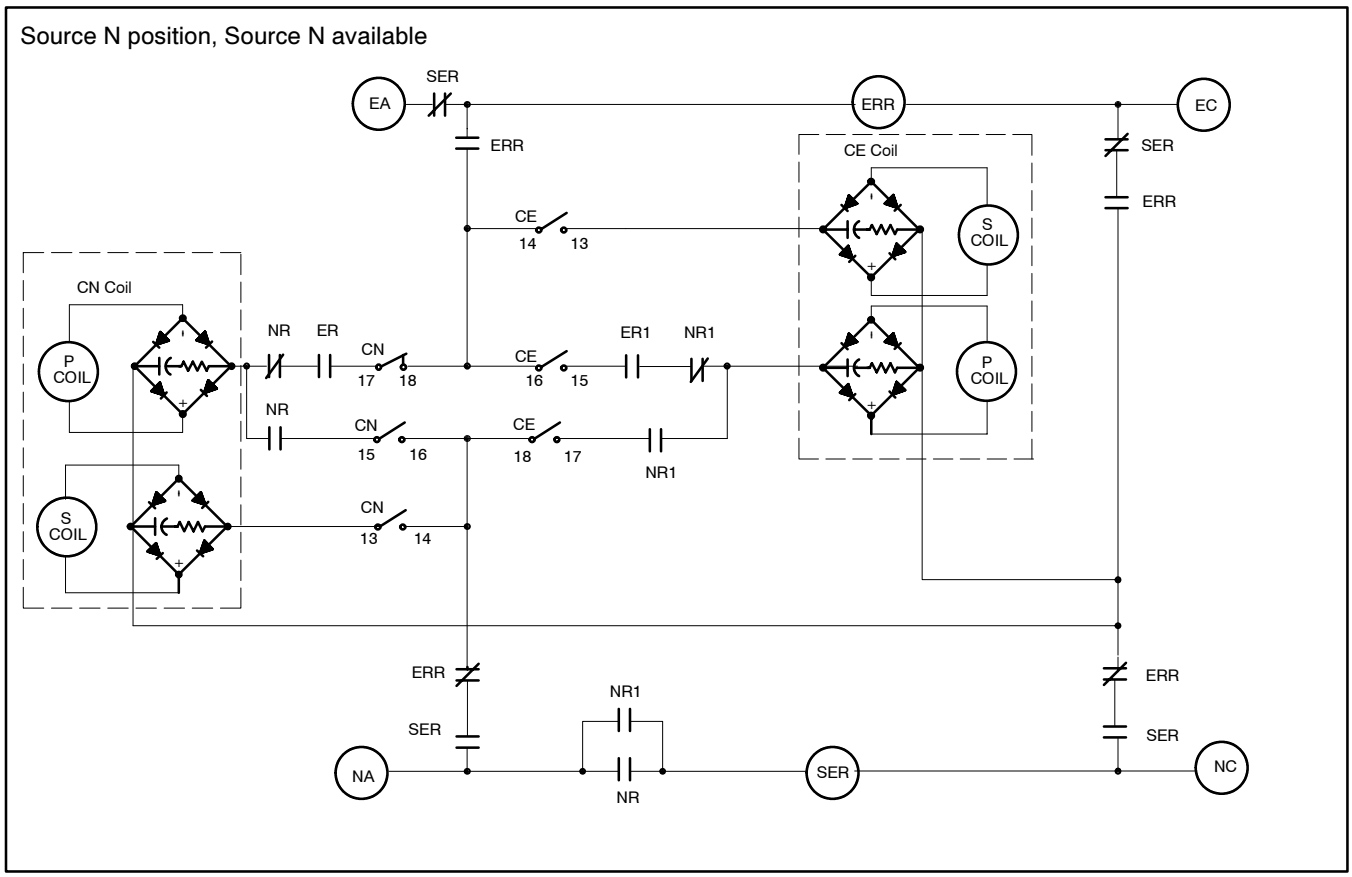


Figure 4-15 1600–3000 Amp Programmed-Transition, Source N Position

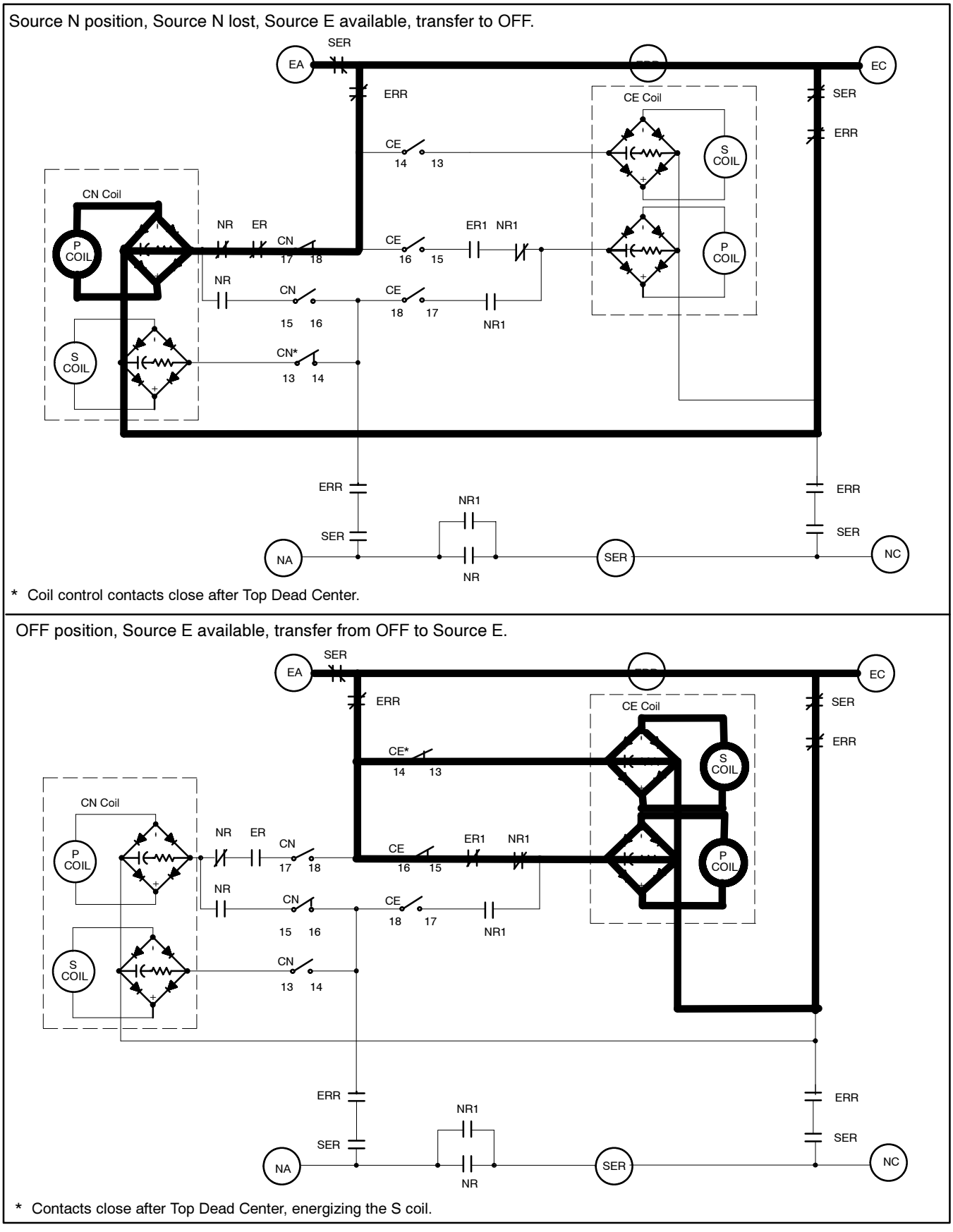


Figure 4-16 1600–3000 Amp Programmed-Transition, Transfer to Source E

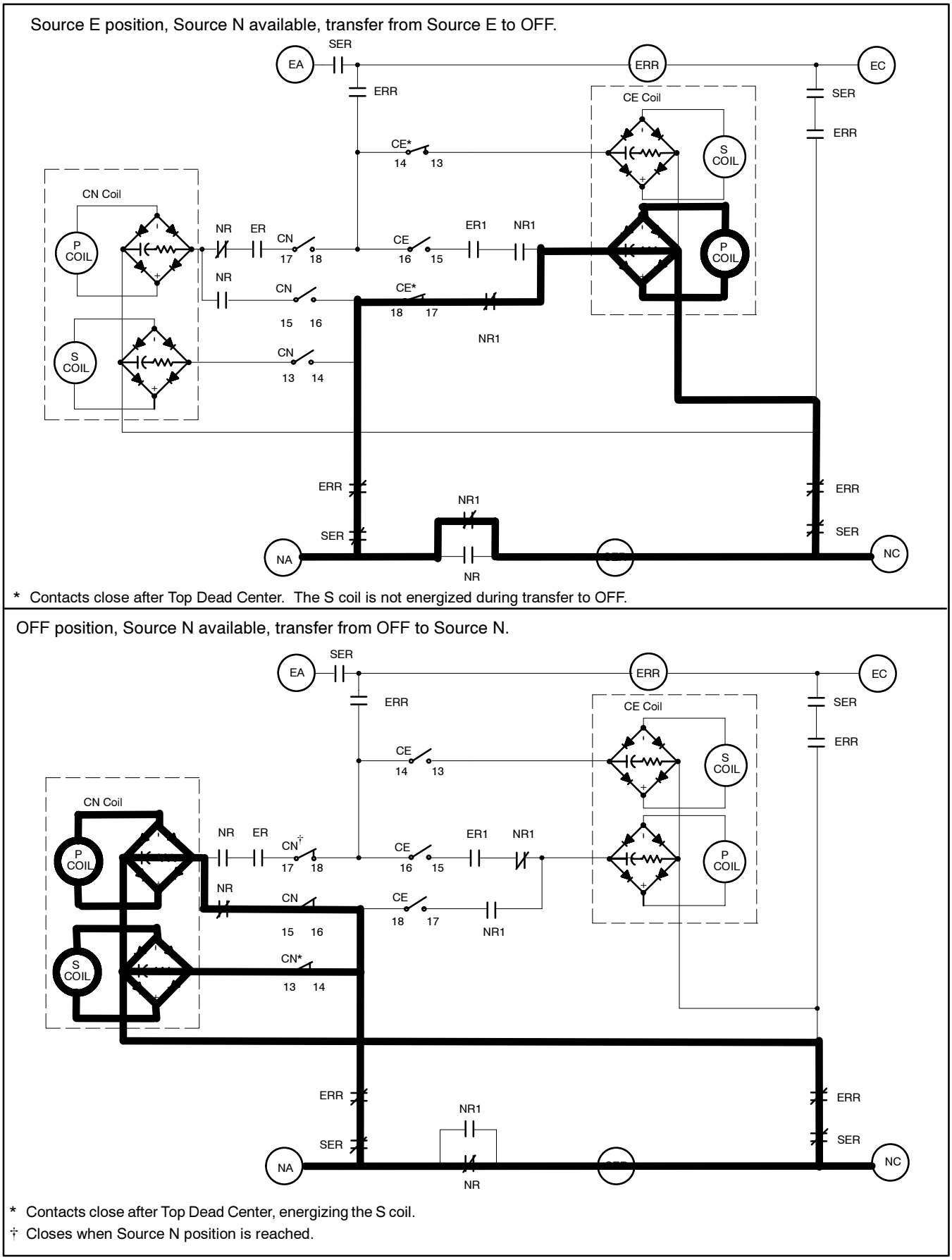


Figure 4-17 1600–3000 Amp Programmed-Transition, Transfer to Source N

Notes

5.1 Introduction

This section contains test and service procedures for 30–200 amp transfer switches.

Use the troubleshooting and test procedures in Sections 2 through 4 to diagnose problems before replacing parts. Use the instructions in this section if inspection, troubleshooting, or other test procedures reveal damaged or defective components that require replacement.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

5.2 Manual Operation

The service procedures in this section call for manual operation of the transfer switch. Refer to the instructions in this section to manually operate the switch. Verify that the power to the transfer switch is disconnected before operating it manually.

Note: A manual operation handle is provided on the transfer switch *for maintenance purposes only*. Do not use the manual operation handle to transfer the load with the power connected.

The 30–200 amp switches have a star-shaped handle for manual operation. The handle is not detachable.

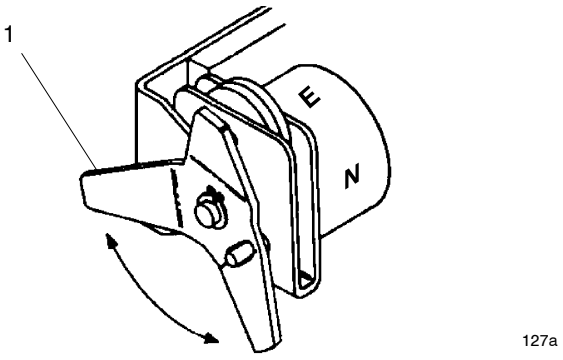
Manual Operation Procedure

1. Verify that the power sources to the transfer switch are OFF.

2. Turn the attached handle to manually operate the transfer switch. See Figure 5-1. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.

   Note: Do not attempt to rotate the U-shaped floating weight or permanent damage may occur.

3. Return the transfer switch to the Normal (or Source N) position.



1. Handle

Figure 5-1 Manual operation handle, 30–200 amp switches

5.3 Operator Coil Replacement

The following tools are needed for this procedure:

- Blade screwdriver
- 5/16 in. nutdriver
- Pliers
- Voltmeter

Note: Always check wiring and connections before replacing components.

Operator Coil Disassembly Procedure

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator engine starting battery charger, if installed; and

disconnecting all generator engine start batteries, negative (-) leads first.

2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch.

3. Locate the coil assembly at the top left corner of the power switching device. See Figure 5-2.

4. Disconnect the rectifier:

   a. Locate the square rectifier mounted on the coil yoke or L-bracket.

   b. Note the connections and disconnect the coil leads and the control wires from the rectifier's push-on terminals.

5. Release the coil assembly. Use a screwdriver to pry the retaining ring out of the groove in the stub core, which extends through the steel L-bracket. Then use a 5/16 in. nutdriver to remove two hex-head screws from the front of the L-bracket.

6. Remove the steel L-bracket and slide the coil and coil washers off the core tube.

   Note: If the coil has burned out, also replace the core tube and core spring. These parts could be damaged from overheating.

7. Remove the core tube: Use a 5/16 in. nutdriver to remove three hex-head screws. Then remove the core tube, core tube retainer, and spacer ring (if used).

8. Remove the core spring from the core.

Operator Coil Assembly Procedure

Note: Lubricate new parts with lubrication kit GM24237.

1. Insert the stub core into the core tube.

2. Lubricate the new core tube and core spring. Apply the lubricant mixture to the inside of the new core, the new core spring, and the core.

3. Install the new core spring: Place the lubricated core spring onto the core shoulder.

4. Install the new core tube:

   a. Slide the core tube retainer onto the core tube.

   b. Place the core tube onto the core spring and core and press the core tube against the steel bracket.

   c. Use three hex-head screws with lock washers to secure the core tube retainer. Be sure that the stub core extends through the end of the core tube.

5. Install the new coil assembly: Slide the spacer ring, then the spring washer, two insulating washers, and the coil onto the core tube. The coil leads must be on the left and extend toward the operator mechanism.

6. Secure the coil assembly:

   a. Place the steel L-bracket onto the stub core and secure it with two hex-head screws.

   b. Use pliers to slide the retaining ring into the groove in the stub core to secure the stub core in the frame.

7. Replace the rectifier, if necessary: Remove the center screw to remove the old rectifier. Install the new rectifier so that the terminal with the red dot is on the upper left.

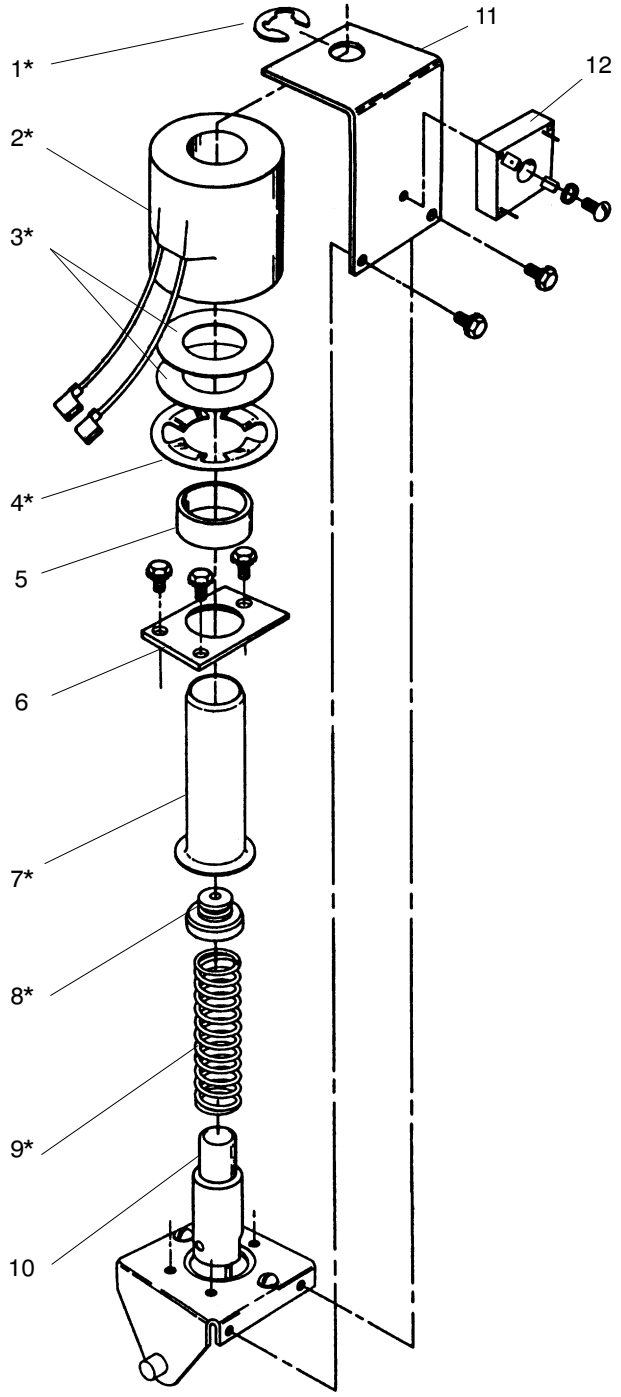
8. Reconnect the coil leads: Connect the coil leads to the rectifier's push-on terminals marked with red dot and no dot (DC + and - output).

9. Reconnect the rectifier: Connect the control wires (AC input) to the rectifier's push-on terminals marked with yellow dots.

10. Manually operate the switch: Use the manual operating handle to operate the switch to check the solenoid assembly. The action should be smooth, without any binding. If not, recheck the solenoid operator part alignment and lubrication. Return the switch to the normal position.

11. Reconnect power supplies to the transfer switch.

12. Reconnect the generator engine starting battery cables, negative (-) leads last; reconnect power to the generator engine starting battery charger, if installed; and move the generator set master switch to the AUTO (automatic) position. The generator set may start and run until the ATS time delay engine cooldown (TDEC) expires.



1. Retaining ring*
2. Coil*
3. Spacer washers*
4. Spring washer*
5. Spacer ring
6. Core tube retainer
7. Core tube*
8. Stub core*
9. Core spring*
10. Core
11. L -bracket
12. Rectifier

* Parts included in coil kit

Figure 5-2 Coil Assembly for 30–200 Amp Switches

5.4 Main Contact Inspection

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator engine starting battery charger, if installed; and disconnecting all generator engine start batteries, negative (–) leads first.
2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch.
3. Remove the arc chutes. For each arc chute:
   a. Use a screwdriver to loosen the screws adjacent to the Emergency source terminal lugs.
   b. Slide or lift the arc chute retainer up to release the arc chute.
   c. Pull the arc chute out of the switch.
4. Inspect the main contacts. Use the manual operating handle to operate the switch and inspect all contact surfaces. Discoloration of the contact surface does not affect performance. If the main contacts are severely eroded due to abnormal operating conditions, repair or replace the switch.
5. Reconnect power supplies to the transfer switch.
6. Reconnect the generator engine starting battery cables, negative (–) leads last, reconnect power to the generator engine starting battery charger, if installed, and move the generator set master switch to the AUTO (automatic) position. The generator set may start and run until the ATS time delay engine cooldown (TDEC) expires.

5.5 Coil Control Contact Test and Replacement

The manufacturer sets the TS coil control contacts so that the switch can operate satisfactorily over a voltage range of 80 to 110% of the nominal system voltage. The coil control contact settings may vary from switch to switch to accommodate minor variances in friction and tolerances.

The adjustments are factory-sealed and usually do not require any change over the life of the switch. If it becomes necessary to check the settings in the field, follow the instructions in the test procedure below. The settings can vary to the extremes and still provide acceptable operation. However, it is necessary that the coil control contacts always open *before* top dead center (TDC) is reached by the solenoid core. This feature is inherent to the basic design of the switch.

5.5.1 Coil Control Contact Test

The TS coil control contacts on this size transfer switch are not field-adjustable. If the following test procedure shows that the coil control contacts are not functioning as described, replace them.

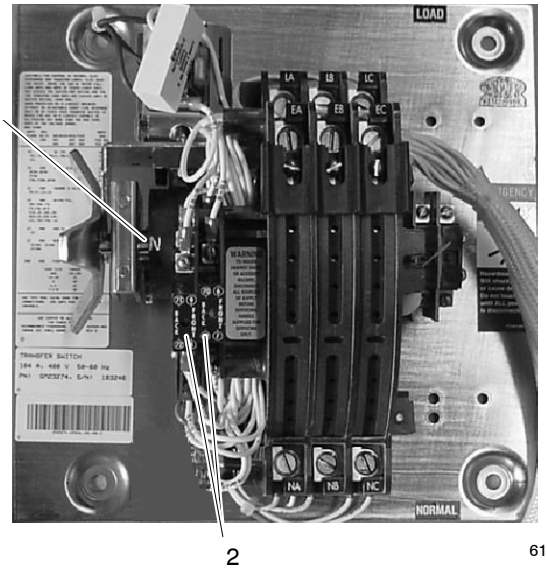
⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

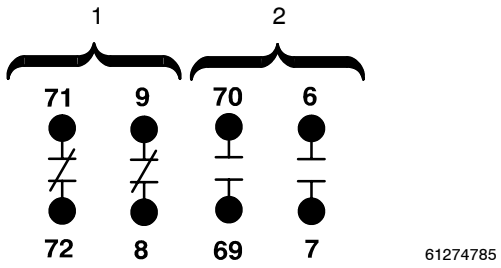
Coil Control Contact Test Procedure

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position, disconnecting power to the generator engine starting battery charger, if installed, and disconnecting all generator engine start batteries, negative (–) leads first.
2. Disconnect all power. Then use a voltmeter to verify that no voltage is present at the switch terminal lugs on both power sources.
3. Locate the TS coil control contact assemblies (see Figure 5-3).
4. To verify the settings of the TS coil control contacts, proceed as follows:
   a. Refer to Figure 5-4 and Figure 5-6. Two sets of contacts interrupt the control current to the operator coil (TS) in each direction (transfer to emergency and retransfer to normal). In Figure 5-4, the transfer switch is in the Normal position and the coil control contacts for the emergency side are closed, ready to allow current to flow to the TS coil to transfer to the Emergency source if the controller signals for transfer.



1. Main contact position indicator
2. Coil control contact assemblies

Figure 5-3 30–200 Amp Transfer Switches



1. Contacts 71-72 and 9-8, for transfers to emergency
2. Contacts 70-69 and 6-7, for transfers to normal

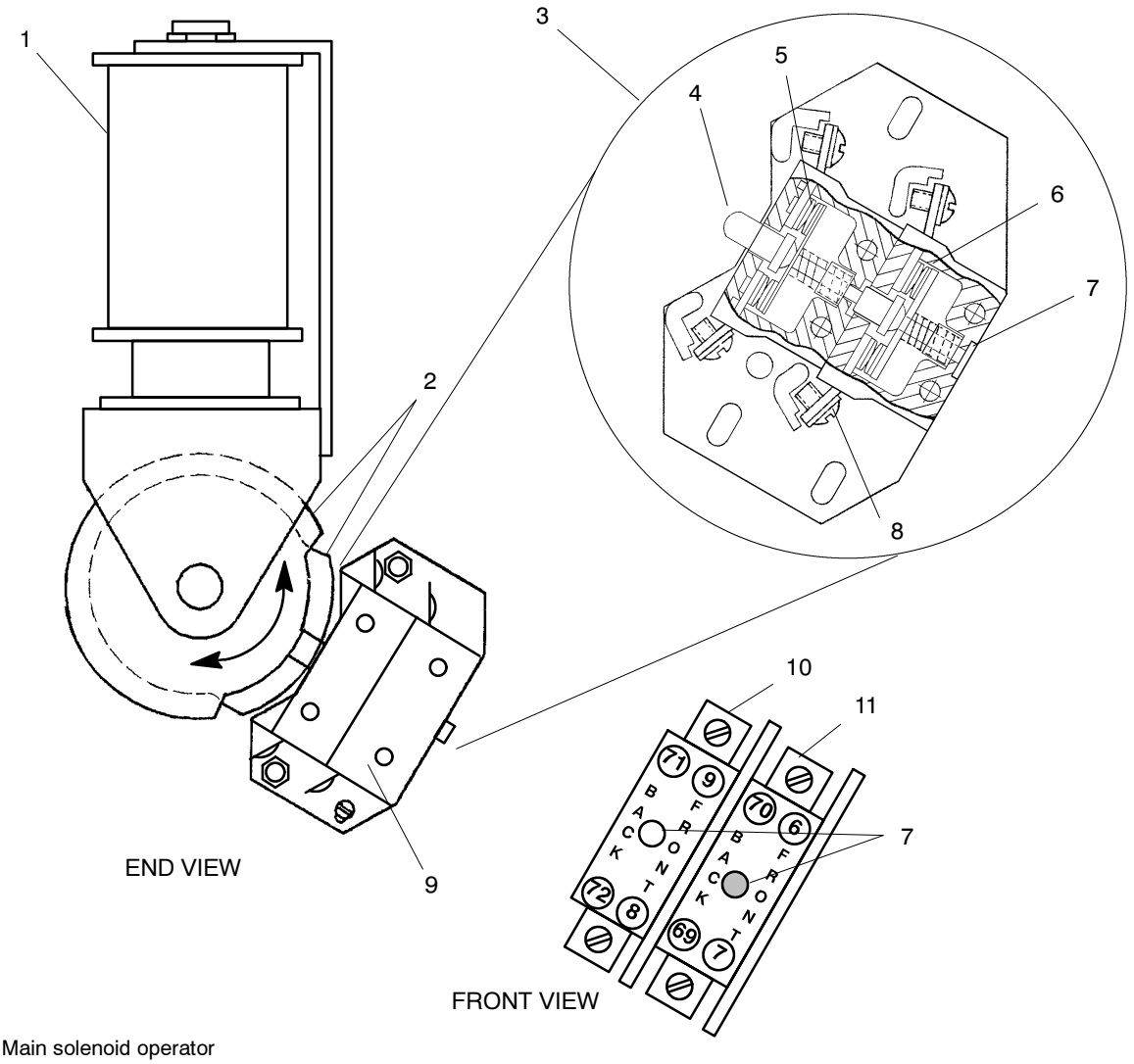
Figure 5-4 TS Coil Control Contact Positions when the Transfer Switch is in the Normal Position

b. With all power disconnected, use an ohmmeter (or a lamp type continuity tester) across each contact while slowly turning the manual operating handle to determine when the control contacts open. (Refer to Section 5.2 for manual operating instructions.) The pairs of coil clearing contacts do not have to operate simultaneously, but both must break the circuit *before* the main solenoid operator core reaches top dead center. See Figure 5-5 for control contact positions.

c. If the coil control contacts do not open before TDC, use the procedure in Section 5.5.2 to replace them These contacts are not field-adjustable.

Condition	**Control Contacts 71–72 & 9–8**	**Control Contacts 70–69 & 6–7**
Main contacts in NORMAL position	Closed	Open
Main contacts in EMERGENCY position	Open	Closed
During transfer from N to E	Open before TDC	Close after TDC
During transfer from E to N	Close after TDC	Open before TDC
N=Normal Position **E=**Emergency Position **TDC=**Top Dead Center of Solenoid core or main contact shaft.		

Figure 5-5 Control Contact Positions



1. Main solenoid operator
2. Cams
3. Typical set of TS coil control contacts (2 required)
4. Operating button (contacts open when the cam presses the operating button)
5. Double-break control contacts (typical 71-72 contacts shown)
6. Typical 9-8 contacts
7. Contact position indicator (contacts are closed when the button is recessed.)
8. Wiring terminal (qty. 4)
9. TS coil control contact assembly
10. Contacts 71-72 and 9-8, for transfers to emergency
11. Contacts 70-69 and 6-7, for transfers to normal

Figure 5-6 TS Coil Control Contact Locations with Main Solenoid Operator

5.5.2 Coil Control Contact Replacement

Under normal conditions the TS Control Contacts do not require replacement over the life of the transfer switch. If replacement becomes necessary, use the follwoing procedure.

Note: Always check wiring and connections before replacing components.

Coil Control Contact Replacement Procedure

1. Disconnect all power to the transfer switch as instructed in the Test Procedure in Section 5.5.

2. Check to verify that the wires connected to the control contact assembly are marked so they can be identified after being disconnected. Add labels if necessary.

3. Disconnect the labeled wires from the control contact assembly.

4. Refer to Figure 5-7. Remove two 5/16″ hex nuts with lock and flat washers from the left side of the control contact assembly. Remove the left control contact assembly. Then remove the two spacers and one #6-32 round head screw with lock and flat washers. Remove the right control contact assembly.

5. Install the new right-side control contact assembly (contacts 70–69 and 6–7). Depress the operating button (see Figure 5-6) to slide the assembly over the cam. Secure the assembly with one #6-32 round head screw with lock and flat washers. Align the assembly so that the screw is approximately centered in the slot.

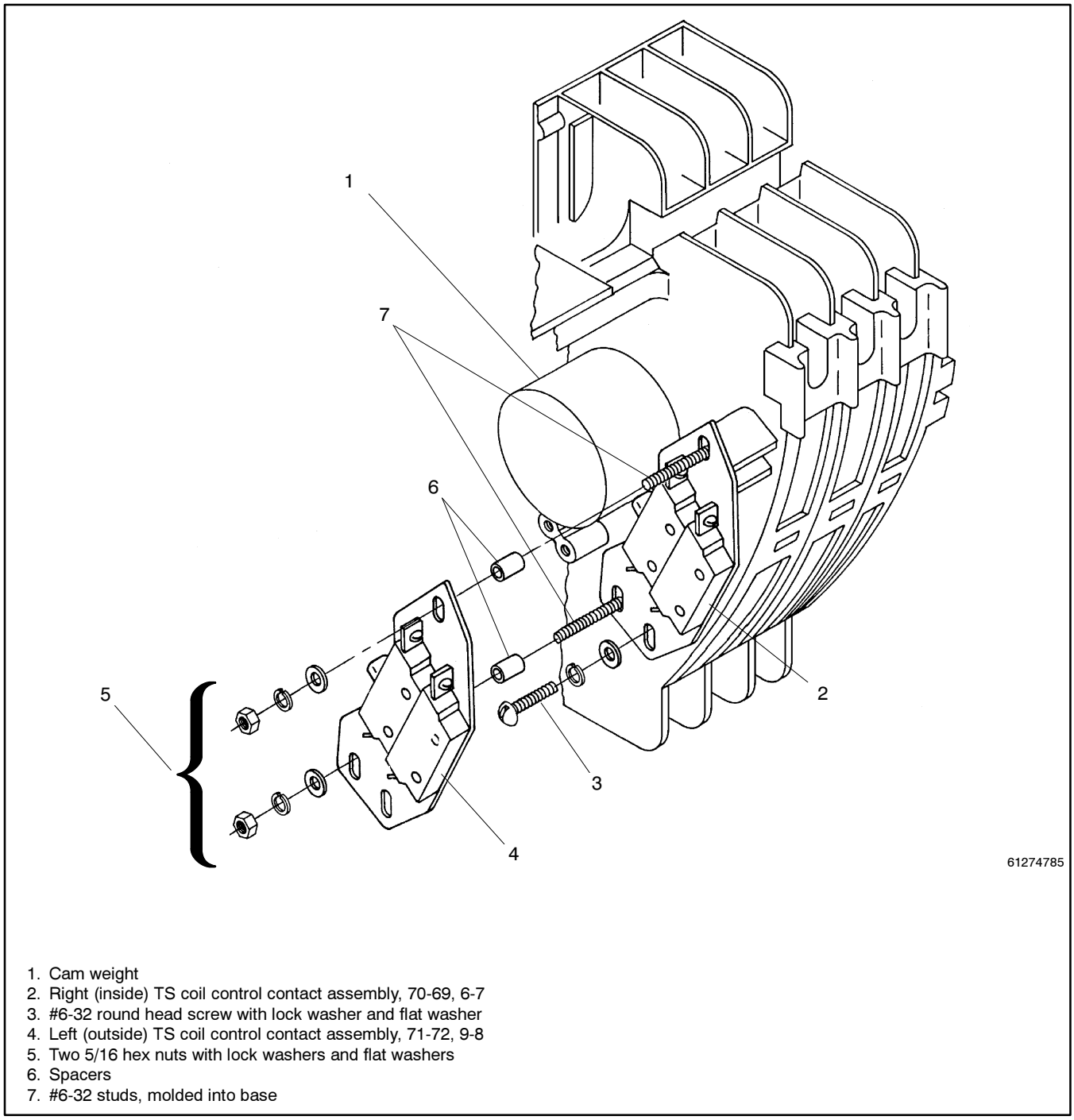
6. Reconnect the labeled wires to the four similarly marked screw terminals.

7. Install two spacers, then install the new left-side control contact assembly (contacts 71–72 and 9–8). Align with the right-side assembly. Secure the control contact assembly with two hex nuts, lock washers, and flat washers. Check that the threaded studs are approximately centered in the slot.

8. Reconnect the four remaining labeled wires to the similarly marked screw terminals on the new left-side control contact assembly.

9. Manually operate the switch by turning the manual operator handle. The action should be smooth without binding.

10. Check the control contact continuity. See the test procedure in Section 5.5.



1. Cam weight
2. Right (inside) TS coil control contact assembly, 70-69, 6-7
3. #6-32 round head screw with lock washer and flat washer
4. Left (outside) TS coil control contact assembly, 71-72, 9-8
5. Two 5/16 hex nuts with lock washers and flat washers
6. Spacers
7. #6-32 studs, molded into base

Figure 5-7 Replacing TS Control Contact Assemblies

This section contains test and service procedures for 225-400 amp transfer switches.

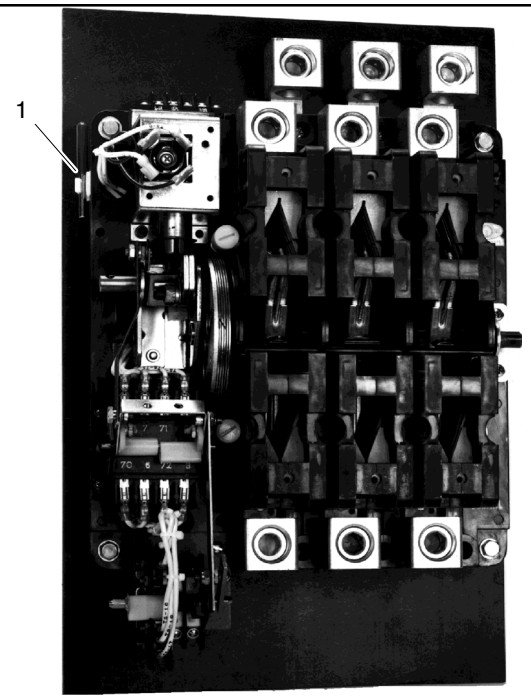
Use the troubleshooting and test procedures in Sections 2 through 4 to diagnose problems before replacing parts. Use the instructions in this section if inspection, troubleshooting, or other test procedures reveal damaged or defective components that require replacement.

6.1 Manual Operation

The service procedures in this section call for manual operation of the transfer switch. Refer to the instructions in this section to manually operate the switch. Verify that the power to the transfer switch is disconnected before operating it manually.

Note: A manual operation handle is provided on the transfer switch *for maintenance purposes only*. Do not use the manual operation handle to transfer the load with the power connected.

225-400 amp transfer switches have a detachable handle for manual operation. See Figure 6-1 for the typical handle storage location.



1. Maintenance handle

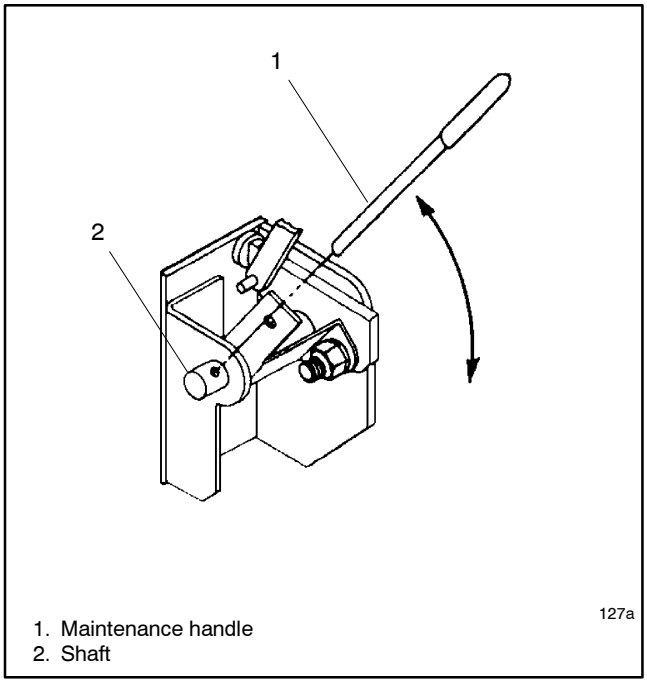
Figure 6-1 Typical Manual Handle Storage

Manual Operation Procedure

1. Verify that the power sources to the transfer switch are OFF.
2. Remove the maintenance handle from the clips on the left side of the transfer switch frame. See Figure 6-1.
3. Insert the maintenance handle into the hole in the shaft on the left side of the operator. See Figure 6-2.
4. Move the maintenance handle up or down as shown to manually operate the transfer switch.
5. Return the transfer switch to the Normal (or Source N) position.
6. Remove the maintenance handle and store it on the frame in the clips provided.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.



1. Maintenance handle
2. Shaft

Figure 6-2 Manual Operation, 225-400 Amp Switches

6.2 Main Contact Replacement

Replace the transfer switch main contacts if inspection, troubleshooting, or testing indicates that the main contacts are damaged or excessively worn. See Section 1.2.2 for inspection information.

The following tools are needed for this procedure:

- Phillips screwdriver
- Blade screwdriver
- 5/32 in. hex key wrench
- 5/16 in. nutdriver
- 9/16 in. socket wrench
- Torque wrench capable of 175 in. lb.
- Voltmeter
- Pliers
- Cotton swab or small brush
- Pencil or wood dowel

Use the detachable manual operating handle *for maintenance purposes only*. Disconnect the power and follow the manual operation instructions in the Operation and Installation manual to move the manual operating handle up or down as needed during these procedures. Do not operate the transfer switch manually when the power is connected.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

Main Contact Replacement Procedure

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position, disconnecting power to the generator engine starting battery charger, if installed, and disconnecting all generator engine start batteries, negative (–) leads first.
2. Disconnect all power sources to the transfer switch by opening switches or circuit breakers. Use a voltmeter to verify that no voltage is present at the transfer switch terminal lugs.
3. Remove the barrier/pole cover and arc chutes to gain access to the main contacts.
   a. Remove four screws in the corners of the barrier/pole cover and remove the cover.
   b. Remove the nylon retainer nuts on both sides of each arc chute. Then tip the chute toward the shaft while pulling it away from the panel.
   c. Place the arc chutes in a safe place for reinstallation later.

Movable Contact Disassembly

The movable contacts are mounted in the shaft. They are secured to the shunts by screws and held in place by the contact spring retainer. See Figure 6-3.

1. Remove the contact spring retainer: Use a 5/16 in. nutdriver to remove four #10-32 hex head screws with shake washers from the shaft. Then remove the retainer.

   Note: The retainer is under spring pressure. Hold the retainer with one hand and loosen all four screws equally to release the pressure.

2. Remove all contact springs: Pull off the contact springs from the heads of the screws.
3. Remove all movable contacts: Remove the 1/4-20 screws with lock washers from the contacts by using a hex key wrench. Then remove the contacts and contact stiffeners.

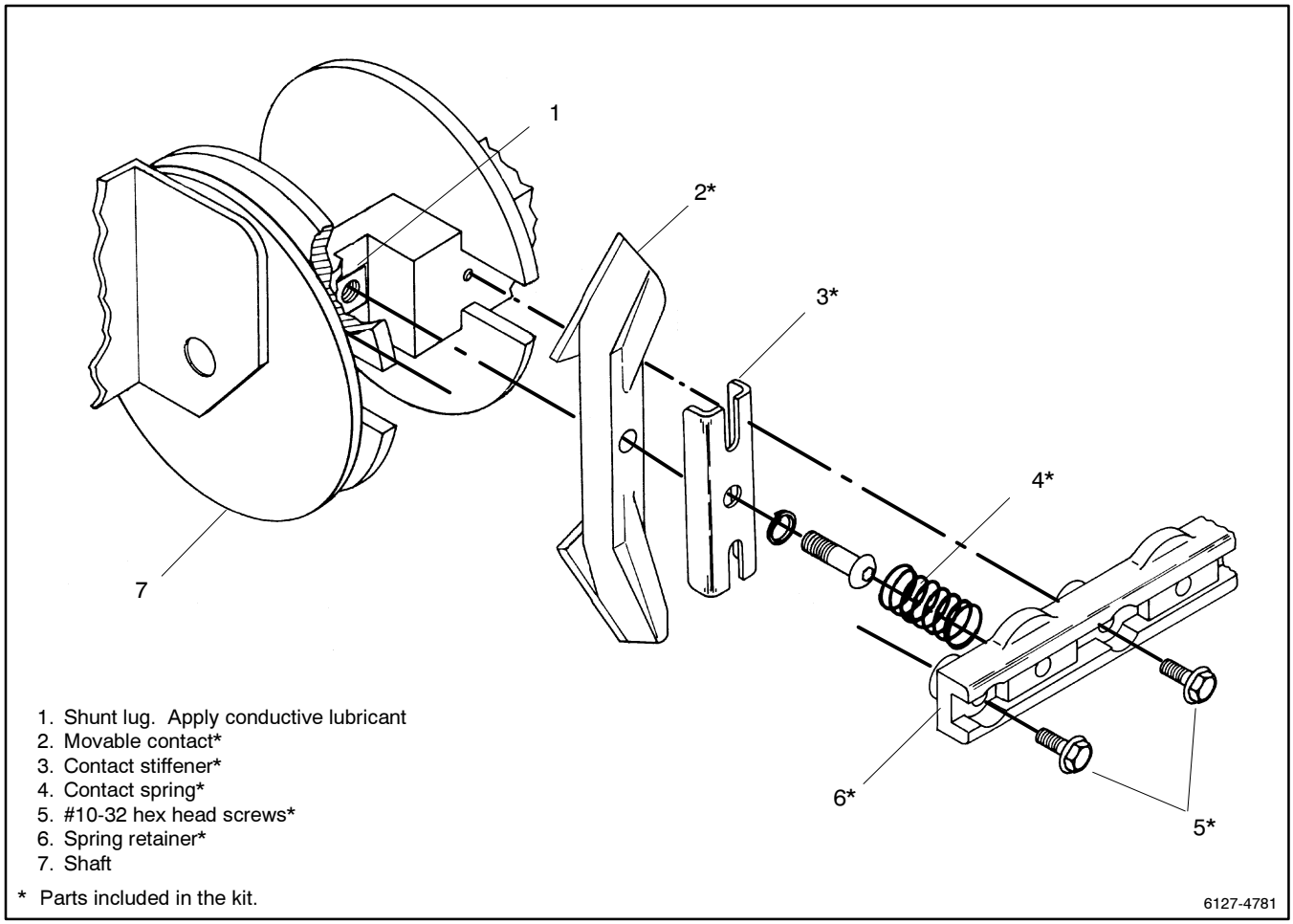


Figure 6-3 Movable Contact

Stationary Contact Disassembly

The stationary contacts are mounted in the molded base. They are secured from the back and screwed to the terminal lugs. See Figure 6-5.

1. Remove all stationary contacts (with terminal lugs): Remove the two hex nuts (from the back) from the threaded studs by using a 7/16 in. socket wrench, then remove the stationary contact (with terminal lug) from the molded base.

2. Remove the terminal lugs: Secure each contact plate in a vise. See Figure 6-4. Remove the terminal screws (from the back) by using a 9/16 in. socket wrench. Save the terminal lugs and screws for reuse.

3. Remove the arc runners: Use a phillips screwdriver to remove two screws from each arc runner. Remove the arc runner by pulling it away from the contact button. Save the screws for reuse.

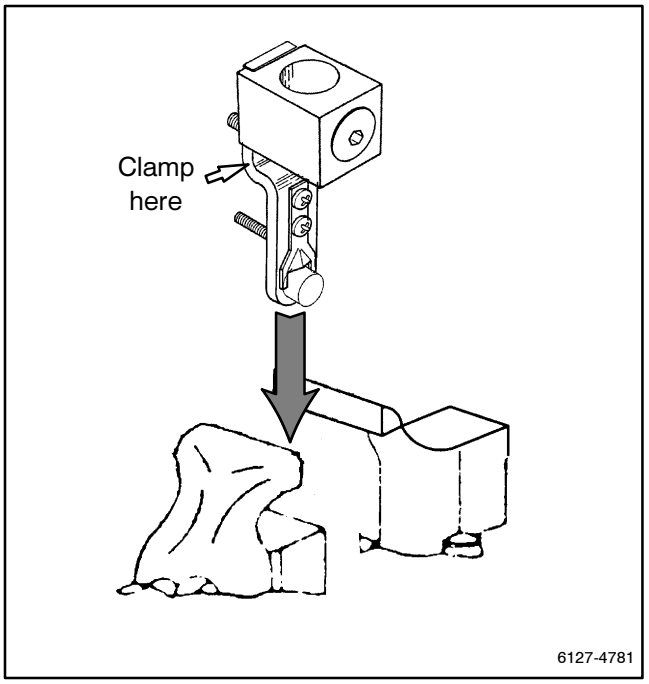
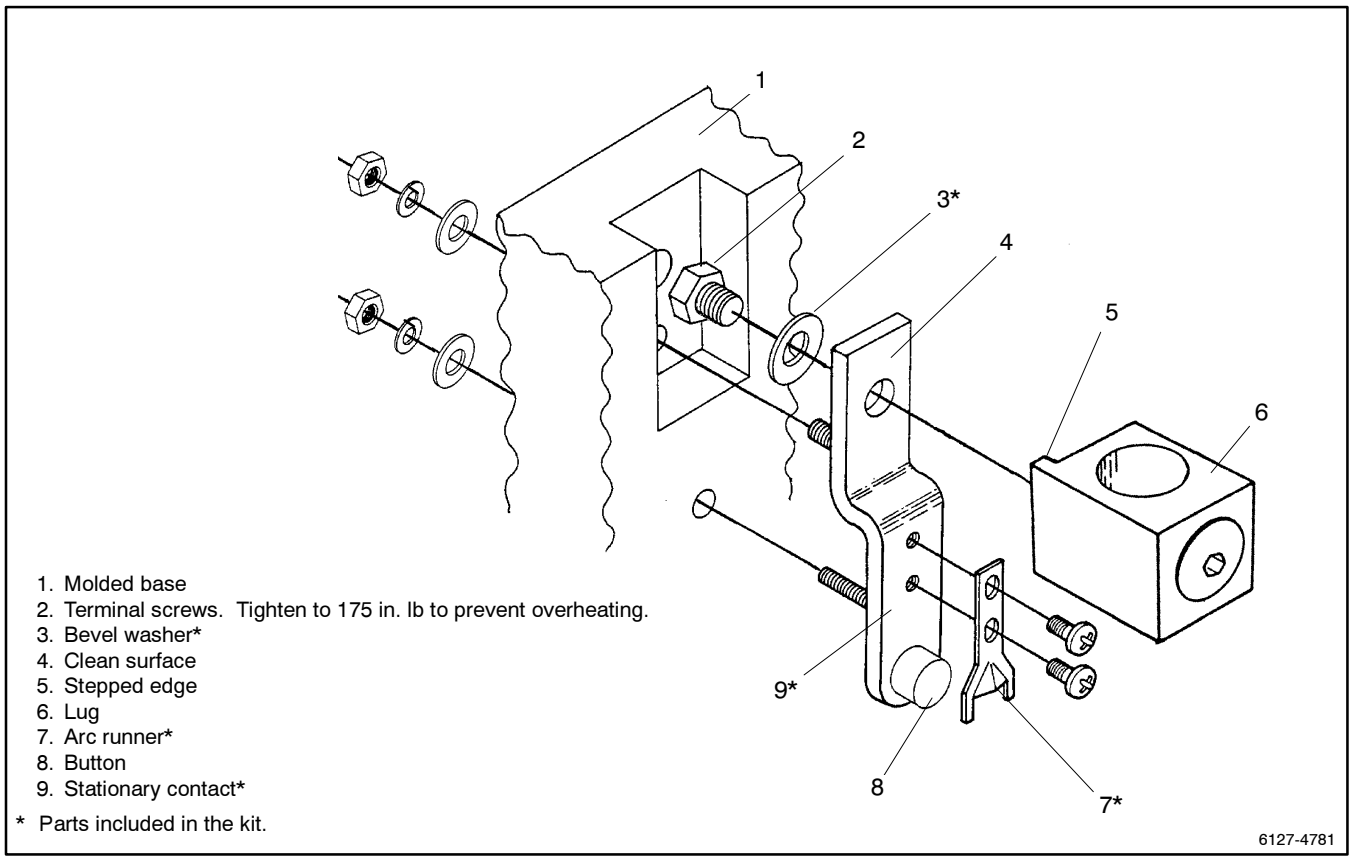


Figure 6-4 Stationary Contact Secured in a Vise to Remove and Install the Terminal Lug and Arc Runner



1. Molded base
2. Terminal screws. Tighten to 175 in. lb to prevent overheating.
3. Bevel washer*
4. Clean surface
5. Stepped edge
6. Lug
7. Arc runner*
8. Button
9. Stationary contact*

* Parts included in the kit.

Figure 6-5 Stationary Contact

Stationary Contact Reassembly

Reassemble as shown in Figure 6-5.

1. Reconnect the terminal lugs:

   a. Make sure that the new contact plate is *clean* before reattaching the terminal lug.

   b. Carefully secure each new stationary contact plate in a vise. See Figure 6-4.

   c. From the back, insert the terminal screw with a *new* bevel washer through the stationary contact plate into the terminal lug (with the stepped edge on the side as shown in Figure 6-5).

   d. Tighten the terminal screws to 19.8 Nm (175 in. lb.).

   Note: To prevent overheating, torque the terminal screws to 19.8 Nm (175 in. lb.).

2. Install *new* arc runners.

   a. Carefully secure each new stationary contact plate in a vise.

   b. Use two Phillips-head screws to install the new arc runner flat against the plate. Be sure that the formed side faces out, the jaws are on both sides of the contact button, and the arc runner is positioned as close as possible to the contact button.

3. Install new stationary contact assemblies: Insert each new stationary contact (with terminal lug & arc runner) into the molded base and secure it by installing two hex nuts with flat and lock washers behind the base. Use a 7/16 in. socket wrench to tighten nuts.

Movable Contact Reassembly

Reassemble as shown in Figure 6-3.

1. Apply conductive lubricant to shunt lugs: Use a cotton swab or small brush to apply conductive lubricant (available from the manufacturer) to the exposed surface of each shunt lug in the shaft.

   Note: Failure to use conductive lubricant between the shunt lug and contact may cause overheating.

2. Install new movable contacts: Place a new contact on the shaft and secure it to the shunt lug with the 1/4-20 screw and lock washer. Each screw passes through the movable contact and contact stiffener into the shunt lug. Use a 5/32 in. hex key wrench to tighten the screw to 100 in. lb.

   Note: To prevent overheating, torque the movable contact screw to 100 in. lb. To prevent binding, check the contact for free movement in the shaft.

3. Install new contact springs: Press a new spring onto the head of each screw that secures a movable contact.

4. Install the contact spring retainer:

   a. Place the spring retainer onto the springs so that they seat into the cavities of the retainer.

   b. Compress the springs with the retainer and hold it in position.

   c. Use a 5/16 in. nutdriver to install the four #10-32 hex head screws with shake washers to secure the spring retainer to the shaft. Tighten the screws.

5. Check contact deflection: Lift the tip of each movable contact to verify freedom of movement in the shaft. If there is binding, loosen the contact screw enough to reposition the shunt lug slightly, then retighten the screw to the proper torque. Recheck the deflection.

6. Install all arc chutes:

   a. Tip the arc chute while placing it over the stationary contact.

   b. Slide the arc chute toward the shaft (up or down) until it stops. Then position it so that it is centered over the stationary contact, and so the movable contact does not strike the arc chute plates.

   c. Secure the arc chute to the panel by using a screwdriver to install (cw) nylon retainer nuts on both sides of the arc chute. Torque the nuts to 12–14 in. lb.

7. Use the manual operation handle to slowly operate the switch, checking the contact clearance with the arc chutes.

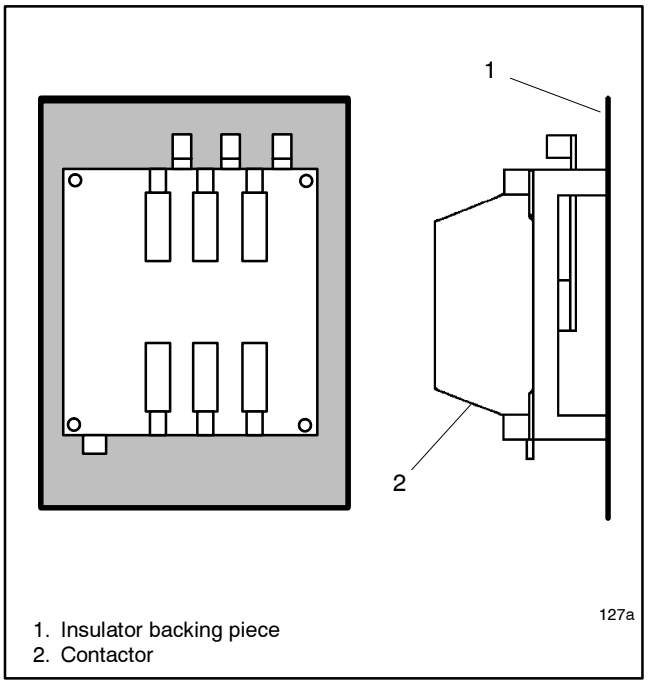
8. Install the barrier/pole cover: Place the cover against the arc chutes and use a Phillips screwdriver to install four screws in the cover.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

Note: To prevent the possibility of personal injury or property damage, be sure to install the insulator backing piece behind the transfer switch when reinstalling it. See Figure 6-6.



1. Insulator backing piece
2. Contactor

Figure 6-6 Insulator for 225–400 amp switches

6.3 Operator Coil Replacement

Replace the coil if inspection or test procedures show that the coil is burned out or shorted.

Coil Assembly Removal

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

The coil assembly is mounted to the top left corner of the base with two screws. Remove it and place it on a work bench for disassembly.

1. Close the top main contacts: Use the manual operator handle to put the switch in the Emergency position.

2. Disconnect the rectifier: Pull off the four terminal lugs from the square rectifier mounted on the coil frame, then bend the wire leads away from the coil assembly.

3. Remove the clip assembly: Use a 5/32 in. hex key wrench to remove (cw) two screws with lock washers from the frame, then remove the coil assembly.

   Note: Hold the coil assembly securely when removing the screws. The spring exerts substantial force on the coil assembly.

4. Remove the core spring: Leave the core and link hooked onto the weight pin, but remove the core spring from the core.

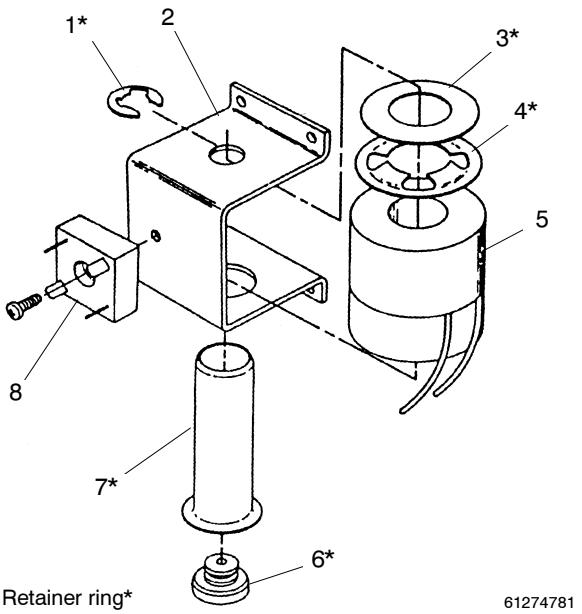
Coil Disassembly

The solenoid coil is held in the frame by the core tube. The retaining ring secures the core tube and stub core. Refer to Figure 6-7 during this procedure.

1. Remove the retaining ring: Use a screwdriver to pry the retaining ring out of the groove in the stub core, which extends through the frame.

2. Remove the core tube and stub core: Pull the core tube out through the other end of the frame. The stub core will come out with the core tube.

3. Remove the coil and washers: Pull the coil and washers out the side of the frame.



1. Retainer ring*
2. Frame
3. Spacer washer*
4. Spring washer*
5. Coil
6. Stub core*
7. Core tube*
8. Rectifier

* Parts included in the kit.

Figure 6-7 Coil Replacement

Coil Reassembly

Position the coil frame on its left side (rectifier on the left) on the workbench. The end of the frame with the large hole should be facing you. See Figure 6-7.

1. Install the new coil: Place a new coil (leads up and facing you), with washers at the far end, into the frame. Be sure the coil leads face the end of the frame with the large hole and that they face up.

2. Install the new core tube:

   a. Drop the stub core into the core tube so that it extends through the end of the tube.

   b. Align the holes in the coil, insulating washer, spring washer, and frame to accept the core tube.

   c. Insert the core tube with stub core through the frame, coil, spacer washer, and spring washer so that the stub core extends through the frame. Use a pencil or wood dowel in the core tube, if necessary, to push the stub core through the frame.

   Note: Do not insert any metal tool inside the core tube.

3. Install the retaining ring: Use pliers to slide the retaining ring into the groove in the stub core to secure the core tube in the frame.

4. Lubricate the core tube and spring: Apply lubricant (a mixture of Dow Corning #44 silicone grease and molybdenum disulfide powder, available from the manufacturer) to the inside of the core tube and to the new core spring. Then insert the spring into the core tube.

Coil Assembly Installation

1. Install the coil assembly:

   a. Place the coil assembly with core spring onto the solenoid core (still connected to the weight pin).

   b. Compress the spring with downward pressure while installing the two screws with a 5/32 in. hex key wrench.

   c. Tighten the screws to secure the coil assembly to the switch base. Note that only the lower left and upper right holes in the coil frame are used.

2. Replace the rectifier, if necessary:

   a. Remove the center screw to remove the rectifier.

   b. Install the new rectifier turned so its terminal with the *red dot* is on the upper left.

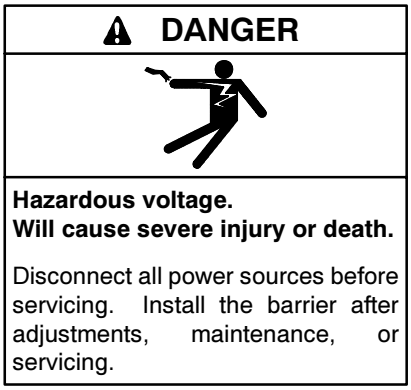
3. Reconnect the coil leads: Connect the coil leads, which have pink connectors, to the rectifier's push-on terminals marked with a *red dot* and *no dot* (DC + and – output).

4. Reconnect the rectifier: Connect the AC control leads, which have white connectors and come from the base, to the rectifier's push-on terminals marked with *yellow dots.*

5. Manually operate the switch:

   a. Use the manual handle to operate the switch to check the solenoid assembly. *The action should be smooth, without any binding.* If not, recheck the alignment of parts and the solenoid operator lubrication.

   b. Return the switch to the *Normal* position (top main contacts open). Then remove the manual handle and store it in the clips on the top left side of the switch.



Note: To prevent the possibility of personal injury or property damage, be sure to install the insulator backing piece behind the transfer switch when reinstalling it. See Figure 6-6.

6.4 Coil Control Contact Test and Adjustment

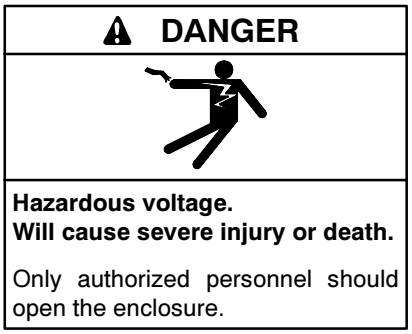
This section explains how to test and adjust the TS coil control contacts in 225–400 amp transfer switches. Only experienced electricians should test and adjust the switch. Observe all standard safety practices.

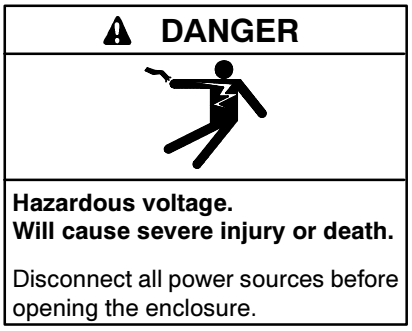
The TS coil control contacts control the duration of time that power is applied to the main solenoid operator (TS Coil). For proper operation, it is important that the contacts open at the proper time during the stroke of the solenoid. Improper adjustment will cause failure to operate at reduced voltages, failure of the main contacts to seat properly, and solenoid failure.

The manufacturer sets the TS coil control contacts so that the switch can operate satisfactorily over a voltage range of 80 to 110% of the nominal system voltage. The coil control contact settings may vary from switch to switch to accommodate minor variances in friction and tolerances.

6.4.1 Coil Control Contact Test

The adjustments are factory-sealed and usually do not require any change over the life of the switch. If it becomes necessary to check the settings in the field, follow the instructions in the Coil Control Contact Test Procedure. The settings can vary to the extremes and still provide acceptable operation. However, it is necessary that the coil control contacts always open *before* the solenoid core reaches top dead center (TDC).





Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Coil Control Contact Test Procedure

Note: When the normal source breaker opens, the engine start circuit closes, signalling the generator set engine to start and run.

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator

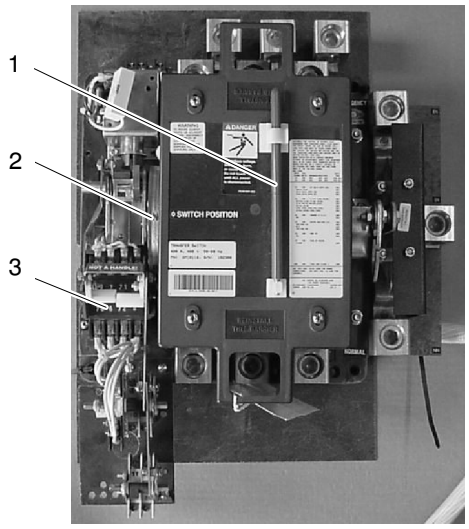
engine starting battery charger, if installed; and disconnecting all generator engine start batteries, negative (–) leads first.

2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch. Then use a voltmeter to verify that no voltage is present at the switch terminal lugs on both power sources.

3. Locate the TS coil control contact assembly. See Figure 6-8 .

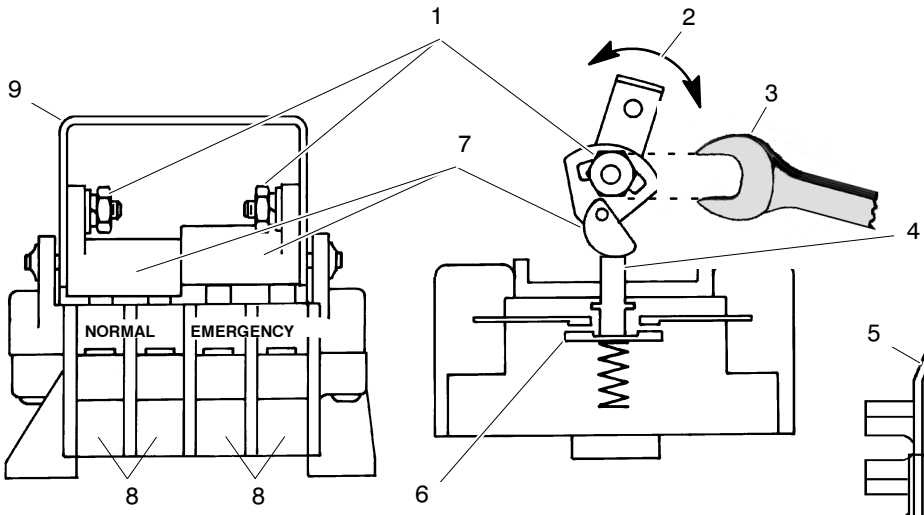
4. Check the settings of the TS control contacts:

   a. Refer to Figure 6-9. Two sets of contacts interrupt the control current to the solenoid operator coil (TS) in each direction (transfer to emergency and retransfer to normal). In Figure 6-9, the transfer switch is in the normal position and the coil control contacts for the emergency side are closed, ready to allow current to flow to the TS coil to transfer to the emergency source if the controller signals for transfer.



1. Manual operator handle storage location
2. Main position indicator: N=closed on normal, E=closed on emergency
3. TS coil contact control assembly

Figure 6-8 Transfer Switch, 225–400 Amp Models



1. Adjustment nut
2. Adjustment range
3. 11/32 in. open-end wrench
4. Operating button
5. Upper drive link
6. Typical contacts. The contacts open when the cam presses the operating button.
7. Cams
8. Control contact sets
9. Drive bracket

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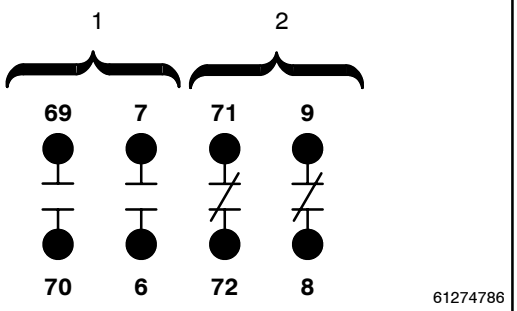
Figure 6-9 TS Control Contact Arrangement (transfer switch is in the normal position)

b. With power disconnected, use an ohmmeter (or a lamp-type continuity tester) across each contact while slowly turning the manual operator handle to determine when the control contacts open. (Refer to Section 6.1 for operating handle instructions.) Compare the contact operation to the positions given in Figure 6-11 and verify that both contacts open *before* the main solenoid operator core reaches top dead center. The pairs of coil clearing contacts do not have to operate simultaneously.

5. If any of the contacts require adjustment, use the following Contact Adjustment Procedures.



1. Contacts 69-70 and 7-6, for transfers to normal
2. Contacts 71-71 and 9-8, for transfers to emergency

Figure 6-10 TS Coil Control Contact Positions when the Transfer Switch is in the Normal Position

Condition	Control Contacts 71-72 & 9-8	Control Contacts 69-70 & 7-6
Main contacts in NORMAL position	Closed	Open
Main contacts in EMERGENCY position	Open	Closed
During transfer from N to E	Open before TDC	Close after TDC
During transfer from E to N	Close after TDC	Open before TDC
N=Normal Position **E**= Emergency **TDC**=Top Dead Center of solenoid core or main contact shaft rotation.		

Figure 6-11 Coil Control Contact Positions

6.4.2 Contact Adjustment

Contacts 71–72 and 9–8. Refer to Figure 6-12.

1. Use the manual operator handle, if necessary, to move the power switching device to the emergency position.

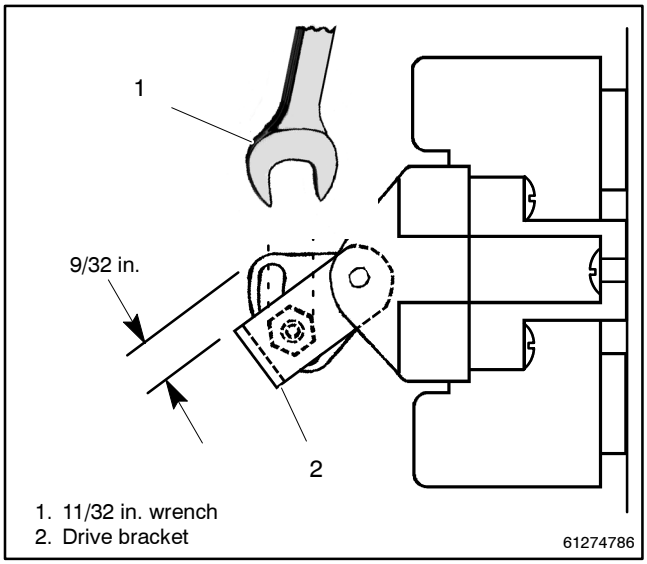
2. Loosen the #8-32 hex nut that unlocks the drive bracket from the cam adjustment slot on the right side of the assembly.

3. Rotate the cam until its top edge is within 9/32 in. from the side of the drive and stroke setting bracket.

4. Retighten the locking nut and verify the adjustment as described in the test procedure.

   Note: The setting shown in Figure 6-12 is satisfactory in most cases. However, to accommodate variances in tolerances, friction, and 80% minimum operating voltage, you can vary the setting over the range of adjustability provided that the control contacts maintain the positions shown in Figure 6-11.

5. Reconnect the engine start circuit.



1. 11/32 in. wrench
2. Drive bracket

Figure 6-12 Adjusting TS Control Contacts 71–72 and 9–8. (View from the right side. Main transfer switch contacts must be closed on emergency side.)

Contacts 69–70 and 7–6. Refer to Figure 6-13.

1. Use the manual operator handle, if necessary, to move the power switching device to the NORMAL position.

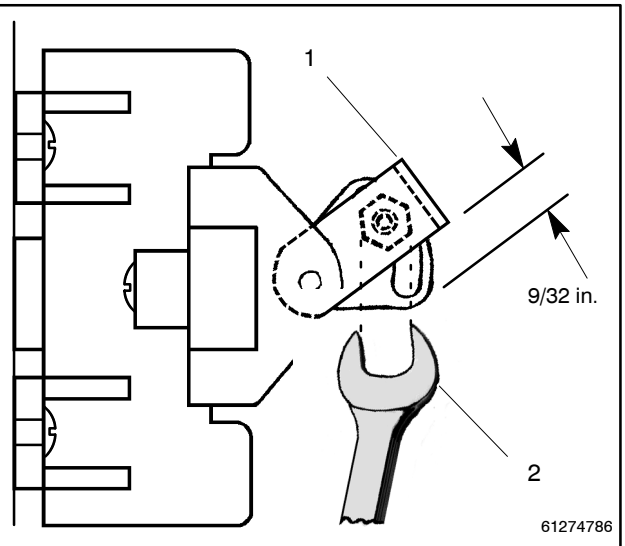
2. Loosen the #8-32 hex nut that unlocks the drive bracket from the cam adjustment slot on the left side of the assembly.

3. Rotate the cam until its bottom edge is within 9/32 in. from the side of the drive bracket.

4. Retighten the locking nut and verify the adjustment as described in the test procedure.

   Note: The setting shown in Figure 6-13 is satisfactory in most cases. However, to accommodate variances in tolerances, friction, and 80% minimum operating voltage, you can vary the setting over the range of adjustability provided that the control contacts maintain the positions shown in Figure 6-11.

5. Reconnect the engine start circuit.



1. Drive bracket
2. 11/32 in. wrench

Figure 6-13 Figure 5. Adjusting TS Control Contacts 69–70 and 7–6 (view from the left side; main transfer switch contacts must be closed on normal side)

6.4.3 Coil Control Contact Replacement

Under normal conditions the TS control contacts do not require replacement over the life of the transfer switch. If replacement becomes necessary, Use the following procedure.

Note: Always check wiring and connections before replacing components.

TS Control Contact Replacement Procedure

1. Disconnect all power to the transfer switch as instructed in the *Test and Adjustment Procedure.*

2. Refer to Figure 6-14. Disconnect the upper drive link by removing the #10–32 shoulder screw, lock washer, and hex nut from the left side of the drive bracket on the control contact assembly. Then reinstall the hardware onto the loose linkage for safekeeping.

3. Disconnect the lower drive link by removing the #10–32 allen head screw and locknut from the right side of the drive bracket. Then reinstall the hardware into the loose link for safekeeping.

4. Verify that the wires connected to the control contact assembly are marked so they can be identified after being disconnected. Add labels if necessary.

5. Disconnect the labeled wires from the control contact assembly.

   Note: Do not pull on the wires. Use a screwdriver to pry off the connectors. Pulling may damage the crimped wire connection.

6. Remove three #8 Phillips head self-tapping screws from the mounting feet and remove the control contact assembly.

7. Install the new control contact assembly onto the switch base. Apply one drop of Loctite® to each mounting screw thread to reform the self-tapping holes and secure the assembly.

8. Reconnect the lower drive link to the drive bracket (right side) with the #10–32 allen head screw and locknut. Check for free play between the locknut and drive link.

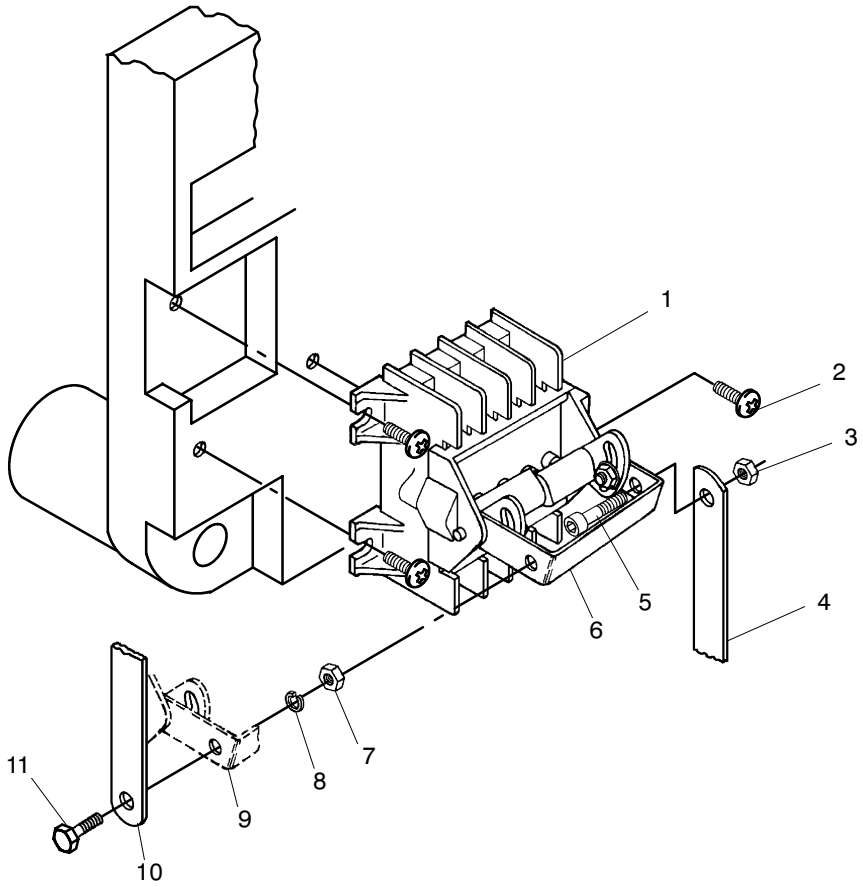
9. Reconnect the upper drive link to the left side of the drive bracket on the control contact assembly with the #10–32 shoulder screw, split lock washer, and hex nut. Check for free play between screw head and drive bracket.

* Loctite is a registered trademark of the Loctite Corporation.

10. Manually operate the drive linkage. The action should be smooth without any binding. Verify that the cams properly operate the pushbuttons on the control and auxiliary contact assemblies.

11. Reconnect the eight labeled wires to the proper terminals.

12. Check the control contact adjustment. See the test and adjustment procedures in Sections 6.4.1 and 6.4.2 .



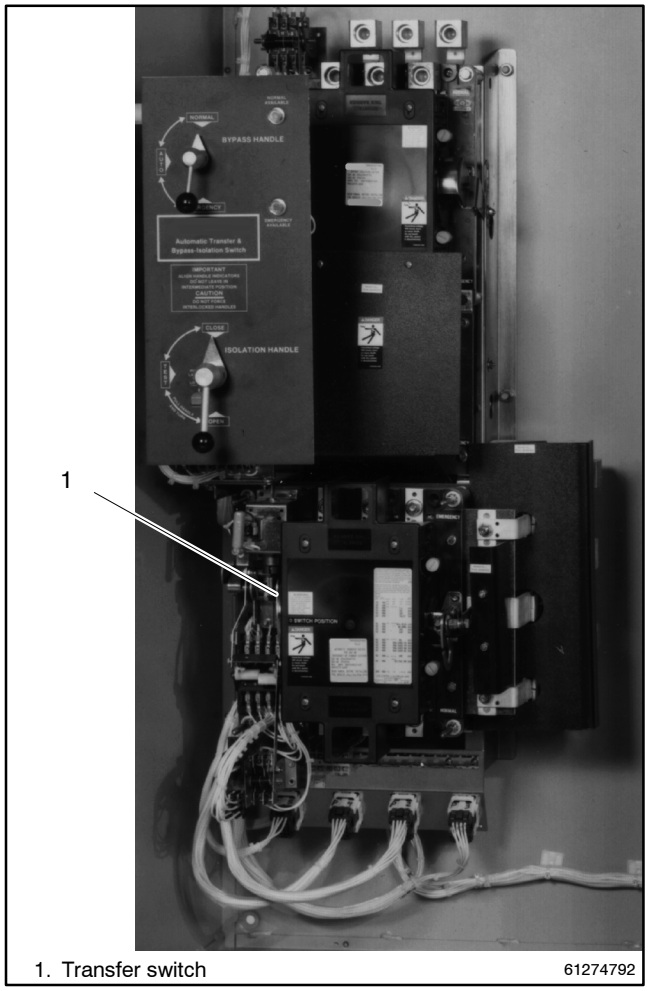
1. TS control contact assembly
2. Phillips head self-tapping mounting screws
3. Locknut, 10-32
4. Lower drive link
5. Allen head screw, 10-32
6. Drive bracket
7. Hex nut
8. Lock washer
9. Drive bracket
10. Upper drive link
11. Shoulder screw, 10-32

Figure 6-14 Figure 6. TS Control Contact Assembly Replacement

Section 7 150–400 Amp Programmed-Transition Transfer Switches and Bypass/Isolation Switches

This section explains how to replace the transfer switch main contacts and operator coil in 150–400 amp bypass/isolation switches and programmed-transition transfer switches (standard or bypass models). This section also contains instructions for adjusting and replacing the control contacts in 150–400 amp bypass/isolation switches.

Figure 7-1 and Figure 7-2 show typical bypass/isolation switches.



1. Transfer switch

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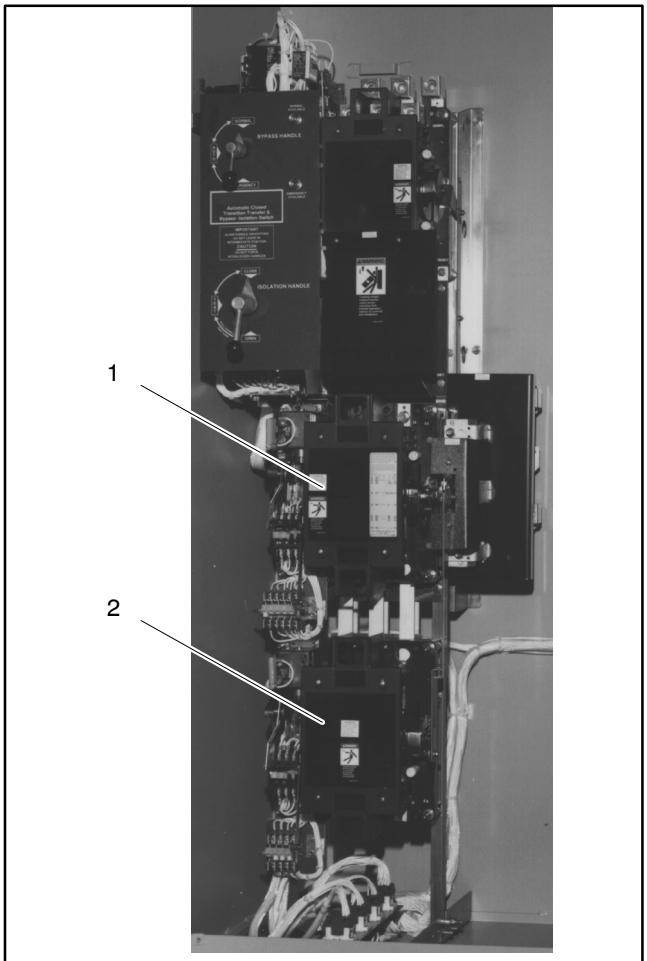
Figure 7-1 Typical Bypass/Isolation Switch



1. Upper transfer switch
2. Lower transfer switch

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Figure 7-2 Typical Programmed-Transition Bypass/Isolation Switch

7.1 Manual Operation

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

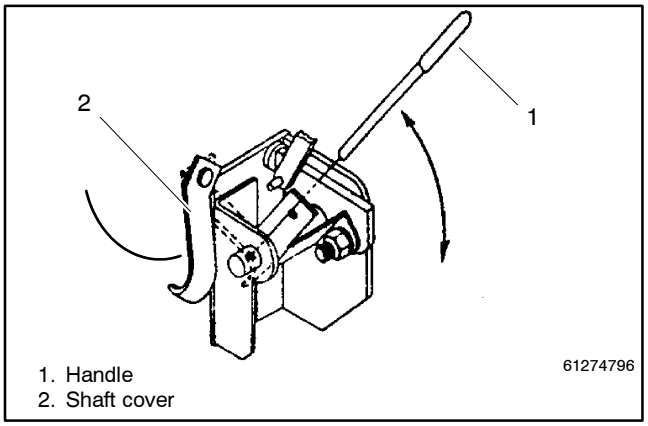
Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

A detachable manual operator handle is provided *for maintenance purposes only.* The handle is stored on the upper left side of the switch.

Note: Bypass and isolate the transfer switch before manually operating it. See the bypass/isolation switch Operation and Installation Manual for instructions.

Swing the shaft cover to the left out of the way. Insert the manual handle into the hole in the shaft, left side of the operator. See Figure 7-3. Move the handle down and up to manually operate the switch, as needed, in the following maintenance procedures.



1. Handle
2. Shaft cover

Figure 7-3 Manual Operator Handle

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

Swing the shaft cover over the shaft after removing the manual operator handle.

7.2 Main Contact Replacement

Refer to the transfer switch Parts Catalog for instructions to obtain replacement parts.

Tools Needed

- Phillips screwdriver
- Blade screwdriver
- 5/32” hex key wrench
- 5/16” nutdriver
- 9/16” nutdriver or socket wrench
- 11/32” open-end wrench
- Torque wrench (100 in-lb)
- Torque wrench (240 in-lb, 20 ft-lb)
- Voltmeter
- Ohmmeter (or continuity tester)
- Pliers
- Cotton swab or small brush
- Pencil or wood dowel
- Ruler

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

Follow these instructions to remove the barrier/pole cover and arc chutes and gain access to the main contacts.

1. Remove the barrier/pole cover: Use a Phillips screwdriver to remove the four cover screws. Then remove the cover.

2. Remove all arc chutes: Use a blade screwdriver to remove the nylon retainer nuts on both sides of each chute. Then tip the chute toward the shaft while pulling it away from the panel. Place the arc chutes in a safe place.

7.2.1 Movable Contacts

Disassembly

The movable contacts are mounted in the shaft. They are secured to the shunts by screws and held in place by the contact spring retainer. See Figure 7-4.

1. Remove the contact spring retainer. Use a 5/16" nutdriver to remove four # 10-32 hex head (Sems) screws with shake washers from the shaft, then remove the retainer.

   Note: The retainer is under spring pressure. Hold the retainer with one hand and loosen all four screws equally to release the retainer pressure.

2. Remove all contact springs. Pull off contact springs from heads of screws.

3. Remove all movable contacts. Remove the 1/4-20 screws with lockwashers from the contacts by using a 5/32" hex key wrench. Then remove the contacts and contact stiffeners.

Reassembly

Reassemble as shown in Figure 7-4.

1. Apply conductive lubricant to shunt lugs. Use a cotton swab or small brush to apply conductive lubricant to the exposed surface of each shunt lug in the shaft.

   Note: Failure to use conductive lubricant between the shunt lug and contact may cause overheating.

2. Install new movable contacts. Place a new contact on the shaft and secure it to the shunt lug with the 1/4-20 screw and lockwasher. Each screw passes through the movable contact and contact stiffener, into the shunt lug. Tighten the screw by using a 5/32" hex key wrench to 100 in-lb.

   Note: To prevent overheating, torque the movable contact screw to 100 in-lbs. To prevent binding, check the contact for free movement in shaft.

3. Install new contact springs. Press a new spring onto the head of each screw that secures a movable contact.

4. Install the contact spring retainer. Place the spring retainer onto the springs so that they seat into the cavities of the retainer. Compress the springs with the retainer and hold it in position. Use a 5/16" nutdriver to install the four # 10-32 hex head (Sems) screws with shake washers to secure the spring retainer to the shaft. Tighten the screws.

5. Check contact deflection. Lift the tip of each movable contact to verify freedom of movement in the shaft. If there is binding, loosen the contact screw enough to reposition the shunt lug slightly, then retighten the screw to proper torque. Recheck deflection.

6. Install all arc chutes. Tip the arc chute while placing it over the stationary contact. Slide the arc chute toward the shaft (up or down) until it stops. Then position it so that it is centered over the stationary contact, and so the movable contact does not strike the arc chute plates. Secure the arc chute to the panel by using a blade screwdriver to install nylon retainer nuts on both sides of arch chute. Torque the nuts to 12-14 in lbs.

7. Slowly operate the switch with the manual handle (see Figure 1). Check contact clearance with the arc chutes.

8. Install barrier/pole cover. Place the cover against the arc chutes. Use a Phillips screwdriver to install the four cover screws.

9. Reinstall the transfer switch. Refer to Section 3 of the Operator's Manual (*Reinstallation* and *Return to Service*).

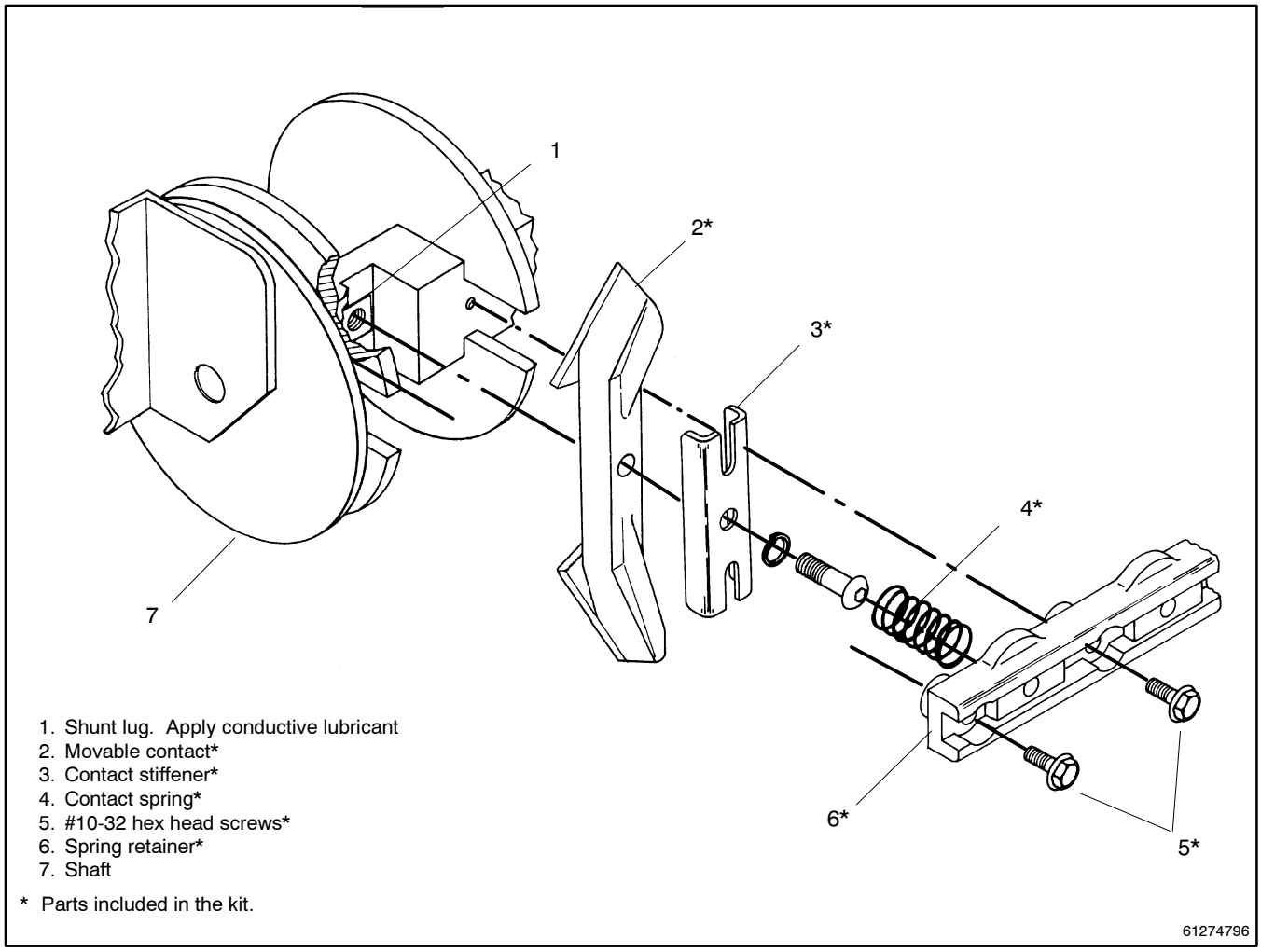


Figure 7-4 Figure 2. Movable contact.

7.2.2 Stationary Contacts

Disassembly

The stationary contacts are mounted in the molded base. They are secured from the back and bolted to the isolation stabs. See Figure 7-5.

1. Remove all arc runner screws. Use a Phillips screwdriver to remove the screw from each arc runner. Remove the arc runner by pulling it away from the contact button.

2. Remove all stationary contacts. Remove the nut and bolt by using a 9/16" open-end wrench and a 9/16" socket wrench. Also remove the two hex nuts from the threaded studs by using a 7/16" socket wrench, then remove the stationary contact from the molded base.

Reassembly

Reassemble as shown in Figure 7-5.

1. Install new stationary contacts. Insert each new stationary contact into the molded base and secure it by installing two hex nuts with flat washers behind the base. Use a 7/16" socket wrench to tighten the nuts.

2. Reconnect the isolation stabs. From the back of the molded base, insert the bolt with flat washers through the isolation stab, bushing, and stationary contact. Secure the connection with the hardware shown in Figure 3. Then use a 9/16" socket wrench and torque wrench to tighten to 20 ft-lbs or 240 in-lbs.

   Note: To prevent overheating, tighten the stationary contact to the isolation stab connection to 20 ft-lbs or 240 in-lbs torque.

3. Install new arc runners. Install each arc runner flat against the plate by using a Phillips screwdriver to install two screws. Be sure that the formed side is out, and that the jaws are on both sides of the contact button.

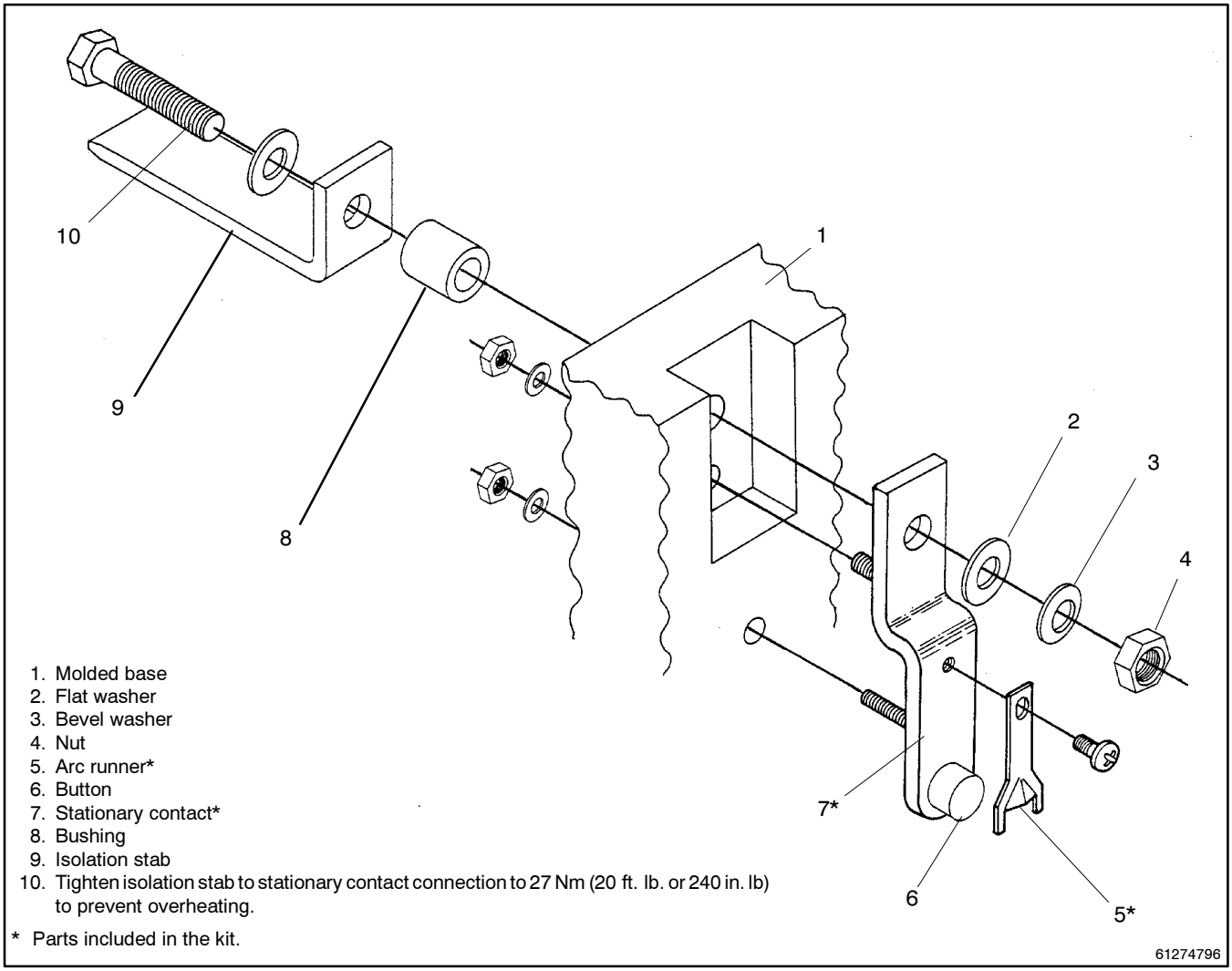


Figure 7-5 Stationary Contact. [Tighten connection to 27 Nm (20 ft. lbs.) to prevent overheatng.]

7.3 Operator Coil Replacement

Refer to th transfer switch Parts Catalog for instructions to obtain replacement parts.

7.3.1 Removing the Coil Assembly

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

The coil assembly is mounted to the top left corner of the base with two screws. Follow these steps to remove the coil assembly and place it on a work bench for disassembly.

1. Close the top main contacts. Use the manual operator handle to put the switch in the *Emergency* position.

2. Disconnect the rectifier. Pull off the four terminal lugs from the square rectifier mounted on the coil frame, then bend the wire leads away from the coil assembly.

3. Remove the clip assembly. Use a 5/32" hex key wrench to remove two screws with lockwashers from the frame, then remove the coil assembly.

   Note: To prevent the possibility of personal injury or property damage, hold the coil assembly securely when removing screws. The spring exerts substantial force on the coil assembly.

4. Remove the core spring. Leave the core and link hooked onto the weight pin, but remove the core spring from the core.

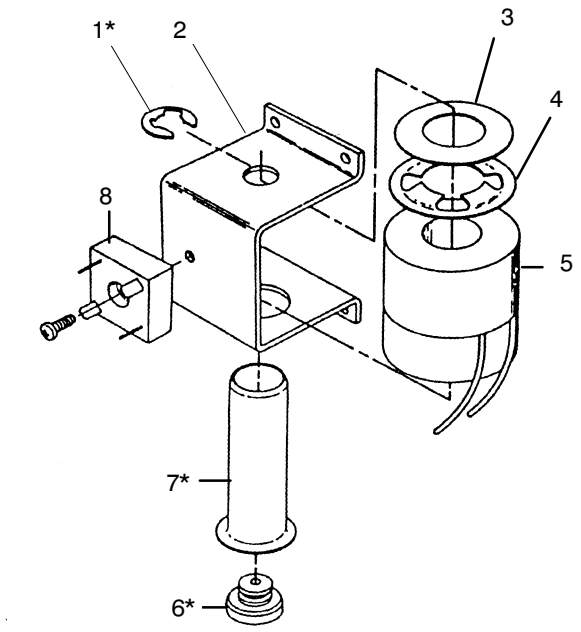
7.3.2 Disassembly

The solenoid coil is held in the frame by the core tube. The retaining ring secures the core tube and stub core. See Figure 4.

1. Remove the retaining ring. Use a blade screwdriver to pry the retaining ring out of the groove in the stub core that extends through the frame.

2. Remove the core tube and stub core. Pull the core tube out through the other end of the frame. The stub core will come out with the core tube.

3. Remove the coil and washers. Pull the coil and washers out the side of the frame.



1. Retainer ring*
2. Frame
3. Spacer washer*
4. Spring washer*
5. Coil
6. Stub core*
7. Core tube*
8. Rectifier

* Parts included in the kit.

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Figure 7-6 Coil Replacement

7.3.3 Reassembly

Position the coil frame on its left side (rectifier on the left) on the workbench. The end of the frame with the large hole should be facing you. See Figure 7-6.

1. Install the new coil: Place a new coil (leads up and facing you), with washers at the far end, into the frame. Be sure the coil leads face the end of the frame with the large hole and that they face up.

2. Install the new core tube: Drop the stub core into the core tube so that it extends through the end of the tube. Align the holes in the coil, insulating washer, spring washer, and frame to accept the core tube. Insert the core tube with stub core through the frame, coil, spacer washer, and spring washer so that the stub core extends through the frame. Use a pencil or wood dowel in the core tube, if necessary, to push the stub core through the frame.

   Note: *Do not insert any metal tool inside the core tube.*

3. Install the retaining ring: Use pliers to slide the retaining ring into the groove in the stub core to secure the core tube in the frame.

4. Lubricate the core tube and spring: Apply lubricant from *lubrication kit* 331800 to the inside of the core tube and to the new core spring. Then insert the spring into the core tube.

7.3.4 Installing Coil Assembly

1. Install the coil assembly: Place the coil assembly with core spring onto the solenoid core (still connected to the weight pin). Compress the spring with downward pressure while installing the two screws with a 5/32" hex key wrench. Tighten the screws to secure the coil assembly to the switch base. Note that only the lower left and upper right holes in the coil frame are used.

2. Replace the rectifier, if necessary. Remove the center screw to remove the rectifier and install the new rectifier turned so its terminal with the *red dot* is on the upper left.

3. Reconnect the coil leads. Connect the coil leads with pink lugs to the rectifier's push-on terminals marked with a *red dot* and *no dot* (DC + and - output).

4. Reconnect the rectifier. Connect the AC control leads with white lugs (from the base) to the rectifier's push-on terminals marked with *yellow dots.*

5. Use the manual handle to operate the switch to check the solenoid assembly (see Figure 1). *The action should be smooth, without any binding.* If not, recheck alignment of parts and lubrication in the solenoid operator. Return the switch to the *Normal* position (top main contacts open). Then remove the manual handle and store it in the clips on the top left side of the switch.

6. Reinstall the transfer switch. Refer to the bypass/isolation switch Operation and Installation manual.

7.4 Control Contact Test & Adjustment

This section explains how to test and adjust the TS Coil Control Contacts. The TS Control Contacts control the duration of time that power is applied to the main solenoid operator (TS Coil). To assure proper operation, it is important that the contacts open at the proper time during the stroke of the solenoid. Improper adjustment will cause failure to operate at reduced voltages, failure of the main contacts to properly seat, and solenoid failure.

The TS Control Contacts are factory set with an adjustable power supply so that the switch can operate satisfactorily over a voltage range of 80 to 110% of the nominal system voltage. To accommodate minor variances in friction and tolerances, it is not unusual for the control contact settings to vary from switch to switch.

The adjustments are factory sealed and usually do not require any change over the life of the switch. If it should become necessary to check adjustments in the field, an approximation can be made by using the following procedure. The adjustments can vary to the extremes and still provide acceptable operation. However, it is important that the TS Control Contacts always open ***BEFORE*** top-dead-center is reached by the solenoid core.

7.4.1 Test and Adjustment Procedure

⚠ DANGER

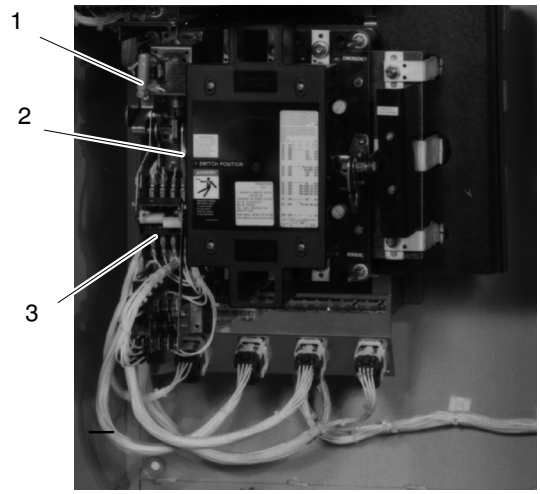
Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

1. Bypass, isolate, and remove the transfer switch. See the Operation and Installation Manual.
2. Locate the TS control contact assembly. See Figure 7-7.



1. Manual operator handle storage
2. Main position indicator:
   N=closed on normal
   E=closed on emergency
3. TS control contact assembly

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Figure 7-7 Control Contact Assembly Location

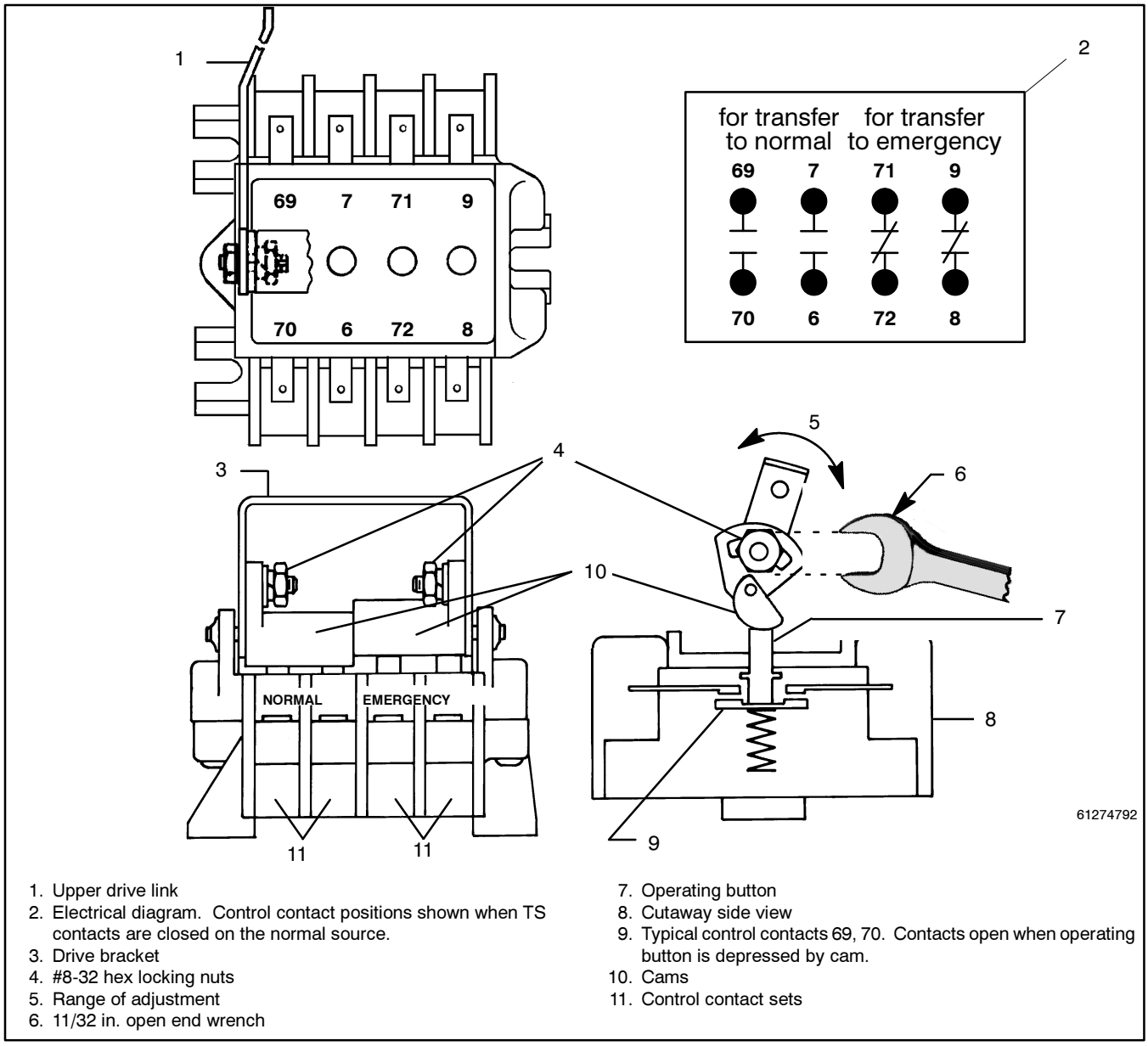
3. To verify settings and field adjust the TS control contacts, proceed as follows:

   a. Refer to Figure 7-9. Two sets of contacts interrupt the control current to the solenoid operator coil (TS) in each direction (transfer to emergency and retransfer to normal). The pairs of coil clearing contacts do not have to operate simultaneously, but both must break the circuit ***BEFORE*** the main solenoid operator core reaches top-dead-center. See Figure 7-8 for control contact positions.

Condition	Control Contacts 71–72 & 9–8	Control Contacts 69–70 & 7–6
Main contacts closed on N	Closed	Open
Main contacts closed on E	Open	Closed
During transfer from N to E	Open before TDC	Close after TDC
During transfer from E to N	Close after TDC	Open before TDC

N=Normal position **E=**Emergency position
TDC=Top dead center of solenoid core or main contact shaft.

Figure 7-8 Control Contact Positions



1. Upper drive link
2. Electrical diagram. Control contact positions shown when TS contacts are closed on the normal source.
3. Drive bracket
4. #8-32 hex locking nuts
5. Range of adjustment
6. 11/32 in. open end wrench
7. Operating button
8. Cutaway side view
9. Typical control contacts 69, 70. Contacts open when operating button is depressed by cam.
10. Cams
11. Control contact sets

Figure 7-9 TS Control Contact Arrangement.

b. With power disconnected, use an ohmmeter (or a lamp type continuity tester) across each contact to determine when the control contacts open while slowly turning the manual operator handle. Refer to Section 7.1, Manual Operation, for operating handle instructions.

c. If adjustment of contacts 71–72 and 9–8 is necessary, refer to Figure 7-10. Make sure the main contacts of the transfer switch are closed on emergency (see position indicator in Figure 7-7). Use the manual operator handle, if necessary, to move the switch to the emergency position. Loosen the #8–32 hex nut that unlocks the drive bracket from the cam adjustment slot on the right side of the assembly. Rotate the cam until its top edge is within 7.1 mm (9/32 in.) from the side of the drive bracket. Retighten the locking nut and verify adjustment as described in step 4, sections a and b.

d. If adjustment of contacts 69–70 and 7–6 is necessary, refer to Figure 7-11. Make sure the main contacts of transfer switch are closed on the normal side (see position indicator in Figure 7-7). Use the manual operator handle, if necessary to move the switch to the normal position. Loosen the 8–32 hex nut that unlocks the drive bracket from the cam adjustment slot on the left side of the assembly. Rotate the cam until its bottom edge is within 7 mm (9/32 in.) from the side of the drive bracket. Retighten the locking nut and verify adjustment as described in step 4, sections a and b.

e. The settings shown in Figure 7-10 and Figure 7-11 are satisfactory in most cases. However, settings can vary over the range of adjustability to accommodate variances in tolerances, friction, and 80% minimum operating voltage provided that the control contact positions as shown in Figure 7-8 are maintained.

f. Reinstall the transfer switch. Refer to the Operator's Manual.

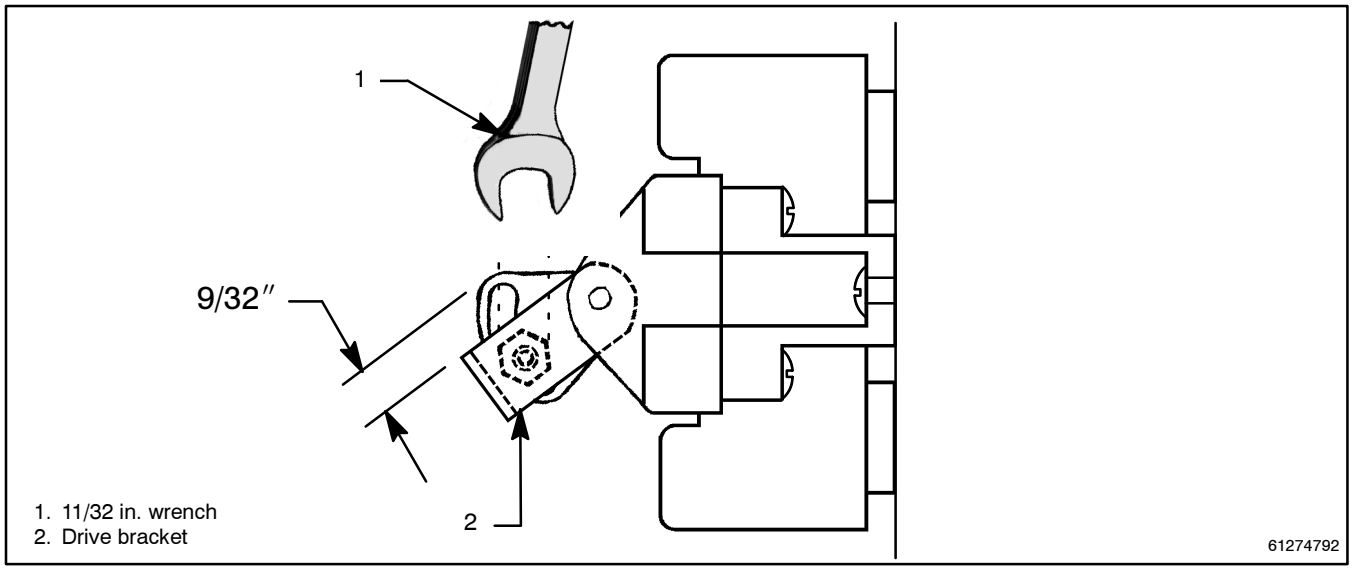


Figure 7-10 Adjusting TS Control Contacts 71-72 and 9-8. View from right side of TS control contact assembly. Main transfer switch contacts must be closed on emergency side.

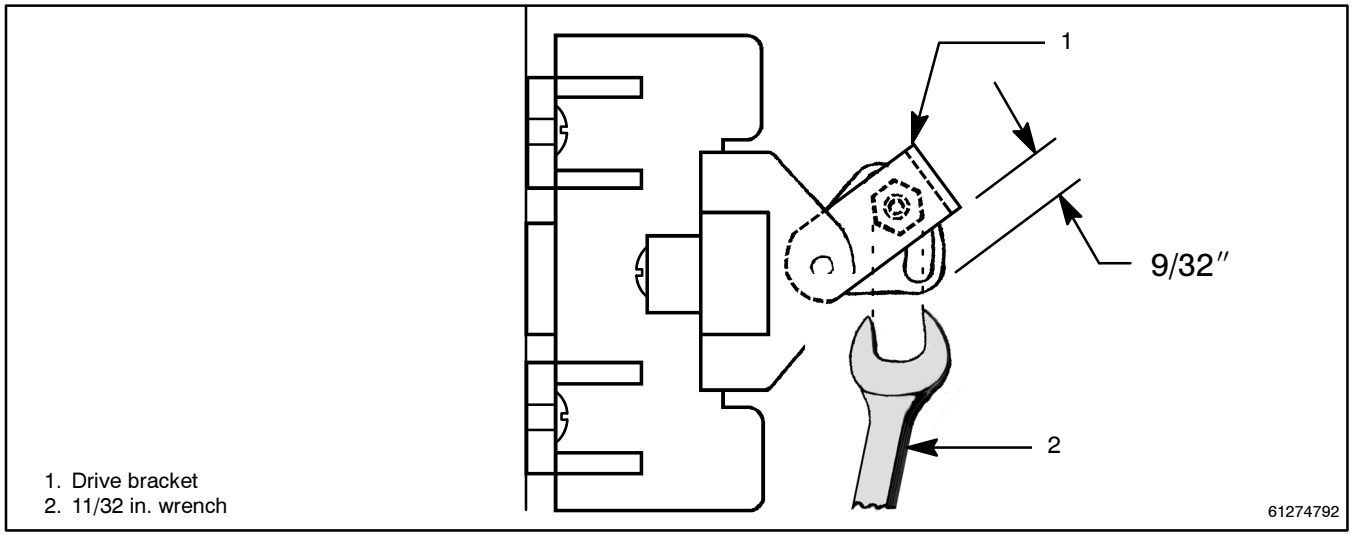


Figure 7-11 Adjusting TS Control Contacts 69-70 and 7-6. View from left side of TS control contact assembly. Main transfer switch contacts must be closed on normal side.

7.4.2 Test Control Contact Replacement

Under normal conditions the TS control contacts do not require replacement over the life of the transfer switch. If replacement becomes necessary, proceed as follows:

1. Bypass, isolate, and remove the transfer switch. See the Operation and Installation Manual.

2. Refer to Figure 7-12. Disconnect the upper drive link by removing the #10-32 shoulder screw, lockwasher, and hex nut from the left side of the drive bracket on the control contact assembly. Then reinstall the hardware into the loose linkage for safekeeping.

3. Disconnect the lower drive link by removing the #10-32 allen head screw and locknut from the right side of the drive bracket. Then reinstall the hardware into the loose link for safekeeping.

4. Check to assure that the leads connected to the control contact assembly are marked so they can be identified after being disconnected. Add labels if necessary.

5. Disconnect the labeled leads from the control contact assembly.

   Note: Do not pull on the leads. Pry off connectors with a screw driver. Pulling may damage the crimped wire connection.

6. Remove three #8 Phillips head self-tapping screws from the mounting feet and remove the control contact assembly.

7. Install new control contact assembly onto switch base. Apply one drop of Loctite® to each mounting screw thread to reform self tapping holes and secure assembly.

8. Reconnect the lower drive link to the drive bracket (right side) with the #10-32 allen head screw and locknut. Check for free play between the locknut and drive link.

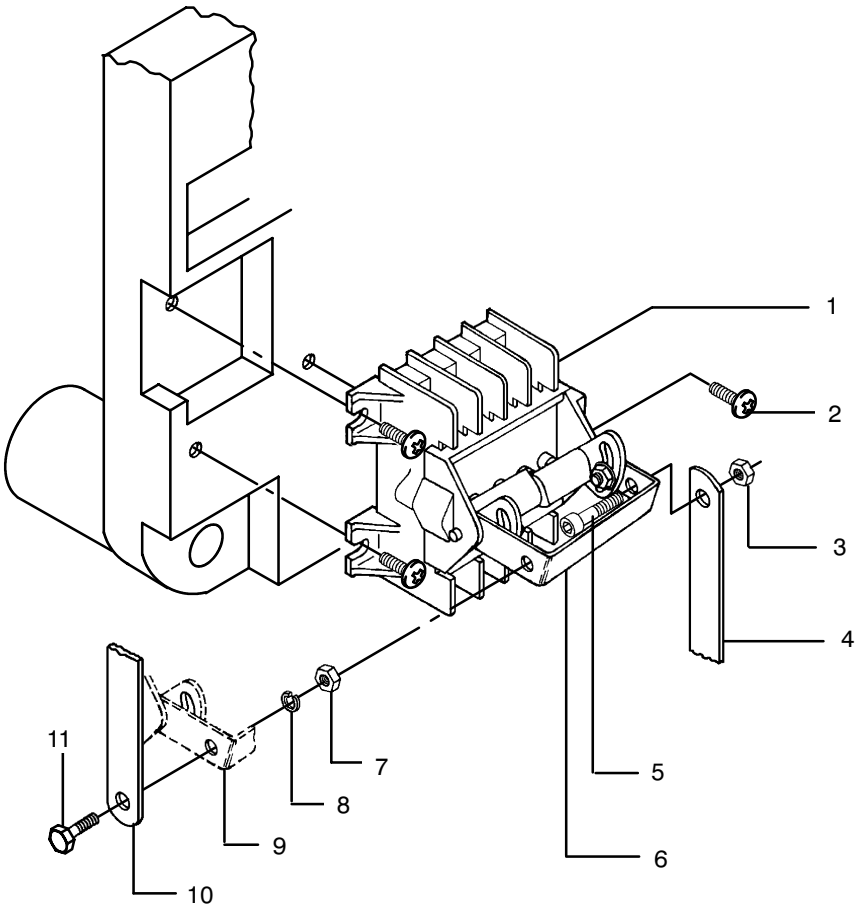
9. Reconnect the upper drive link to the left side of the drive bracket on the control contact assembly with the #10-32 shoulder screw, split lockwasher, and hex nut. Check for free play between screw head and drive bracket.

10. Manually operate the drive linkage. The action should be smooth without any binding. Be sure the cams properly operate the pushbuttons on the control and auxiliary contact assemblies.

11. Reconnect the eight labeled leads to the proper terminals.

12. Check the control contact adjustment. See Section 7.4.1, Test and Adjustment Procedure.

* Loctite is a registered trademark of the Loctite Corporation.



1. TS control contact assembly
2. Phillips head self-tapping mouniting scrrews (3 ea.)
3. #10–32 locknut
4. lower drive link
5. #10-32 allen head screw
6. Drive bracket
7. Hex nut
8. Lockwasher
9. Drive bracket
10. Upper drive link
11. #10-32 shoulder screw

Figure 7-12 TS Control Contact Assembly Replacement

This section explains how to replace the arcing and main contacts and the solenoid coil and assembly in 600–1200 amp transfer switches.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Tools Needed

- Safety glasses (for eye protection)
- Straight blade 6 in. screwdriver, 1/4–3/8 in.
- Short handle blade screwdriver
- Ratchet drive, 3/8 in., 6 in. and 12 in. extensions
- Sockets, 3/8 in., 1/2 in., 9/16 in.
- Open-end or box wrenches, 3/8, 7/16, 9/16, and 1/2 in.
- Nutdriver, 5/8 in.
- Torque wrench, 0 to 20 ft. lb. (240 in. lb.)
- Needlenose and regular pliers
- Wire labels

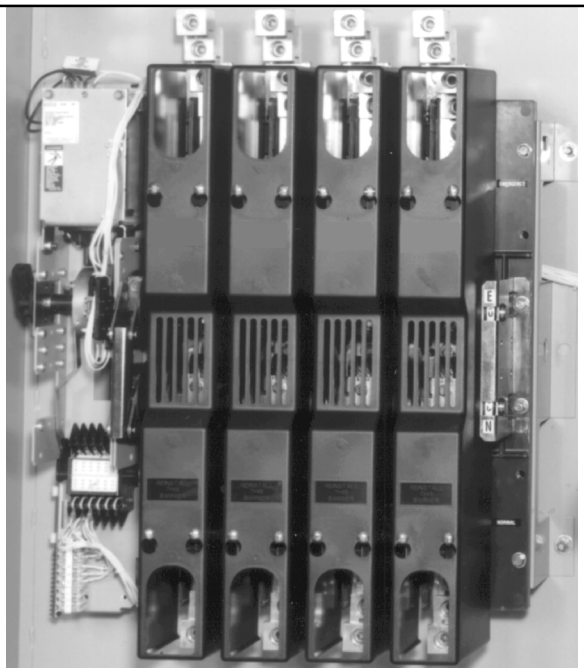


Figure 8-1 600 Amp Transfer Switch (3-pole with switched neutral shown; 600 amp has two-barrel terminal lugs)

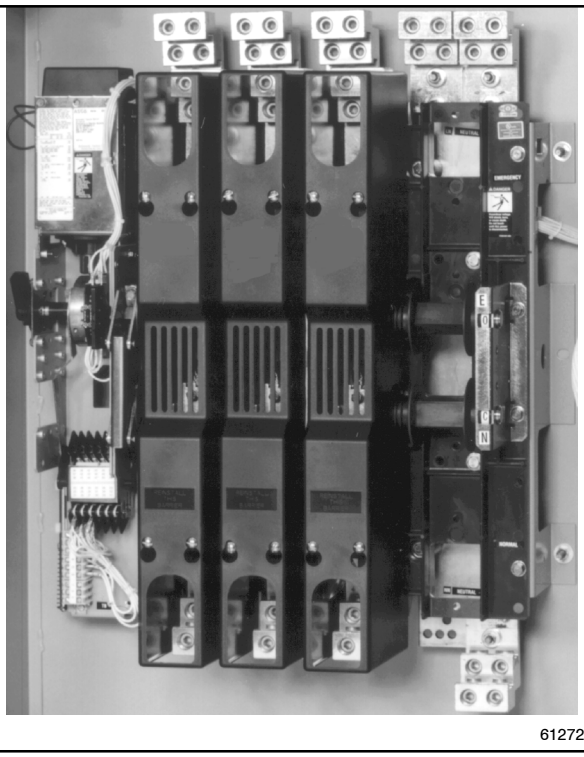


Figure 8-2 800–1200 Amp. Transfer Switch (3-pole with solid neutral shown)

8.1 Maintenance Handle

A detachable maintenance handle is provided on the frame of the transfer switch *for maintenance purposes only*. After the transfer switch is completely deenergized, this handle can be used to change the position of the contacts and operator mechanism. The windows in the right side of the transfer switch frame indicate which contacts are open and closed.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

Manual Operation Procedure

1. Deenergize the transfer switch. After deenergizing both power sources, open the enclosure door. Use a voltmeter to verify that no electrical power is present at the transfer switch terminals.

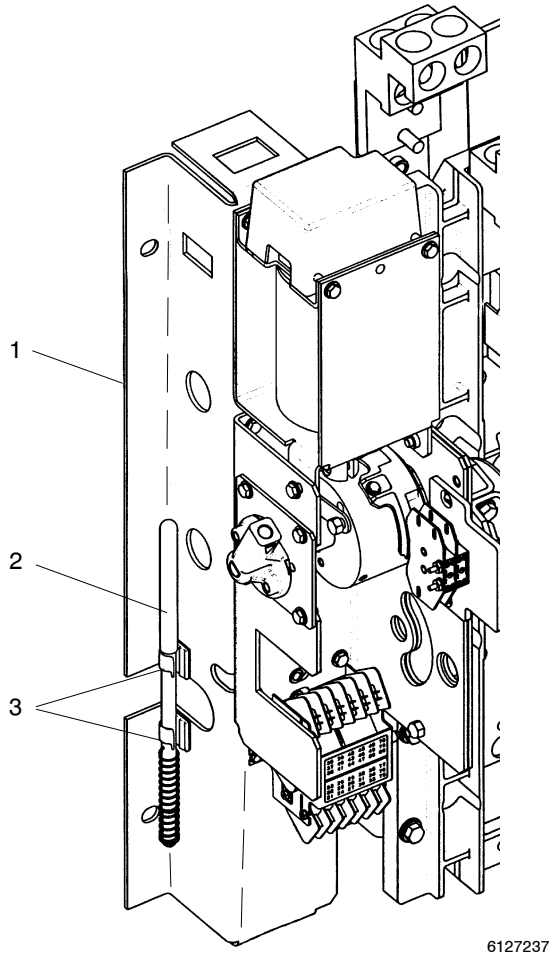
2. Install the maintenance handle. Locate and remove the maintenance handle from clips on the left side of the transfer switch frame. Insert the handle into the molded hub on the left side of the operator. See Figure 8-4, Figure 8-3, and Figure 8-5**.**

3. Move the maintenance handle up or down as shown to manually operate the transfer switch to the opposite position.

   Note: If Normal and Emergency connections are reversed this operation is also reversed.

4. Return the transfer switch to the Normal position. Observe that the window indicators (right side) show the top shaft O (open) and the bottom shaft C (closed).

5. Remove the maintenance handle and store it on the frame (left side) in the clips provided.



1. Transfer switch, left side
2. Maintenance handle
3. Storage clips

Figure 8-3 Maintenance Handle and Storage Clips

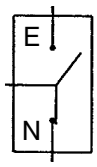
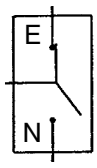
ATS Position		Handle	Indicators
Normal			E = O upper contacts open N = C lower contacts closed
Emergency			E = C upper contacts closed N = O lower contacts open

Figure 8-4 Maintenance Handle Positions

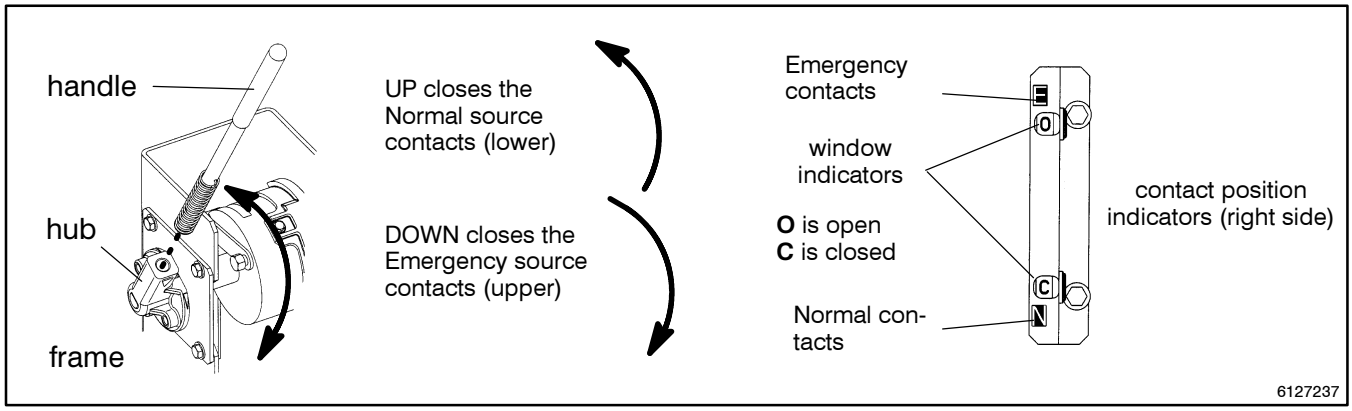


Figure 8-5 Maintenance Handle Operation and Contact Position Indicators

8.2 Main and Arcing Contact Replacement

8.2.1 Arc Chute and Barrier Removal

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

The contact assemblies (two for each pole) are located to the right of the operator mechanism.

1. Deenergize the transfer switch. After deenergizing both power sources, open the enclosure door. Use a voltmeter to verify that no electrical power is present at the transfer switch terminals.

2. Use the maintenance handle (if necessary). Open the contacts that will be replaced (if not already open). See Section 8.1.

3. Remove the interphase barriers (one per pole). Use a blade screwdriver to loosen four round head screws holding each barrier to the arc chutes. Slide the barrier up until the keyholes clear the round head screws, then remove the barrier. See Figure 8-8.

4. Remove the arc chutes. Use a 5/8 in. nutdriver to remove the two long insulator nuts. Then pull the arc chute outward (off the long threaded rods). See Figure 8-8.

5. Remove the movable contact cover. Use your thumb and fingers to squeeze the sides inward until the contact cover is released from the shaft clamp (both sides). Then remove the movable contact cover. See Figure 8-6 and Figure 8-7.

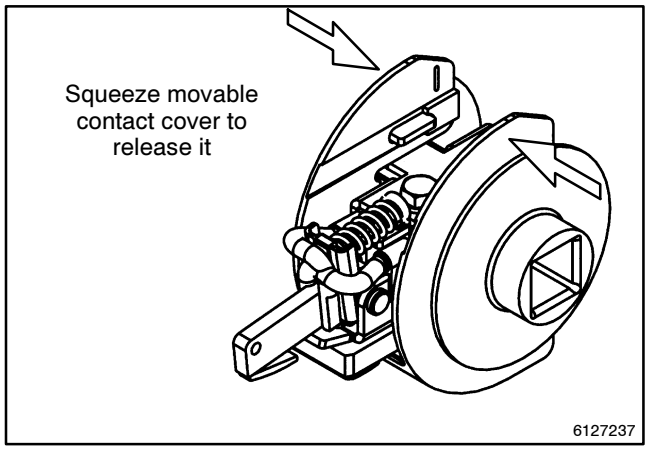
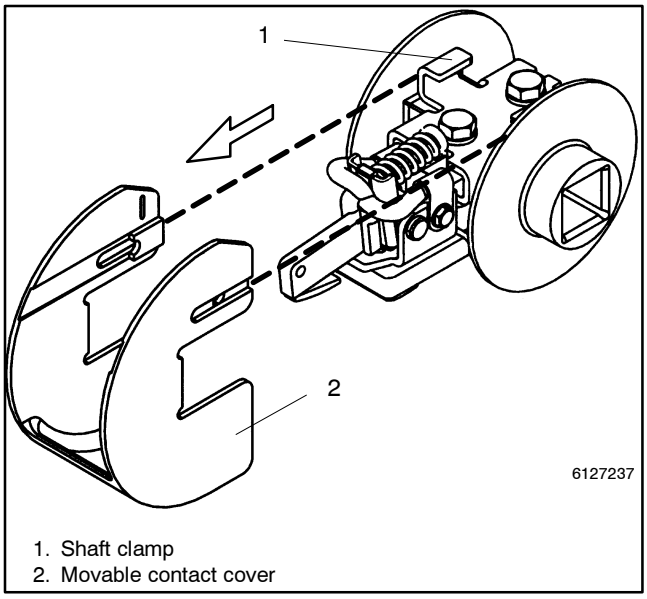
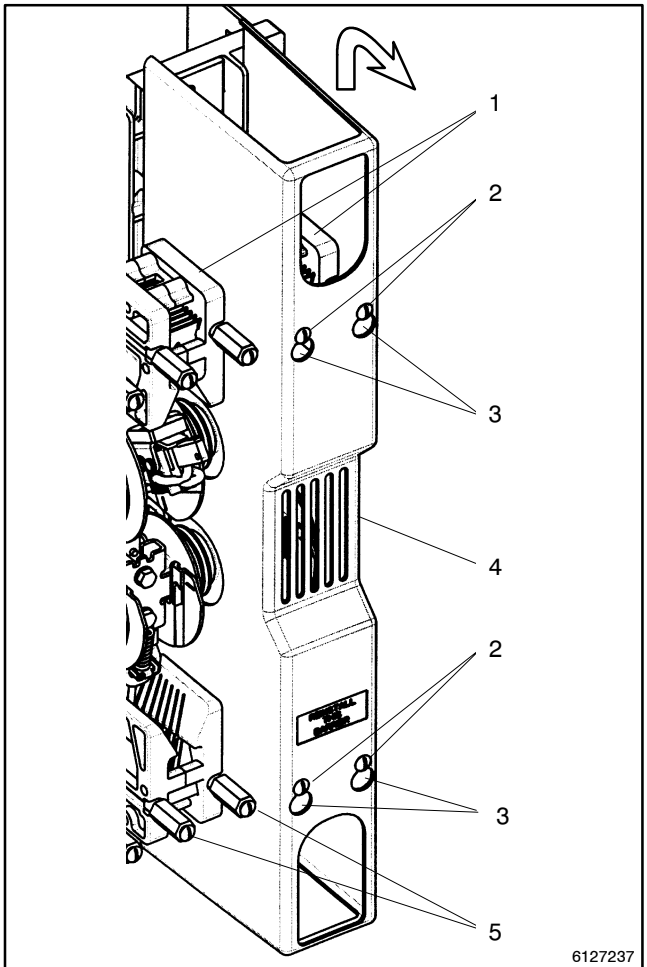


Figure 8-6 Movable Contact Cover Release



1. Shaft clamp
2. Movable contact cover

Figure 8-7 Movable Contact Cover Removal



1. Arc chutes
2. Loosen round head screws (do not remove)
3. Keyslots
4. Barrier
5. Insulator nuts

Figure 8-8 Interphase Barrier Removal

8.2.2 Contact Inspection

The main contacts are protected by arcing contacts. The arcing contacts make first and break last to avoid arcing at the main contacts. Contact condition should be checked annually. Contacts should be replaced when contact material becomes severely worn. Discoloration is normal. Do not file contacts because it wastes material. Instead use light emery paper to clean the contact surfaces. If the main contacts require replacement, follow the procedure for *Main and Arcing Contact Assembly Replacement*. If only the arcing contacts require replacement, follow the procedure for *Arcing Contact Replacement*.

Open the contacts that will be replaced (if not already open) by using the maintenance handle. See Section 8.1.

8.2.3 Movable Arcing Contacts

Arcing Contacts *make* first and *break* last during load transfer. They protect the main contacts.

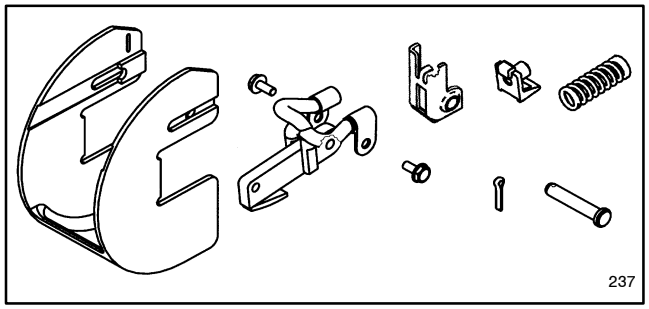


Figure 8-9 Replacement Movable Arcing Contact Kit (Kit includes 1 movable arcing contact with cover, arcing contact spring, spring bracket, spring retainer, and hardware. A 3-pole switch requires 6 kits.)

Movable Arcing Contact Replacement Procedure

⚠ WARNING

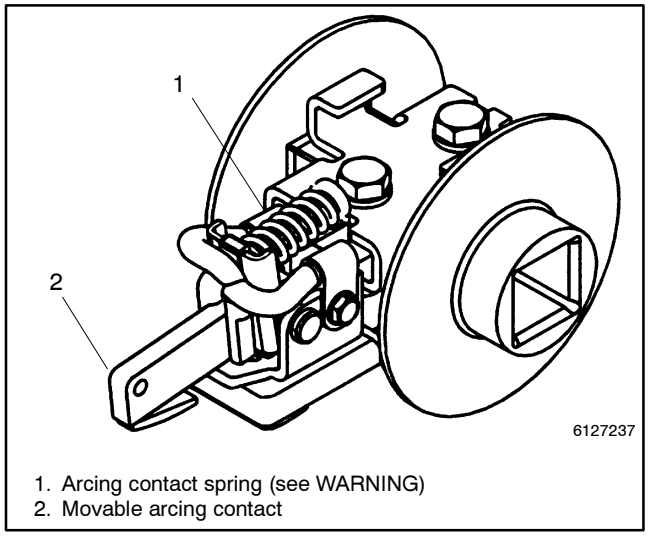
Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Note: To prevent the possibility of eye injury, wear safety glasses when removing the arcing contact spring. The spring may fly off if not held securely.

1. Remove the movable contact cover. See Section 8.2.1.

2. Remove the movable arcing contact spring. Use a screwdriver (or spring compressor) to carefully release the movable arcing contact spring from the tab on the shaft clamp. *See the note above!* Then remove the spring and spring retainer. See Figure 8-11.



1. Arcing contact spring (see WARNING)
2. Movable arcing contact

Figure 8-10 Movable Contact Assembly

3. Disconnect the movable arcing contact shunts. Use a 5/16 in. open-end or box wrench to remove two SEMS screws that secure the movable arcing contact shunts to the pivot bracket. See Figure 8-11.

4. Remove the pivot pin from the pivot bracket. Use needlenose pliers to straighten and remove the cotter pin that secures the pivot pin. Then remove the pivot pin, spring bracket, and movable arcing contact. See Figure 8-11.

5. Install the new movable arcing contact. Install the new spring bracket into the pivot bracket. Then insert the new movable arcing contact into the slot of the spring bracket. Next insert the new pivot pin through the pivot bracket, spring bracket, and movable arcing contact. Install the new cotter pin into the end of the pivot pin (spread or bend the cotter pin to secure the assembly). See Figure 8-11.

6. Connect the new movable arcing contact shunts. Install two SEMS screws (#10-32 3/8 in.) to connect the two shunts of the new movable arcing contact to the pivot bracket. Tighten the screws with a 5/16 in. open-end or box wrench. See Figure 8-11.

   Note: To prevent the possibility of eye injury, wear safety glasses when installing the new arcing contact spring. The spring may fly off if not held securely.

7. Install the new movable arcing contact spring. Install the new spring retainer onto the tab on the spring bracket. Then use a screwdriver (or spring compressor) to carefully install the new movable arcing contact spring between the spring retainer and the tab on the shaft clamp. See Figure 8-11.

8. Install the new movable contact cover onto the movable contact assembly. Use your thumb and fingers to squeeze the sides inward until the contact cover is latched onto the metal bracket (both sides). See Figure 8-6 and Figure 8-7.

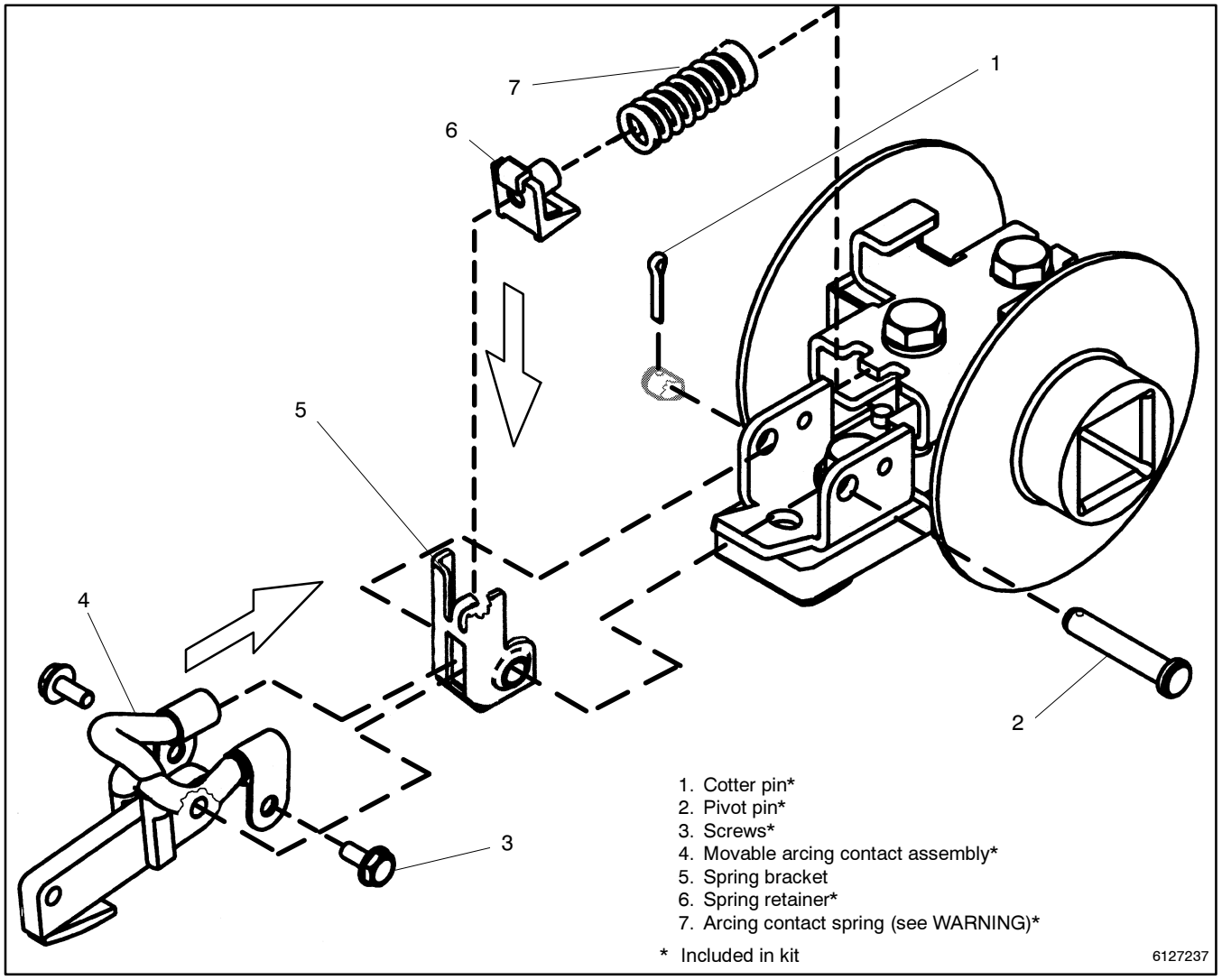


Figure 8-11 Movable Arcing Contact Assembly

8.2.4 Movable Main Contacts

Main contacts *make* last and *break* first during load transfer. They carry the electrical load.

Replacement movable main contacts are available as part of the Movable Contact Assembly, which includes the main contact and the arcing contact.

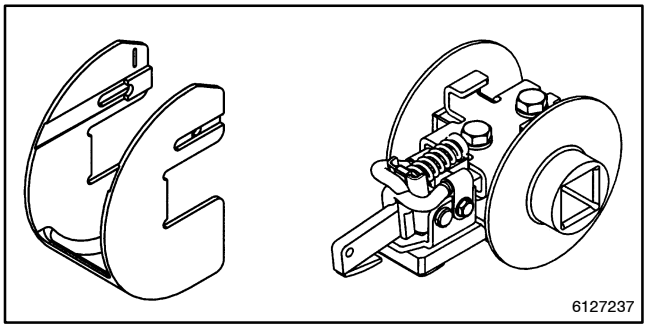


Figure 8-12 Replacement Movable Contact Kit (Kit includes 1 movable contact with cover and main shunt hardware. A 3-pole switch requires 6 kits.)

Movable Arcing/Main Contact Replacement Procedure

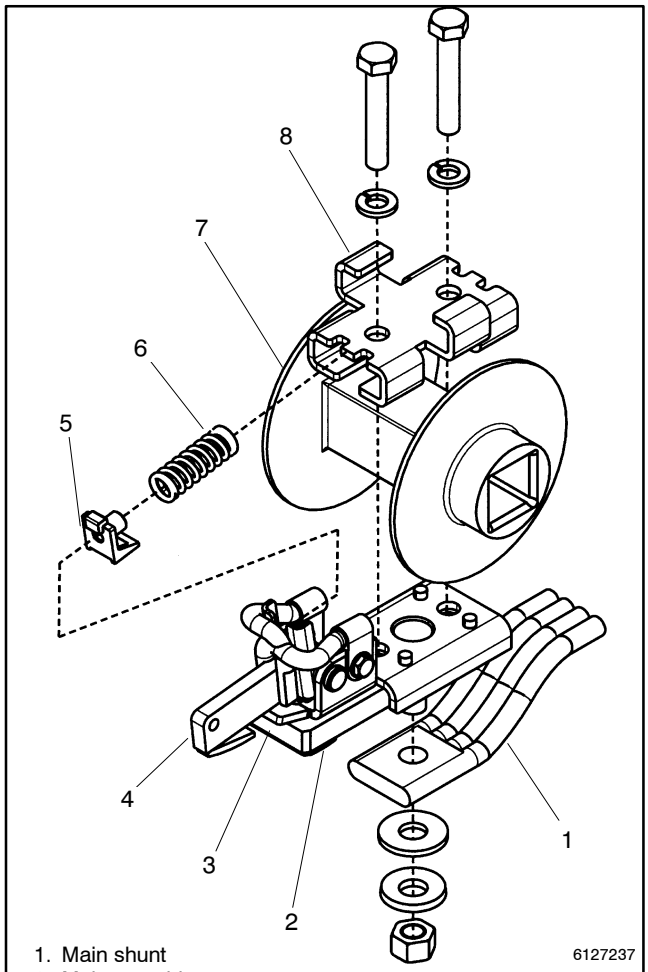
⚠ WARNING

Airborne particles.
Can cause severe injury or blindness.

Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

1. Remove the movable contact cover. See page 3.
2. Disconnect the main shunt. Use a 3/8 in. open-end or box wrench to remove the hex nut (with disc and flat washers) that secures the main shunt to the bottom of the main movable contact assembly. See Figure 8-13.

   Note: To prevent the possibility of eye injury, wear safety glasses when removing the arcing contact spring. The spring may fly off if not held securely.
3. Remove the movable arcing contact spring. Use a screwdriver (or spring compressor) to carefully release the movable arcing contact spring from the tab on the metal bracket. See the WARNING first! Then remove the spring and spring retainer. See Figure 8-13.



1. Main shunt
2. Main movable contact
3. Movable arcing and main contact assembly*
4. Movable arcing contact
5. Spring retainer*
6. Arcing contact spring (see WARNING)*
7. Shaft insulator; replace only if badly damaged
8. Shaft clamp*

* Included in kit

Figure 8-13 Movable Main Contact Assembly

4. Disconnect the main shunt. Use a 3/8 in. open-end or box wrench to remove the hex nut (with disc and flat washers) that secures the main shunt to the bottom of the main movable contact assembly. See Figure 8-13.
5. Remove the shaft clamp and movable contact assembly. Use a 5/16 in. socket wrench to remove the two hex head bolts (with lock washers) that secure the movable contact assembly and shaft clamp to the shaft. See Figure 8-13.

Note: Replacing the shaft insulator is usually unnecessary. If it is badly damaged, contact the manufacturer of DDC/MTU Power Generation products for assistance. Disassembly and readjustment of the main contact shaft will be required.

6. Install the new movable contact assembly. Position the new movable contact assembly under the shaft (align protrusions on both side). Secure it by installing the new shaft clamp and the new 5/16-18 x 1 3/4 in. long hex head bolts with split lock washers. Tighten both bolts to 5 ft. lb., then continue tightening them to 11 ft. lb. See Figure 8-13.

7. Reconnect the main shunt. Make sure the main shunt and new movable contact assembly surfaces are clean (do not use any abrasive). Position the main shunt under the movable contact assembly (onto the stud) and secure it with a new 3/8 in. flat washer, new 3/8 in. disc washer (curved surface toward nut), and new 3/8 in. hex nut. Use a 3/8 in. open-end or box wrench to tighten nut (cw). See Figure 8-13.

   Note: To prevent the possibility of eye injury, wear safety glasses when installing the new arcing contact spring. The spring may fly off if not held securely.

8. Install the new movable arcing contact spring. Install the new spring retainer onto the tab on the spring bracket. Then use a screwdriver (or spring compressor) to carefully install the new movable arcing contact spring between spring retainer and the tab on the shaft clamp. See Figure 8-13. See the the Note above first!

9. Install the new movable contact cover. Install the new movable contact cover onto the movable contact assembly. Use your thumb and fingers to squeeze the sides inward until the contact cover is latched onto the metal bracket (both sides). See Figure 8-6 and Figure 8-7.

8.2.5 Stationary Arcing Contacts

Figure 8-14 shows the replacement stationary arcing contact kit. Refer to the ATS Parts Catalog for instructions to obtain replacement parts.

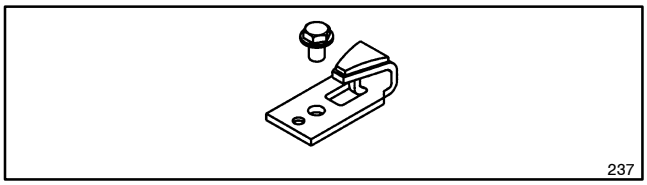


Figure 8-14 Replacement Stationary Arcing Contact Kit (Includes 1 stationary arcing contact and mounting screw. 3-pole switch requires 6 kits.)

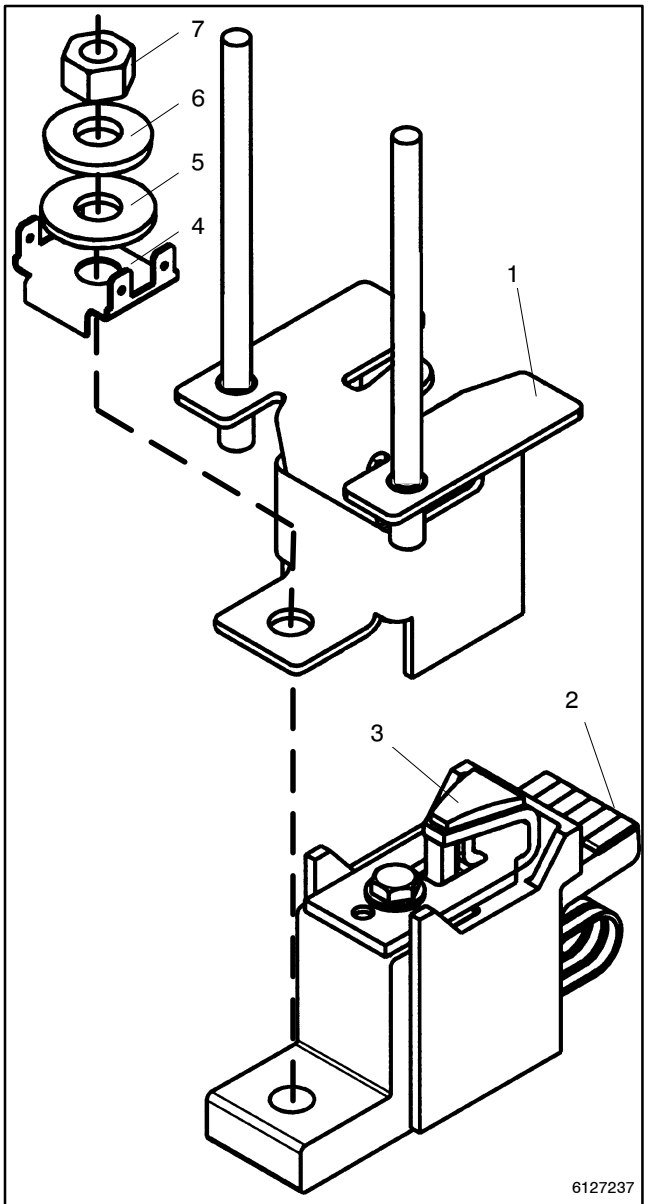
Stationary Arcing Contact Replacement Procedure

1. Remove the stationary contact assembly. Use a 3/8 in. socket wrench with 12 in. extension to remove the hex nut from the base of the stationary contact assembly. Then remove the washers, quick connect terminal plate, and stationary contact assembly from the stud in the bus plate. See Figure 8-15.

2. Remove the stationary arcing contact. Use a 3/8 in. socket wrench to remove the hex head (SEMS) screw, then remove the stationary arcing contact. See Figure 8-16.

3. Install the new stationary arcing contact. Make sure the arcing contact and contact block surfaces are clean (do not use any abrasive). Use a 3/8 in. socket wrench to install a new hex head screw (SEMS 1/4-20 x 3/8 in. long) and a new stationary arcing contact onto the contact block. The rectangular protrusion should align with the rectangular hole in the arcing contact. Tighten the screw to 7.5 Nm [5.5 ft. lb. (66 in. lb.)]. See Figure 8-16.

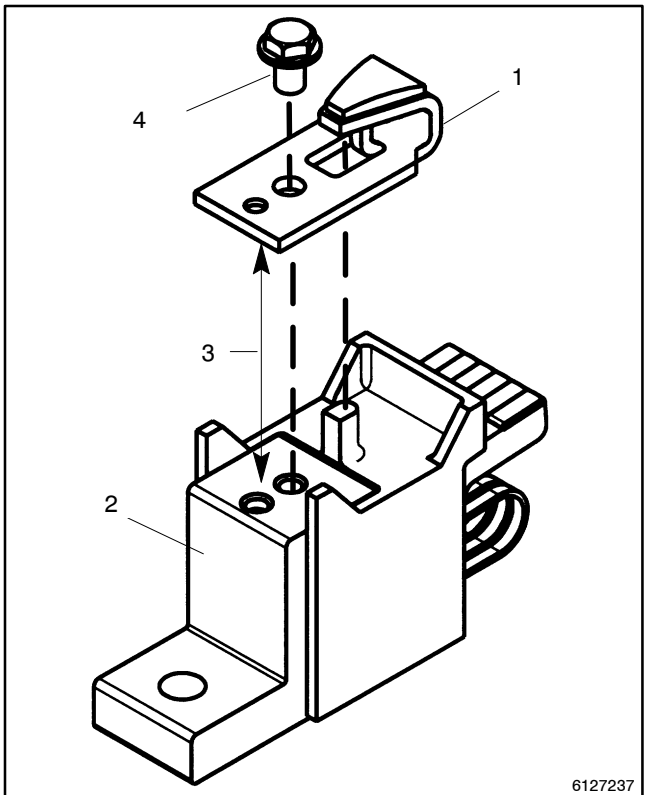
   Note: Torque the stationary arcing contact mounting screw to 7.5 Nm [5.5 ft. lb. (66 in. lb.)] to prevent overheating at the contact block.



1. Arc chute mounting bracket
2. Main contacts
3. Arcing contact
4. Terminal plate
5. Flat washer
6. Disc washer
7. Hex nut

Note: Tighten hex nut to 20 ft. lb. (240 in. lb.)

Figure 8-15 Stationary Contact Assembly



1. Arcing contact*
2. Contact block
3. These surfaces must be clean
4. SEMS screw (1/4-20 x 3/8 in. long)*
   Tighten to 7.5 Nm [5.5 ft. lb. (66 in. lb.)]

* Included in kit

Figure 8-16 Stationary Arcing Contact

4. Reinstall the stationary contact assembly. Make sure the bus plate and contact assembly surfaces are clean (do not use any abrasive). Position the stationary contact assembly onto the stud in the bus plate. Use a 3/8 in. socket wrench with 12 in. extension to install the quick connect terminal plate, heavy flat washer, new heavy disc washer (curved surface out), and 3/8 in. hex nut to secure the assembly. Tighten to 27.1 Nm (20 ft. lb.) torque. See Figure 8-13.

   Note: Torque the stationary contact assembly nut to 27.1 Nm (20 ft. lb.) to prevent overheating at the bus plate.

8.2.6 Stationary Contact Assembly Replacement

Replacement stationary contacts (arcing and main) are available as an assembly. See Figure 8-17.

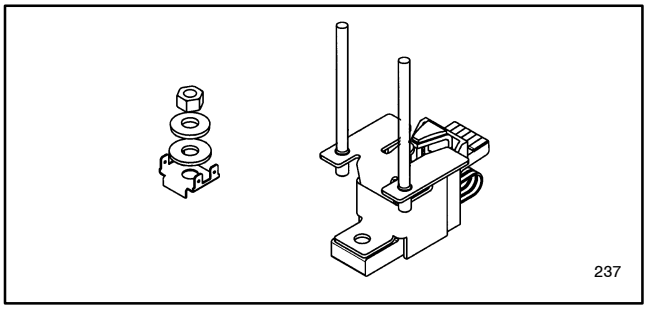


Figure 8-17 Replacement Stationary Contact Kit (Includes 1 stationary main and arcing contact assembly with arc chute bracket and mounting hardware. A 3-pole switch requires 6 kits.)

Stationary Contact Assembly Replacement Procedure

1. Remove the stationary contact assembly. Use a 3/8 in. socket wrench with 12 in. extension to remove the hex nut from the base of the stationary contact assembly. Then remove the washers, quick connect terminal plate, and stationary contact assembly from the stud in the bus plate. See Figure 8-15.

2. Install the new stationary contact assembly. Make sure the bus plate and contact assembly surfaces are clean (do not use any abrasive). Position the new stationary contact assembly onto the stud in the bus plate. Use a 3/8 in. socket wrench with 12 in. extension to install the new quick connect terminal plate, new heavy flat washer, new heavy disc washer (curved surface out), and new 3/8 in. hex nut to secure the assembly. Tighten to 27.1 Nm (20 ft. lb.) torque. See Figure 8-15.

8.2.7 Arc Chute and Barrier Reinstallation

After the arcing or main contacts are replaced, reinstall the arc chutes and interphase barriers as described in the following procedure.

1. Check the arc chute mounting rods. Make sure the two threaded rods are installed in the arc chute support plate. They should extend out from the plate no more than 82 mm (3.25 in.). The two treaded rods should have thread sealant to hold the proper length. See Figure 8-18.

2. Reinstall the arc chute. Slide the arc chute (arc splitters toward the contacts and recess for nuts outward) between the two long threaded rods. Reinstall the two long insulator nuts (round shoulder in) and use a 5/8 in. nutdriver to GENTLY tighten until snug. Do not overtighten these nuts. See Section 8.2.1.

3. Reinstall the interphase barrier. Install the barrier over the arc chutes and slide it up until the four round head screws align in the four keyholes in the barrier. Then slide the barrier down. Use a blade screwdriver to tighten the four round head screws to secure the barrier to the arc chute insulator nuts. See Section 8.2.1.

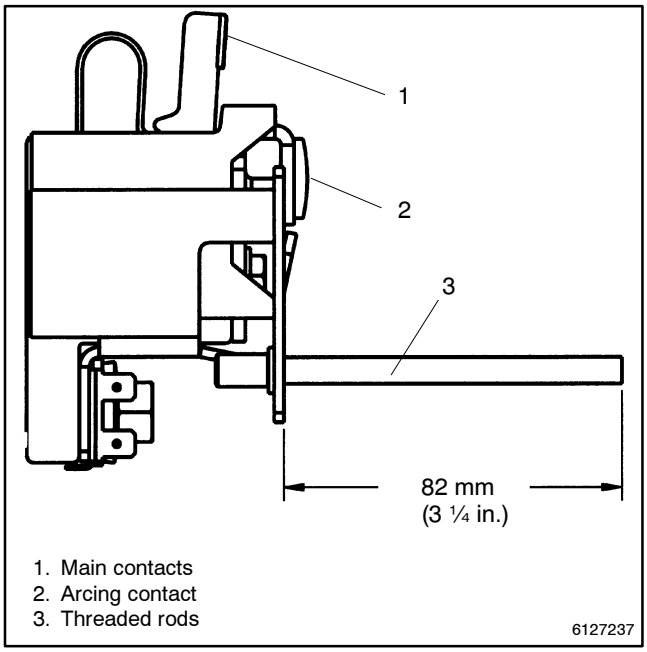


Figure 8-18 Threaded Rods For Arc Chutes

8.3 Solenoid Coil and Solenoid Assembly Replacement

See Figure 8-19 for the solenoid assembly location.

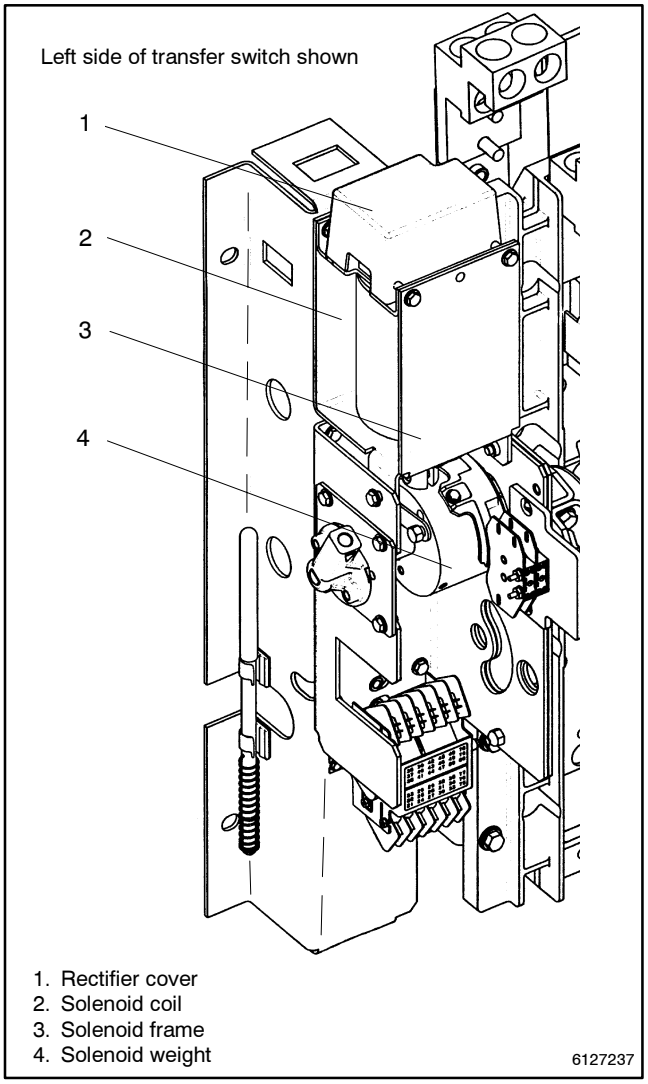


Figure 8-19 Solenoid Operator Assembly

8.3.1 Solenoid Coil Replacement

Solenoid coil kits include only the coil. Refer to the ATS Parts Catalog for the coil kit part number for your transfer switch.

Solenoid Coil Replacement Procedure

1. Remove the rectifier cover and disconnect the coil leads. Use a blade screwdriver to loosen one screw (do not remove it), then remove the rectifier cover. Disconnect the two coil leads from the rectifier. See Figure 8-20.

2. Remove solenoid retaining bracket and coil. Use a 3/8 in. socket, open-end, or box wrench to remove the four SEMS screws from the solenoid retaining bracket. Then remove the bracket from the top of the solenoid. Remove the solenoid coil by pulling it upward (off the core tube) and out of the frame. See Figure 8-21.

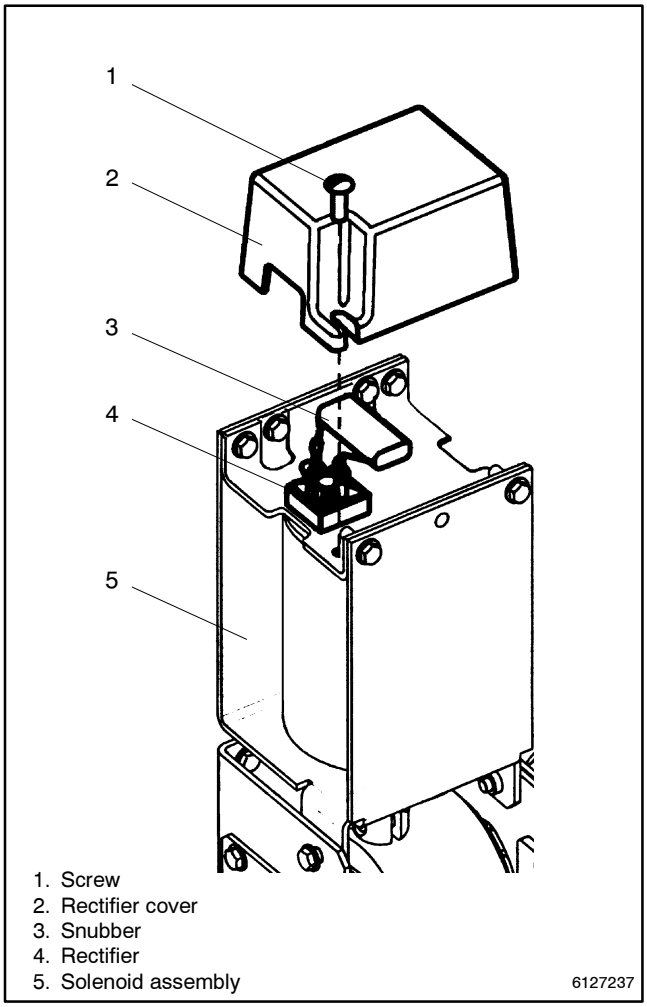
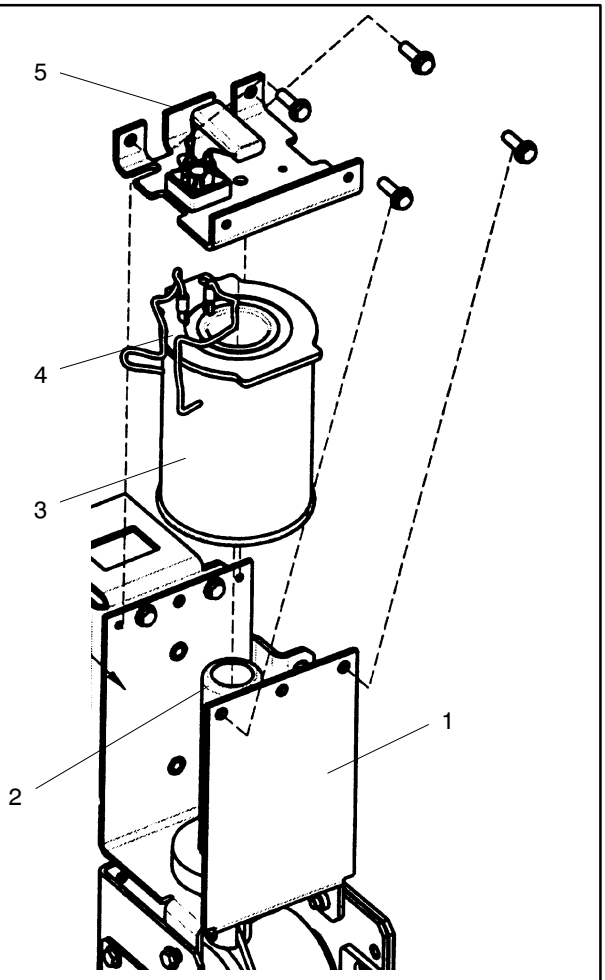


Figure 8-20 Rectifier Cover

3. Install the new solenoid coil. Position the new replacement coil so that the flange end is on top and the coil leads are on the left side. Install the coil (in this position) into the frame by pushing it downward (onto the core tube) and into the frame. Secure the coil by reinstalling the solenoid retaining bracket. Use a 3/8 in. socket, open-end, or box wrench to install four SEMS screws. Tighten the screws to 7.5 Nm (5.5 ft. lb. or 66 in. lb.) torque. See Figure 8-21.

4. Connect the new coil and reinstall the rectifier cover. Install the quick-connect coil leads onto the rectifier terminals (DC). Then install the rectifier cover onto the top of the solenoid frame. Use a blade screwdriver to tighten the screw. See Figure 8-20.



1. Solenoid frame
2. Solenoid core tube
3. Solenoid coil*
4. Flange on coil
5. Solenoid retaining bracket

* Included in kit

6127237

Figure 8-21 Solenoid Coil

8.3.2 Solenoid Assembly Replacement

Solenoid assemblies include entire solenoid with frame, coil, core tube, core spring, and core and link.

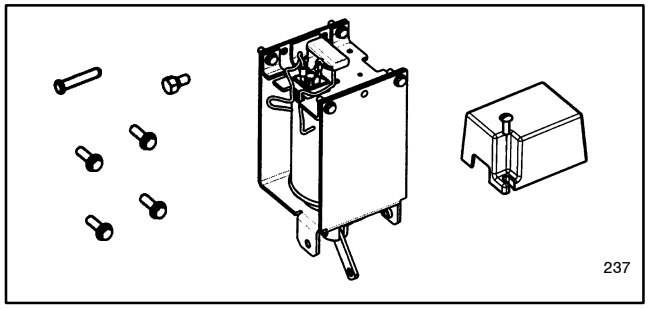


Figure 8-22 Replacement Solenoid Assembly with core and link (includes rectifier and cover, clevis pin, drive link screw, 4 mounting screws, and thread sealant)

Solenoid Assembly Replacement Procedure

1. Put the transfer switch in the EMERGENCY position. The upper contacts must be closed to replace the solenoid assembly. If necessary, use the maintenance handle to operate the transfer switch to the EMERGENCY position. See Section 8.1.

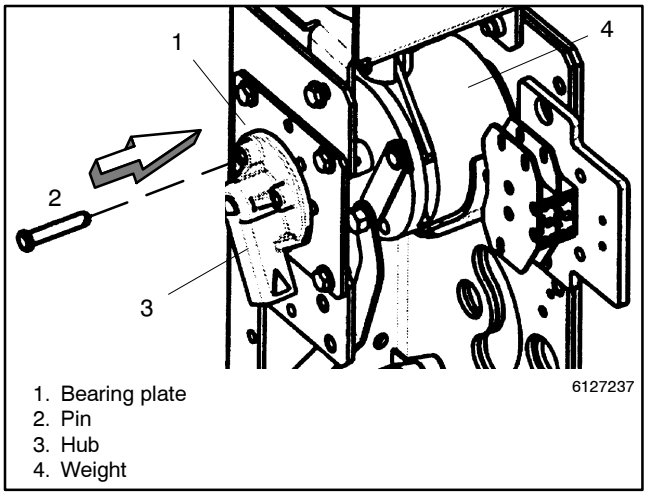
2. Insert the weight locking pin. To prevent the operator from moving during disassembly insert the clevis pin through the hub and into the bearing plate. See Figure 8-23.

3. Remove the retaining screw and link pin from the weight. Use a 7/16 in. open-end or box wrench to remove the retaining screw from the left side of the weight. Then remove the link pin from the left side of the weight. See Figure 8-24.

4. Remove the rectifier cover and disconnect the two wires. Use a blade screwdriver to remove one screw, then remove the rectifier cover. Then disconnect the two wires coming into the solenoid assembly from the harness. See Figure 8-20.

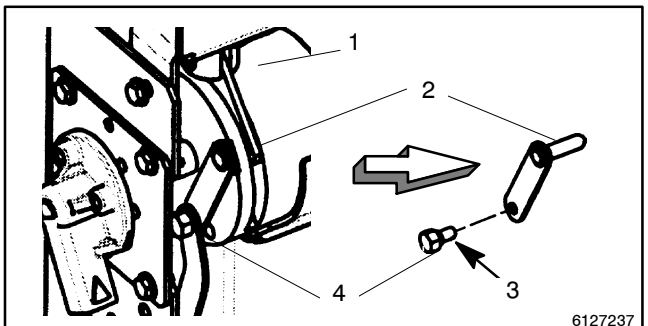
5. Remove the solenoid assembly. Use a 3/8 in. open-end or box wrench to remove four SEMS screws (two at the top, one on either side). See Figure 8-25.

6. Transfer the labels from the old solenoid to the new one. Carefully remove the nameplate, WCR label, and DANGER label from the old solenoid. Then apply them to the new solenoid.



1. Bearing plate
2. Pin
3. Hub
4. Weight

Figure 8-23 Weight Locking Pin

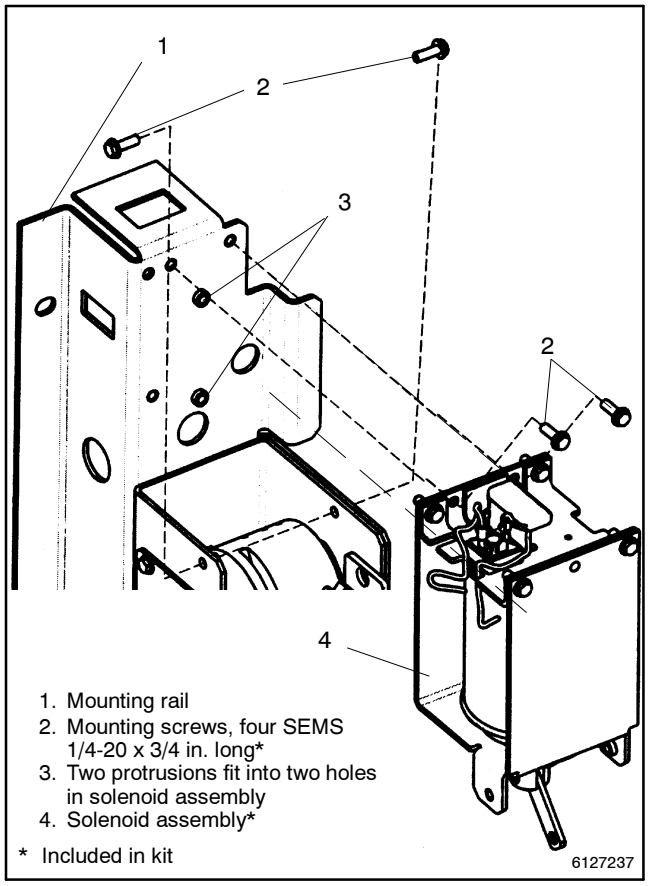


1. Weight
2. Link pin
3. Apply Loctite® 242 thread sealant
4. Link retaining screw

Figure 8-24 Retaining Screw and Link Pin

7. Install the new solenoid assembly. Position the new solenoid assembly onto the mounting rail so that the two protrusions align with the holes in the solenoid assembly. The core link should be in the slot in the weight. Use a 3/8 in. open-end or box wrench to install four new 1/4-20 x 3/4 in. long SEMS screws (two at the top, one on either side. See Figure 8-25.

8. Install the new rectifier cover and connect the two wires. Connect the two wires from the harness (previously disconnected) to the rectifier terminals (AC). Then install the new rectifier cover onto the solenoid assembly. See Figure 8-20.



1. Mounting rail
2. Mounting screws, four SEMS 1/4-20 x 3/4 in. long*
3. Two protrusions fit into two holes in solenoid assembly
4. Solenoid assembly*

* Included in kit

Figure 8-25 Solenoid Assembly

9. Reinstall the link pin and screw it into the weight. Install the link pin into the left side of the weight (through the core link from the solenoid assembly). Apply Loctite® 242 sealant onto the threads of the 1/4-20 link retaining screw. Then install the screw through the control contact link and link pin into the left side of the weight. Use a 7/16 in. open-end or box wrench to tighten the retaining screw. There should be some play to allow movement of the control contact link. See Figure 8-24.

10. Remove the weight locking pin. To unlock the weight from the bearing plate, remove the clevis pin from the hub. This is very important! Otherwise severe damage will occur when transfer switch is reenergized! See Figure 8-23.

    Note: To prevent severe damage to the solenoid assembly, remove the clevis pin from the hub on the left side. Removing the clevis pin unlocks the weight, allowing free movement of the operator when it is reenergized.

11. Manually operate the transfer switch. Use the maintenance handle (page 2) to operate the transfer switch several times. It should operate smoothly; if not, recheck the solenoid assembly installation.

* Loctite is a registered trademark of the Loctite Corporation.

8.4 Coil Control Contact Replacement

The coil control contact assembly (two pushbutton switches) is located below the solenoid operator on the left side of the transfer switch. See Figure 8-26 and Figure 8-27.

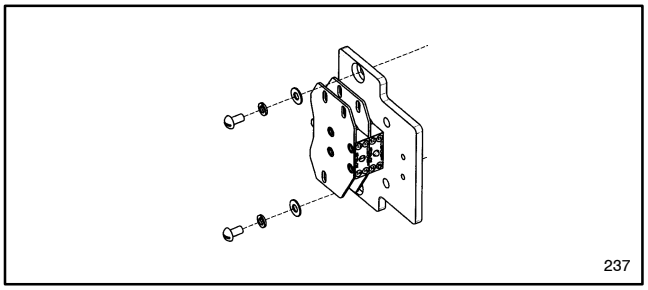


Figure 8-26 Coil Control Contact Kit (with mounting hardware)

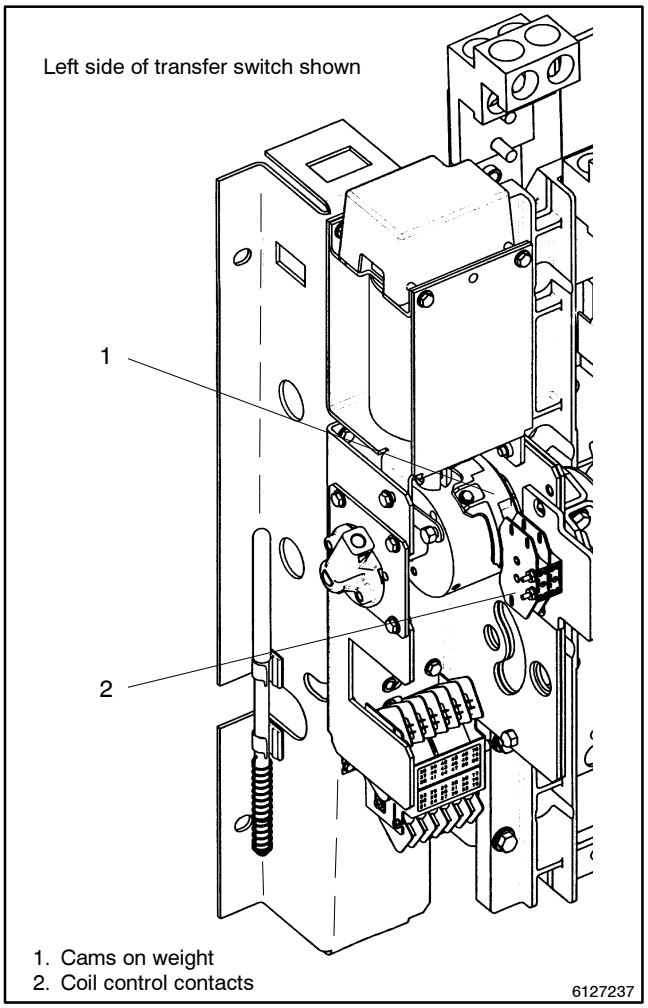


Figure 8-27 Solenoid Operator Assembly

Coil Control Contacts Replacement Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1. Deenergize the transfer switch. After deenergizing both power sources, open the enclosure door. Use a voltmeter to verify that no electrical power is present at the transfer switch terminals.

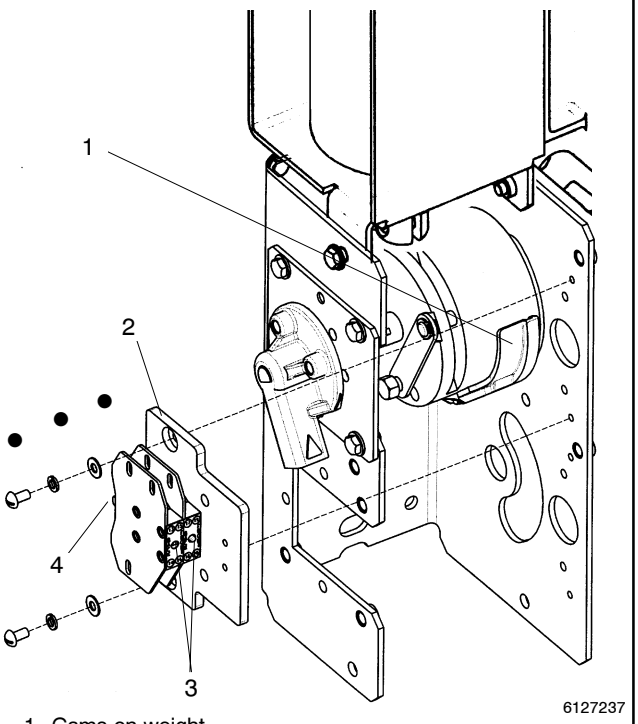
2. Label the eight wires connected to the control contacts. Carefully label all wires that are connected to the control contacts. Then use a narrow blade screwdriver to disconnect the eight wires.

3. Remove the control contact assembly. Use a short handle blade screwdriver to remove two screws with lock and flat washers. Then remove the control contact assembly. See Figure 8-28.

4. Install the new control contact assembly. Position the new control contact assembly with its pushbuttons against the cams on the weight. Use a short handle blade screwdriver to install two screws with lock and flat washers. See Figure 8-28.

5. Connect the eight labeled wires to the control contacts. Carefully reconnect the wires (disconnected in step 2) to the new control contact assembly.

6. Manually operate the transfer switch. Use the maintenance handle (see Section 8.1) to operate the transfer switch several times. You should see the two indicators change alternately from open to closed. If not, recheck the installation. See Figure 8-28.



1. Cams on weight
2. Coil control contact assembly*
3. When installed, these two indicators show one closed and the other open
4. Pushbuttons

* Included in kit

Figure 8-28 Coil Control Contact Assembly

Notes

This section explains how to replace the transfer switch main contacts, operator coil, and control contacts in 600- and 800-amp bypass/isolation switches.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Tools Needed

- Medium blade screwdriver
- Voltmeter, ohmmeter
- Phillips screwdriver
- Needle-nose pliers
- Offset screwdriver
- Cotton swab or small brush
- 1/4 in. nutdriver
- 5/16 in. nutdriver
- 7/16 in. nutdriver
- 1/2 in. nutdriver
- 3/4 in. nutdriver
- 1/4 in. dia. rod or drill
- 1/8 in. hex key wrench
- 3/16 in. hex key wrench
- 5/16 in. open-end wrench
- 7/16 in. socket wrench
- 1/2 in. socket wrench
- 11/32 in. open-end wrench
- Loctite® 222

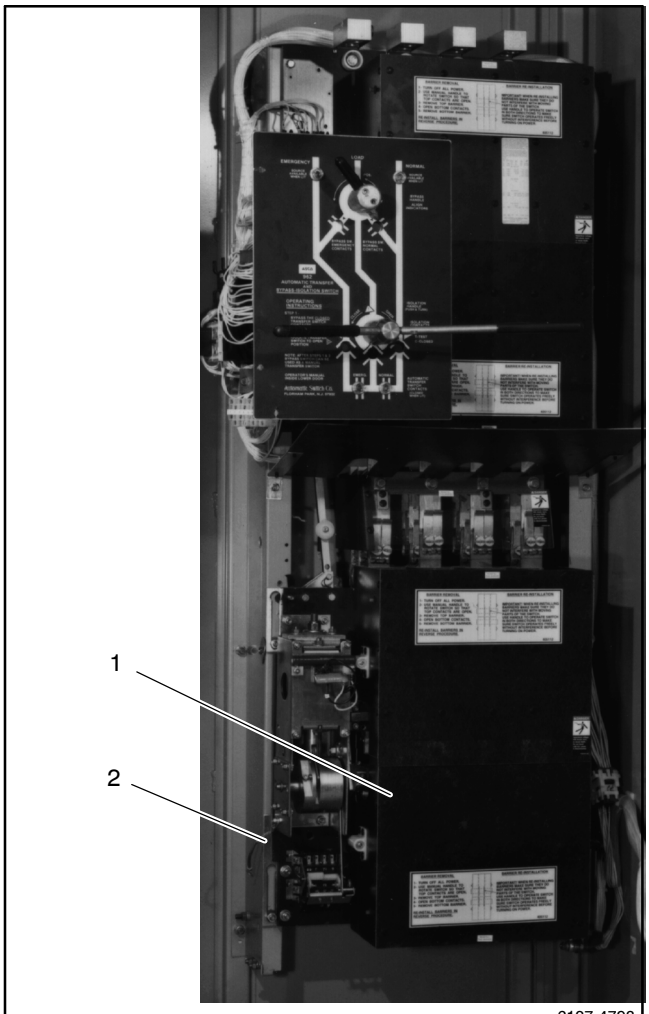
* Loctite is a registered trademark of the Loctite Corporation.

- Thread sealant
- Torque wrench (32 in. lb.)
- Bench vise
- Ruler

9.1 Manual Operation

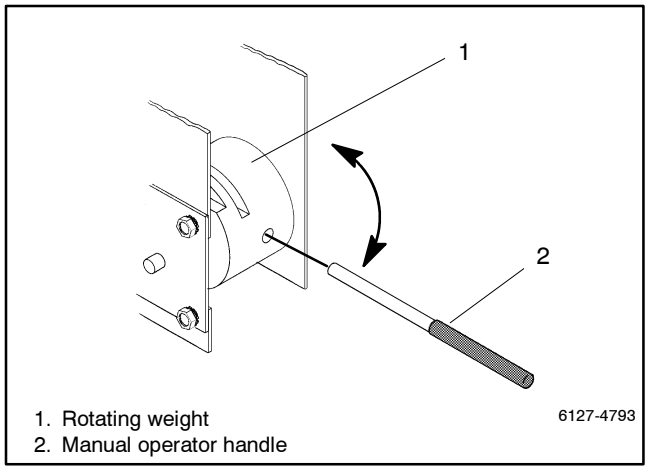
A detachable manual operator handle is provided *for maintenance purposes only.* The handle is stored on the coil frame, left side of the switch.

Note: To prevent the possibility of personal injury or property damage, do not manually operate the transfer switch until it is bypassed and isolated.



1. Transfer switch
2. Manual operator handle storage location

Figure 9-1 Transfer Switch



1. Rotating weight
2. Manual operator handle

Figure 9-2 Manual Operator Handle

Insert the manual handle into the hole in the rotating weight on the left side of the switch. See Figure 9-2. Move the handle down and up to manually operate the switch, as needed, in the following maintenance procedures.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

9.1.1 Main Contact Replacement

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

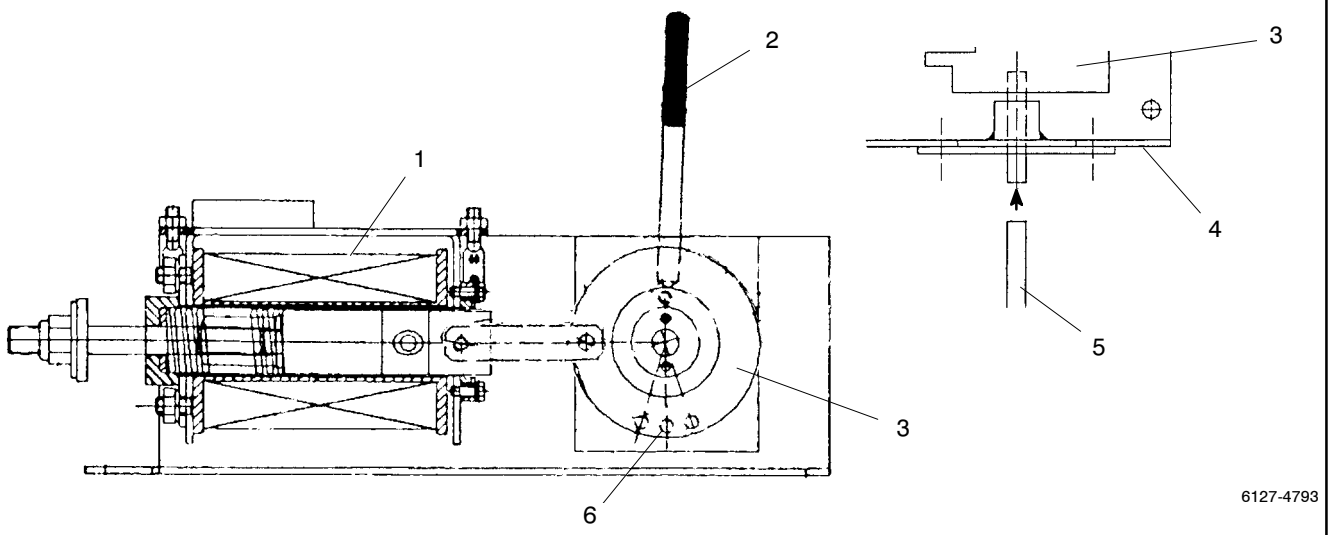
Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

The barriers and arc chutes must be removed to gain access to the main contacts. Use the manual operator handle to put the switch in the NORMAL position to remove the top barrier. Then put the switch in the EMERGENCY position to remove the bottom barrier.

1. Remove the two barriers (see Section 9.2).
2. Remove all arc chutes. Use a blade screwdriver to remove two nylon retainer nuts and fiber clamp piece on each chute. Then carefully pull the arc chute away from the panel.
3. Put the switch in the center position (TDC). Use the manual handle to open the contacts until a 1/4 in. diameter rod (drill bit) can be inserted into the *center* hole in the side of the weight. It will hold the operator in the top-dead-center position and the contact shaft in a mid position. See Figure 9-3.



1. Coil
2. Manual operator handle
3. Weight
4. Operator frame side wall
5. 1/4 in. diameter rod
6. Center hole

Note: Insert rod through sidewall and into the center hole weight to lock weight in TDC (center) position.

Figure 9-3 Rod Inside of Solenoid Operator Weight

Movable Contacts Disassembly

The movable arcing and main contacts are mounted on the shaft assembly. The main contacts are screwed to the back side of the two finger blocks and to the shunts. The arcing contact assemblies, which extend from the ends of the main contacts, are the normal replacement parts. They *make* first and *break* last to protect the main contacts. See Figure 9-4.

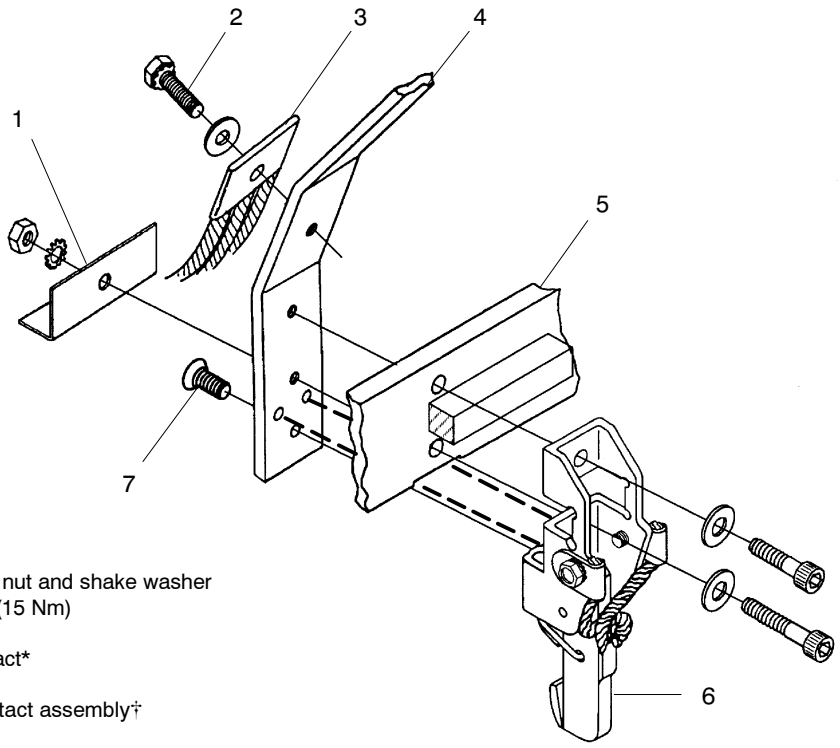
Movable Arcing Contacts and Main Contacts

1. Close the bottom main contacts. Remove the 1/4 in. rod while using the manual operator handle to put the switch in the *normal* position (bottom contacts closed). See Figure 9-3.

2. Disconnect the main shunts. Use a 1/2 in. socket wrench to remove the large hex head (SEMS) screw and flat washer to disconnect the shunt from the movable main contact.

3. Remove the arcing contact assembly. Use a 1/8 in. hex key wrench to remove the retaining screw from the base of the arcing contact assembly.

4. Remove the movable main contacts. Use the manual handle again to insert the spacer between the finger block and panel. Use a 3/16 in. hex key wrench to remove four socket head screws securing the movable arcing contact and movable main contact to the finger blocks. Use a 7/16 in. socket wrench to hold the nut securing the L insulator behind the main contact while removing the screw. Then remove the movable main contact.



1. L insulator with hex nut and shake washer
2. Tighten to 11 ft. lb. (15 Nm)
3. Shunt
4. Movable main contact*
5. Finger block
6. Movable arcing contact assembly†
7. Retaining screw†

* Indicates parts included in main contact kit.
† Indicates parts included in arcing contact kit.
‡ Apply Loctite® 222, 1/8 in. hex key wrench, tighten to 32 in. lb. (3.6 Nm).

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Figure 9-4 Movable Contacts

9.1.2 Stationary Contacts Disassembly

The stationary arcing and main contacts are mounted on the contact pivot blocks. The main contacts are held in the contact pivot blocks by the arc chute mounting brackets. The arcing contacts, which are screwed to the front of the contact pivot blocks, are the normal replacement parts. They *make* first and *break* last to protect the main contacts. See Figure 9-5.

Stationary Arcing Contacts

1. Remove the arc runner plate. Use a medium blade screwdriver to remove the flathead screw. Place your finger behind the plate to catch the spring nut. Then slide the arc runner plate out from under the arcing contact to remove it.

2. Remove the two insulator pieces. Carefully work the large insulator piece out from under the arcing contact while pulling it off the two long threaded rods. *Do not bend the insulator severely because it must be reused.* Also remove the thin insulator shim.

3. Remove all stationary arcing contacts. Use a medium blade screwdriver to remove the flathead screw then remove arcing contact.

Stationary Main Contacts

1. Remove the insulator trays. Use a medium blade screwdriver to remove two flathead screws from the arc chute mounting brackets, then remove the insulator tray.

2. Remove the arc chute mounting brackets. Use a 5/16 in. open end or box wrench and an offset screwdriver to remove two nuts from the screws through the contact pivot block. Then remove both arc chute mounting brackets.

3. Remove the stationary main contacts and springs. Use a pair of needle-nose pliers to release the spring leaves from the individual contact segments and work the main contacts out of the pivot block. *Do not damage the inside of the contact pivot block.* Then remove the contact spring.

9.1.3 Stationary Contacts Reassembly

Refer to Figure 9-5.

1. Apply conductive lubricant to hinge joints. Use a cotton swab or small brush to apply conductive lubricant (Dynaloy 495) to the inside of the contact pivot blocks. Also apply a thin film of conductive lubricant to the curved surface of each new main contact segment.

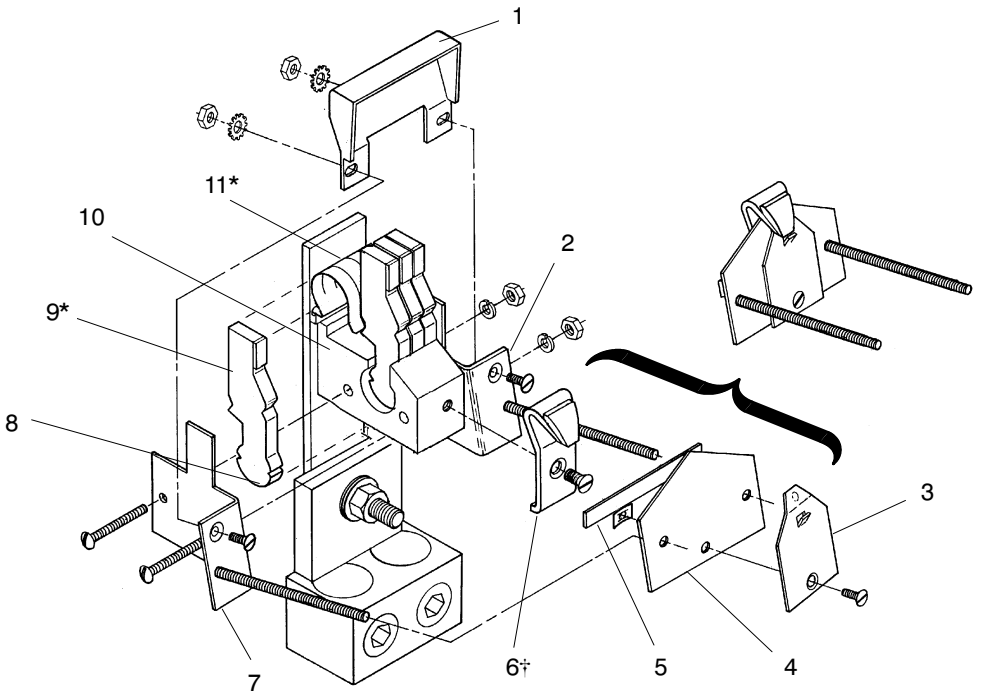
   Note: Failure to apply conductive lubricant to the main contact hinge joints will cause overheating.

2. Install new contact segments and springs. Place a new contact spring into the spring base insulator and hold it in place with one hand. With your other hand carefully install a new contact segment into the contact pivot block. Depress the contact spring leaves to work the contact into the center. In a similar manner install the remaining contact segments from either side of the pivot block. Carefully use a pair of needle-nose pliers to position the spring leaves close to the pivot block in the notch in each contact.

3. Install arc chute mounting brackets. Place left and right arc chute mounting brackets on either side of the contact pivot block. Then insert two long #8-32 screws through the brackets and pivot block. Secure the brackets with lockwashers and nuts, and use a 5/16 in. open end or box wrench and an offset screwdriver to tighten the two nuts.

4. Check contact deflection. Press in on each stationary main contact to verify freedom of movement and spring pressure. If there is binding, check the position of the spring leaves and conductive lubrication.

5. Install the insulator trays. Place the insulator tray mounting tabs behind the arc chute mounting brackets. Fasten the insulator tray with two #6-32 flathead screws with lockwashers and nuts. Use a blade screwdriver to tighten the screws.



1. Insulator tray
2. Right arc chute mounting bracket
3. Arc runner
4. Large insulator piece
5. Small insulator piece
6. Stationary arcing contact†
7. Left arc chute mounting bracket
8. Apply conductive lubricant to main contact hinge joints.
9. Stationary main contact segment*
10. Contact pivot block
11. Stationary main contact leaf spring*

* Indicates parts included in main contact kit.
† Indicates parts included in arcing contact kit.

Figure 9-5 Stationary Contacts

Stationary Arcing Contacts

1. Install new stationary arcing contacts. Apply a few drops of Loctite® 222 thread sealant to the threads of the large flat head screw. Then attach each new contact to the pivot block by using a medium blade screwdriver to install the large flat head screw. Tighten the screw.

2. Install two insulator pieces. Slide the large insulator piece onto the two long threaded rods. Carefully work the pointed side of the insulator under the arcing contact while pushing the insulator in. Insert the thin insulator shim behind the large insulator before pressing it all the way in. Position the thin insulator shim close to the threaded rods.

3. Install the arc runner plate. Hold the thin insulator shim in place close to the threaded rods while sliding the arc runner plate under the arcing contact. The arc runner plate should fit snugly and its tab must touch the tip of the arcing contact. Secure the arc runner plate to the large insulator piece with the small flat head screw and spring nut.

9.1.4 Movable Contacts Reassembly

Reassemble as shown in Figure 9-4.

Movable Main Contacts and Arcing Contacts

1. Install the new movable main contacts. Place the new movable main contact behind the two finger blocks. Use the manual operator handle to insert the spacer or to open the top contacts enough to slide the new movable main contact in place.

2. Install new arcing contact assembly on the main contact. Secure it with two socket head screws through the finger block. Use the longer screw to install the L insulator behind the main contact and secure it with a nut with lock washer. Use a 3/16 in. hex key wrench to tighten the screws.

   Note: Be sure to install the L insulator behind the main contact.

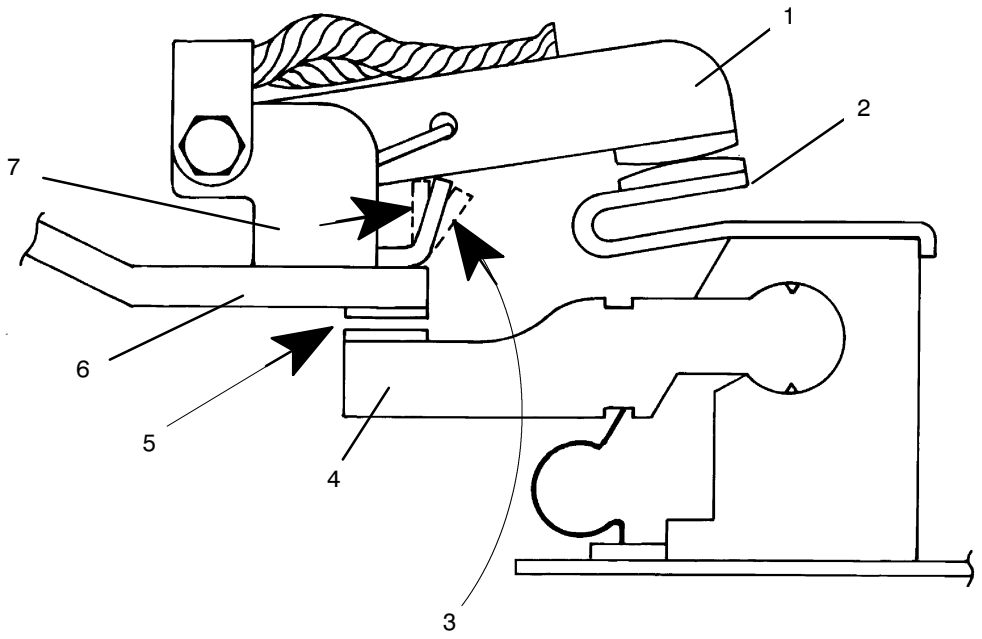
   Apply Loctite ® 222 thread sealant to threads of the retaining screw. Install retaining screw through the main contact into the base of the arcing contact. Then, using a 1/8 in. hex wrench, tighten the screw to 3.6 Nm (32 in. lb.).

3. Check the main contact gap. When installing a new arcing contact assembly, a gap of 5/32 in. between the main contacts is automatically obtained when the arcing contacts just touch. However, if a minor adjustment is necessary to obtain this gap, bend the adjustment tab on the arcing contact assembly. Refer to Figure 9-6 for instructions on tab adjustment.

   Note: Recheck any adjustment by manually operating the switch a few times and recheck the gap between the main contacts.

4. Close the bottom main contacts. Use the manual operator handle to remove the spacer and to put the switch in the *Normal* position (bottom contacts closed).

5. Reconnect the main shunts. Attach the main shunt to the back of the movable main contact with the large hex head (SEMS) screw with flat washer. Use a 1/2 in. socket wrench to tighten to 15 Nm (11 ft. lb.).

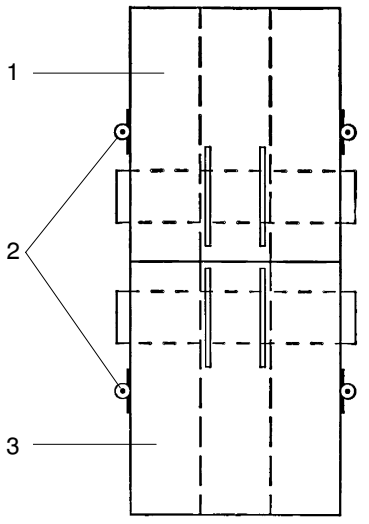


1. Movable arcing contact
2. Stationary arcing contact
3. Adjustment tab*
4. Stationary main contact
5. With 5/32 in. gap at main contacts, arcing contacts should just touch.
6. Movable main contact
7. Bracket

* To increase gap, bend tab away from bracket. To decrease gap, bend tab toward bracket.

Figure 9-6 ArcIng Contact Adjustment (side view).

9.2 Transfer Switch Barrier Removal and Installation



1. Top barrier
2. Mounting screws
3. Bottom barrier

Figure 9-7

Note: IMPORTANT! When reinstalling barriers, make sure they do not interfere with moving parts of the switch. Use handle to operate switch in both directions to make sure switch operates freely without interference before turning on power.

9.2.1 Barrier Removal

1. Bypass and isolate the transfer switch. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

2. Use the manual operator handle to put the switch in the NORMAL position (top contacts open). See Figure 9-2.

3. Use a Phillips screwdriver to loosen only two screws and remove the top barrier. Slide the barrier up and tilt outward.

4. Use the manual operator handle to put the switch in the EMERGENCY position (bottom contacts open).

5. Use a Phillips screwdriver to loosen only two screws and remove the bottom barrier. Slide the barrier down and tilt it outward.

9.2.2 Barrier Installation

1. Install all arc chutes. Slide the arc chute (arc splitters toward the panel) between the long threaded rods. Place the arc chute retainer onto the arc chute. Use a screwdriver to gently tighten the two nylon retainer nuts on both sides of the arc chute. Do not overtighten these nuts.

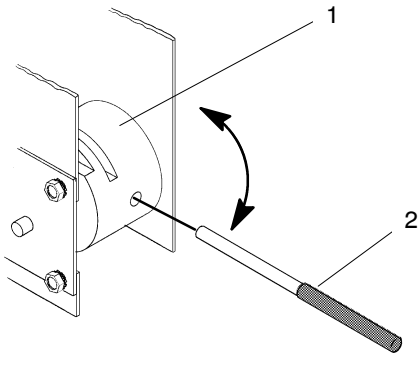
2. Check the clearance between the contacts and the arc chutes. Use the manual operator handle to slowly open and close the contacts while checking that they do not hit the arc chutes.

3. Install the bottom barrier. Use the manual operator handle to put the switch in the *Emergency* position (top contacts closed). Then reinstall the bottom barrier; make sure that the center barriers are *outside* the movable barriers on the switch. Tighten the two Phillips head screws.

4. Install the top barrier. Use the manual operator handle to put the switch in the NORMAL position (bottom contacts closed). Then reinstall the top barrier; make sure that the center barriers are *outside* the movable barriers on the switch. Tighten the two Phillips head screws.

   Note: Manually operate the switch to be sure there is no misaligment or binding before operating it electrically.

5. Return the transfer switch to service. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.



1. Rotating weight
2. Manual operator handle

Figure 9-8 Manual Operator Handle

9.3 Operator Coil Replacement

9.3.1 Coil Assembly Removal

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

The coil assembly is mounted in the operator assembly on the left side of the panel. It must be removed to a work bench for disassembly. See Figure 9-9, Figure 9-10, and Figure 9-11.

1. Put the transfer switch in the EMERGENCY position. Use the manual operator handle (Figure 9-2) if necessary to close the top contacts.

2. Disconnect the rectifier and resistor (Figure 9-9) Carefully pull off the two white power wires and the two black coil leads from the square rectifier mounted on the coil assembly. Do not remove the blue varistor. Then remove the two hex nuts to disconnect the two white wires from the resistor (one on each end).

3. Remove the retaining screw and link pin (Figure 9-10). Use a 3/16 in. hex key wrench to remove the hex socket head screw from the weight. Then use a screwdriver to pry out the link pin in left side of the weight.

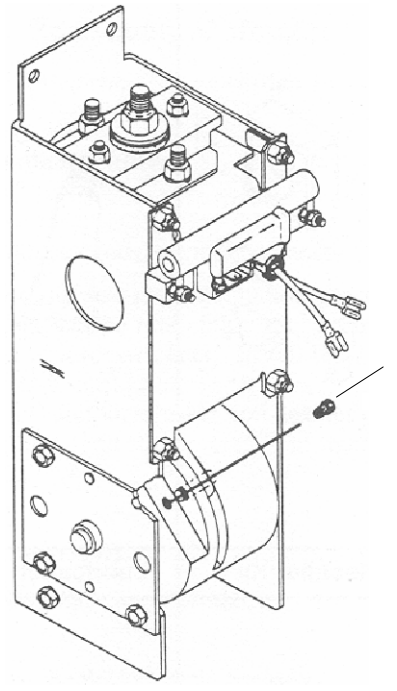
4. Remove the coil assembly (Figure 9-11). Use a 7/16 in. nutdriver or wrench to remove four hex nuts from the operator frame. Then remove the coil assembly to a work bench.

9.3.2 Coil Removal

The solenoid coil is held in the coil frame by the core tube assembly. See Figure 9-12.

1. Remove the core tube assembly. Use a 1/2 in. nutdriver or wrench to remove the upper and lower hex nuts and lock washers from top end of the coil frame. Then pull out the core tube assembly.

2. Remove the coil from the coil frame. Slide the grommet with coil leads out of the slot. Use a 5/16 in. nutdriver or wrench to loosen (only) three coil-clamping SEMS head screws (lower end of coil frame), then pull out the coil and end washer.



1. Retaining screw

Figure 9-9 Retaining Screw

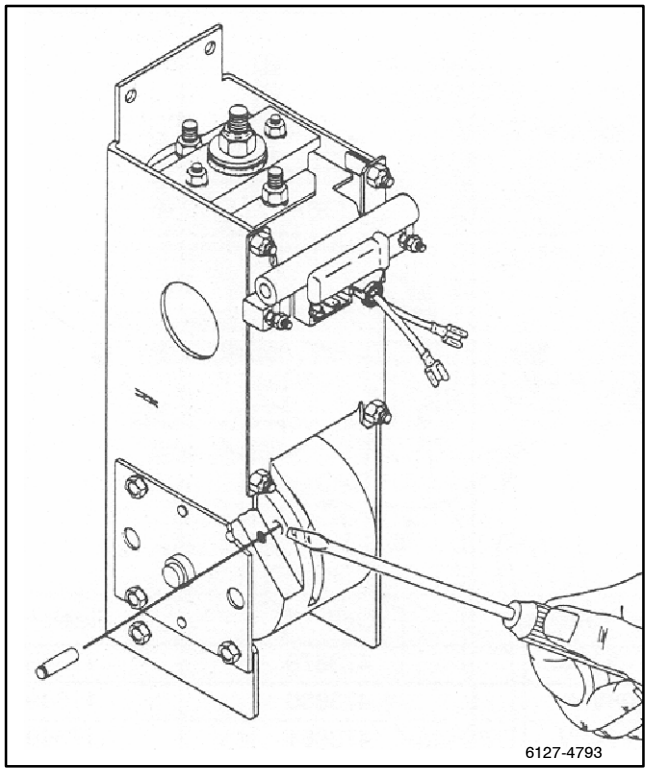


Figure 9-10 Link Pin

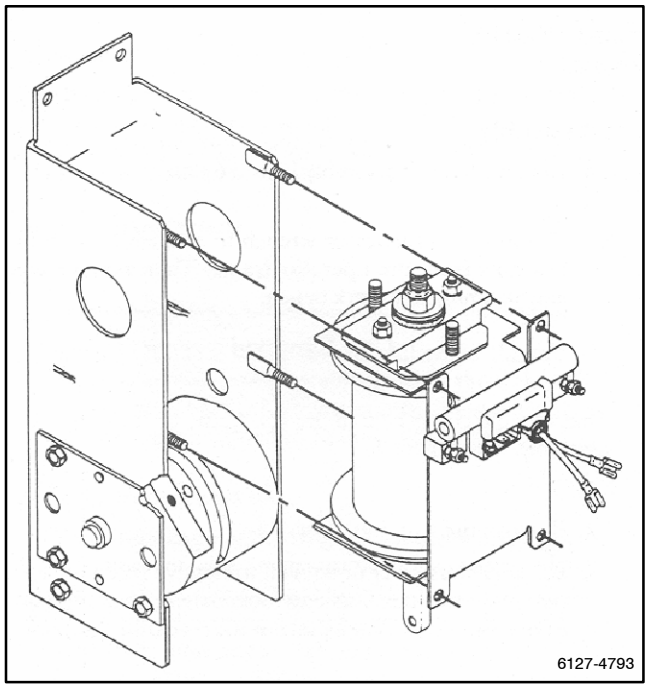


Figure 9-11 Removal of Coil Assembly from Operator Frame

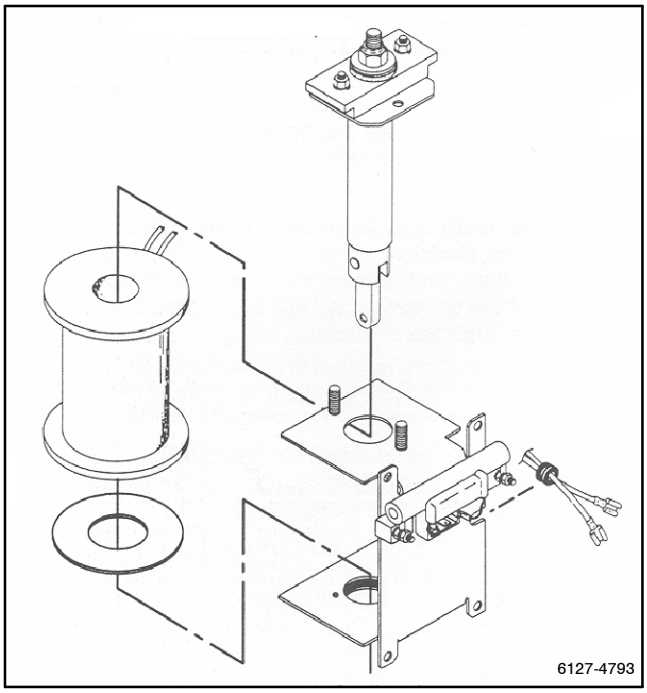


Figure 9-12 Removal of Coil and Core Tube Assembly

9.3.3 Core Tube and Core Disassembly

Disassembly of the core tube assembly is normally not required. If, however, the coil has overheated and has damaged the core tube assembly, rebuilding it is necessary. You will need an assistant to help you reassemble it, and you need to reset the stroke (explained in Sections 9.4 and 9.5). See Figure 9-13 and Figure 9-14.

Note: To avoid damage, do not tighten the vise on the core or core tube!

Note: To prevent the possibility of personal injury, hold the core tube assembly securely away from yourself when removing the center hex nut; the spring exerts substantial outward force on the core and link.

1. Remove the core and compression spring. See Figure 9-13. Hold the link in a vise to secure the assembly. Use a 3/4 in. nutdriver or wrench to remove the center large hex nut from the threaded stem end of the core.

   Note: When the center hex nut is removed, the assembly will suddenly release the core and spring from the lower end of the core tube assembly.

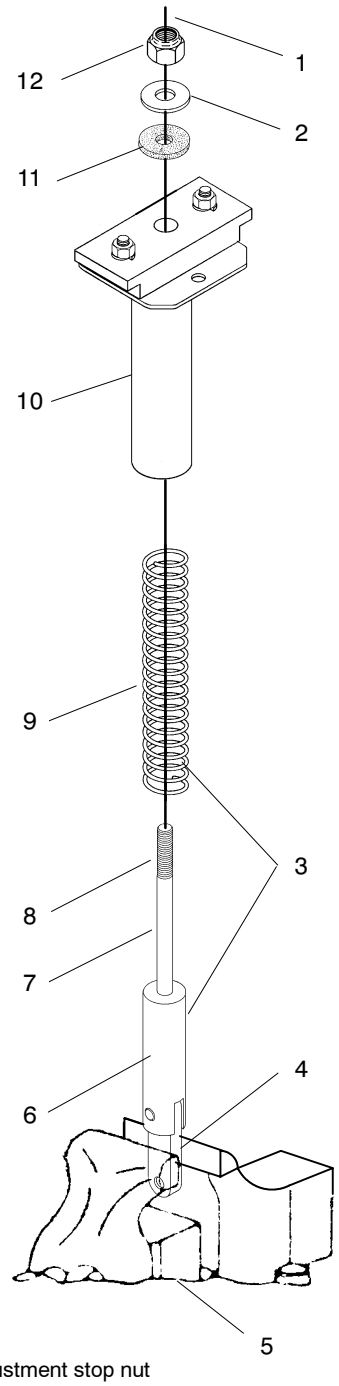
2. Take apart the core tube assembly. See Figure 9-14. Use a 1/2 in. nutdriver or wrench to remove the left and right hex nuts and lockwashers and pull the spring retainer off the core tube retaining plate. Then push the core tube through the retaining plate to remove it.

9.3.4 Core Tube and Core Reassembly

Replace damaged parts (core tube and core spring) and lubricate the core and core spring with Lubrication Kit GM24237 before reassembly. You will need an assistant to help compress the spring while you install the hardware. See Figure 9-13 and Figure 9-14.

1. Put together the core tube assembly Figure 9-14. Insert the core tube through the retaining plate (flared end seats on top). Then install the spring retainer (recessed hole inward) onto the retaining plate and use a 1/2 in. nutdriver or wrench to tighten the two 5/16-18 hex nuts on 5/16 in. lock washers.

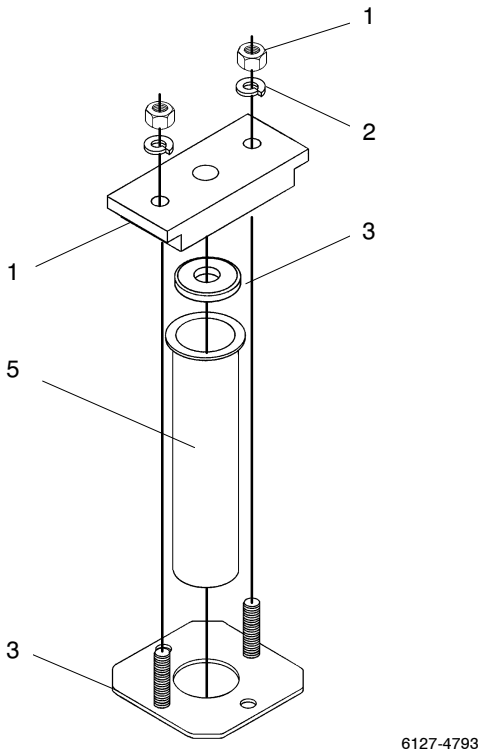
2. Lubricate the core and core spring. Use the Lubrication Kit to apply a thin coating onto the core surface and onto the core spring.



1. Stroke adjustment stop nut
2. Flat washer*
3. Lubricate surface using lubrication kit
4. Link
5. Vise
6. Core
7. Core and link assembly
8. Stem
9. Compression spring*
10. Core tube assembly
11. Leather washer*
12. Hex nut, 1/2-13 with nylon insert*

* Indicates parts included in coil kit.

Figure 9-13 Core Tube And Core Disassembly



1. 5/16-18 hex nut
2. 5/16 in. split lock washer
3. Nylon guide washer*
4. Core tube retaining plate*
5. Core tube*
6. Spring retainer

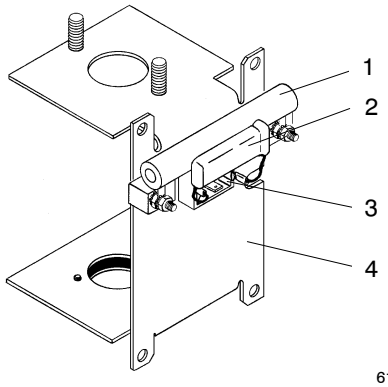
* Indicates parts included in coil kit.

Figure 9-14 Core Tube Assembly

Note: To prevent the possibility of personal injury, hold the core tube assembly securely away from yourself when installing center hex nut; the spring exerts substantial outward force on the core and link.

3. Assemble the core, spring, and core tube assembly. See Figure 9-13. With the link held securely in a vise, set the lubricated core spring onto the core stem. Check to see if the nylon guide washer is still inside the spring retainer; if it is not, place it inside the spring retainer.

   Have an assistant push the core tube assembly onto the spring and hold it down (guide the threaded core stem through the center hole) while you add the leather washer (threaded), flat washer, and 1/2–13 hex nut onto the core stem. Use a 3/4 in. nutdriver or wrench to tighten the nut (it must be adjusted later for proper stroke of 1 1/8 in.); refer to Sections 9.4 and 9.5 .



1. Resistor
2. Snubber
3. Rectifier
4. Coil frame

Figure 9-15 Rectifier and Resistor

9.3.5 Coil Installation

Replace the coil before assembly if it is damaged. See Figure 9-12.

1. Install the replacement coil. With coil leads up and to the right, insert the new coil with a coil washer on the bottom into coil frame. Then run the coil leads through the grommet and slide the grommet into the slot (on the right side of the coil frame).

2. Install the core tube assembly. Insert the core tube assembly down through the hole in the coil frame and use a 1/2 in. nutdriver or wrench to tighten the upper and lower hex nuts with lock washers on the coil frame.

3. Tighten the coil-clamping screws. Use a 5/16 in. nutdriver or wrench to tighten the three SEMS head screws on the bottom of the coil frame.

9.3.6 Coil Assembly Installation

The coil assembly can now be reinstalled onto the operator assembly on the left side of the switch panel. See Figure 9-9, Figure 9-10, and Figure 9-11.

1. Install the coil assembly onto the operator frame (Figure 9-11). Place the coil assembly onto the four studs on the operator frame and align the link into the slotted weight. Use a 7/16 in. nutdriver or wrench to tighten the four hex nuts.

2. Install the link pin and retaining screw (Figure 9-10). Insert the link pin (groove side out)

into the left side of the weight and through the link. Then install the hex socket head retaining screw into the weight and use a 3/16 in. hex key wrench to tighten it.

3. Reconnect the resistor/rectifier on the coil frame (Figure 9-9). Replace the resistor (if necessary), reconnect the two white wires with ring lugs to each end, and install and tighten the hex nuts. Replace the rectifier (if necessary) and carefully reconnect the four wires with push-on lugs to the rectifier terminals as follows: connect the two white power wires to the AC terminals ~, and connect the two black coil leads to the DC terminals (red dot and no dot, polarity does not matter). Be sure the blue snubber is still installed between the DC terminals. See Figure 9-15.

4. Use the manual operator handle to manually operate the transfer switch. It should operate smoothly without any binding. If not, recheck the alignment of parts and the lubrication in the solenoid operator. Close the bottom contacts and remove the manual handle.

5. Reinstall the transfer switch. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

9.4 Control Contact Test and Adjustment

This section explains how to test and adjust the TS coil control contacts. The TS control contacts control the duration of time that power is applied to the main solenoid operator (TS coil). To assure proper operation, it is important that the contacts open at the proper time during the stroke of the solenoid. Improper adjustment will cause failure to operate at reduced voltages, failure of the main contacts to properly seat, and solenoid failure.

Tools Needed

- Voltmeter
- Ohmmeter
- Continuity lamp
- 11/32 in. open end wrench
- 1/4 in. rod or drill bit

Test and Adjustment Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

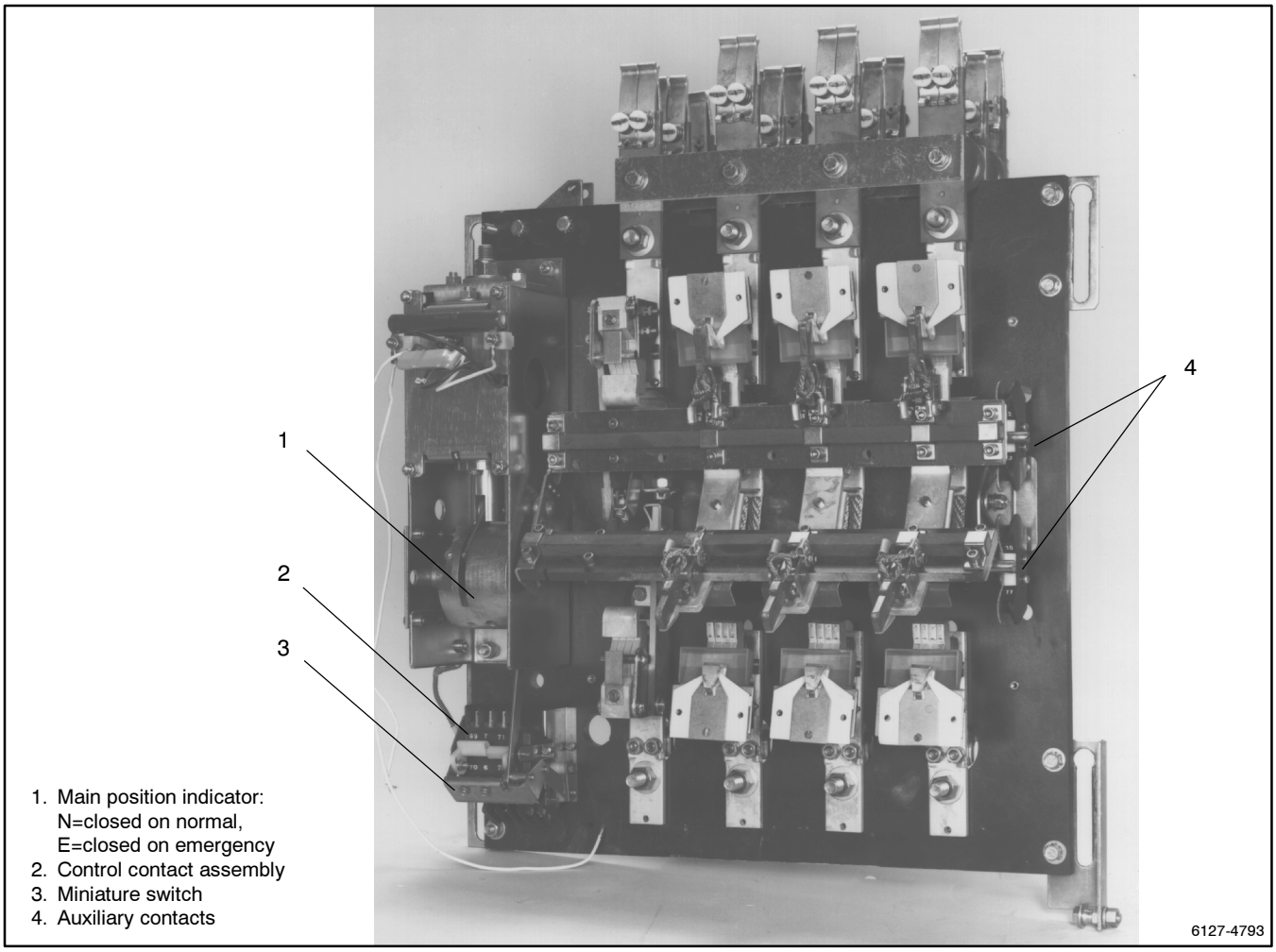
Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

1. Bypass, isolate, and remove the transfer switch.

2. Locate the TS control contact assembly; see Figure 9-16. The control contacts are mounted on a metal bracket below the solenoid frame, and are connected with a drive link to the operator weight. There are other auxiliary microswitches inside, underneath the bracket, which are not part of this control circuitry.



1. Main position indicator:
   N=closed on normal,
   E=closed on emergency
2. Control contact assembly
3. Miniature switch
4. Auxiliary contacts

Figure 9-16 Transfer Switch with Barriers Removed

3. The TS control contacts are factory set with an adjustable power supply so that the switch can operate satisfactorily over a voltage range of 80 to 110% of the nominal system voltage. To accommodate minor variances in friction and tolerances, it is not unusual for the control contact settings to vary from switch to switch.

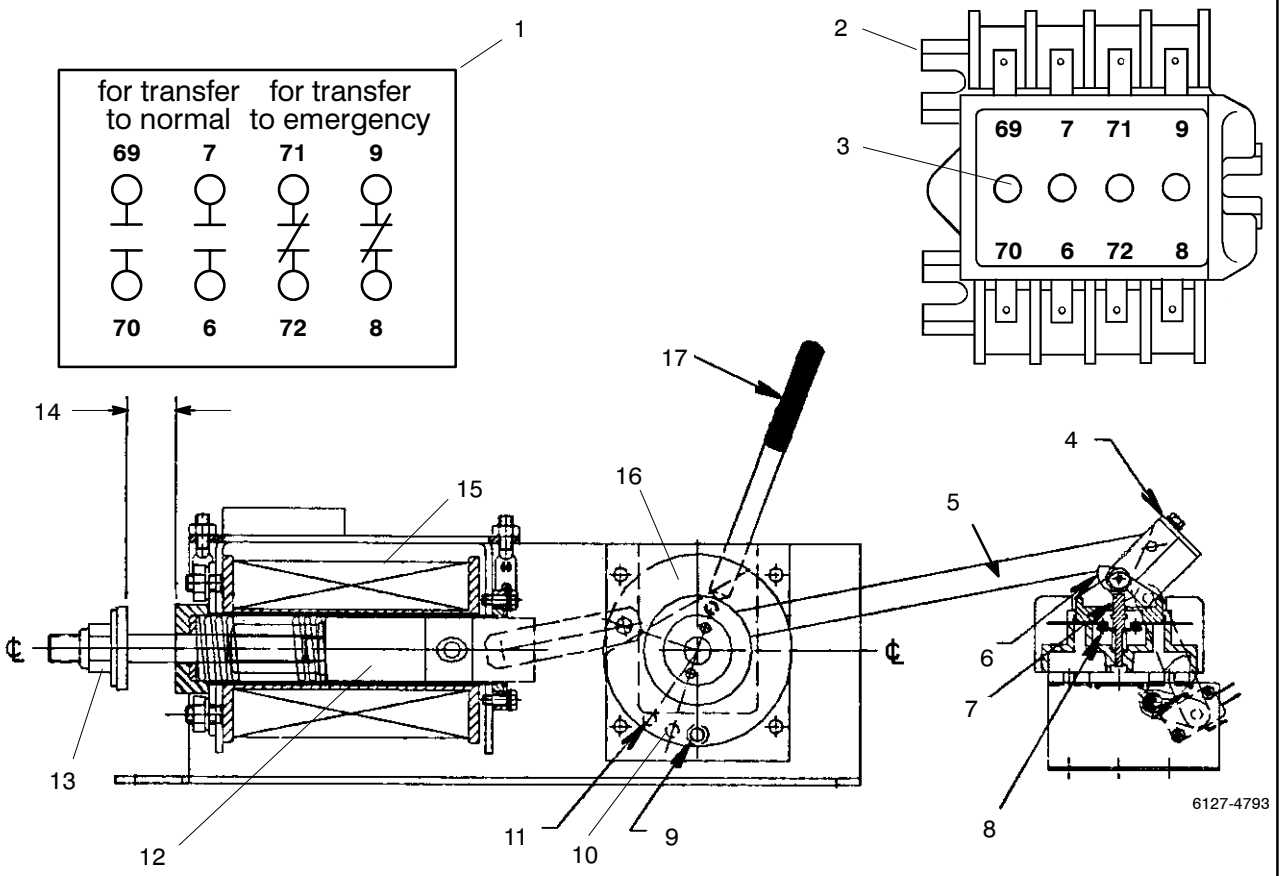
   The adjustments are factory-sealed and usually do not require any change over the life of the switch. If it should become necessary to check adjustments in the field, an approximation can be made by following the instructions in steps 4–6. The adjustments can vary to the extremes and still provide acceptable operation. However, it is important that the TS control contacts always open *before* top-dead-center is reached by the solenoid core.

4. To verify settings and field-adjust the TS Control Contacts, proceed as follows (refer to Figure 9-18):

   a. Two sets of contacts interrupt the control current to the solenoid operator coil (TS) in each direction (transfer to emergency and retransfer to normal). The pairs of coil clearing contacts do not have to operate simultaneously, but both must break the circuit *before* the main solenoid operator's core reaches its maximum top-dead-center position. See the table in Figure 9-17 for the control contact position sequence.

Condition	Control Contacts 71-72 & 9-8	Control Contacts 69-70 & 7-6
Main contacts closed—on N	Closed	Open
Main contacts closed—on E	Open	Closed
During transfer from N to E	Open before TDC	Close after TDC
During transfer from E to N	Close after TDC	Open before TDC
N=Normal position E=Emergency position TDC=Top dead center of solenoid core or main contact shaft **Note:** All contacts are open at TDC. See step 7.		

Figure 9-17 Coil Control Contact Positions



1. Electrical diagram (control contact positions when main TS contacts are closed on the Normal source.)
2. Control contact assembly
3. Button
4. Drive bracket
5. Drive link
6. Cams
7. Operating button
8. Control contacts 69–70 (typical). Contacts open when operating button is depressed by cam.
9. Emergency adjustment hole in weight (Step 6)
10. TDC (Step 7)
11. Normal adjustment hole in weight (Step 5)
12. Core
13. Stroke adjustment nut
14. Reference solenoid core stroke dimension 1.040 in.; 1 1/8 in. maximum stroke in TDC position (Step 7)
15. Coil
16. Weight
17. Operator manual handle

Figure 9-18 TS Control Contact Arrangement Below Solenoid Operator

b. With power disconnected, use an ohmmeter (or a lamp-type continuity tester) across each contact to determine when the control contacts open while slowly turning the manual operator handle. Refer to Section 9.1, Manual Operation, for operating handle instructions.

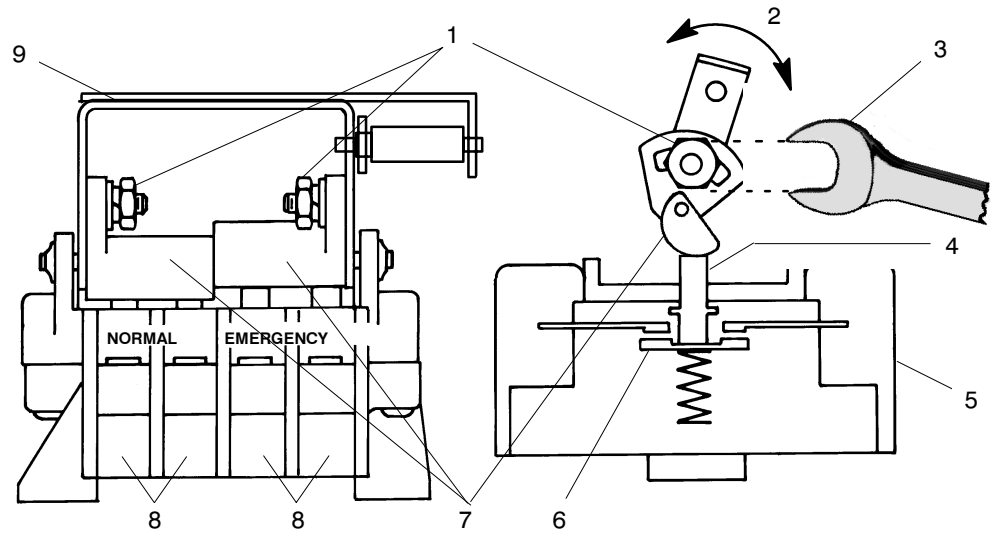
Note: There are three positioning holes in the side of the weight used for adjustment purposes. The center hole is used for TDC (top-dead-center) positioning. The other two are used for setting the control contacts. Make sure that positioning is correct for the task at hand.

5. If adjustment of contacts 71–72 and 9–8 is necessary, proceed as follows (refer to Figure 9-18 and Figure 9-19):

a. Close the main contacts of the transfer switch on Normal. Starting from the closed-on-normal position, use the manual operator handle to rotate the weight until a rod can be inserted into first hole (normal adjustment hole) in the side of the weight.

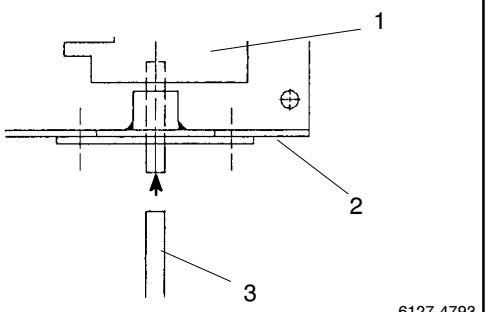
b. Insert a 1/4 in. diameter rod through the hole in the sidewall and into the first hole in the side of the weight. See Figure 9-20.

c. Adjust the right control contact cam so that the contacts just break. Use a continuity lamp or ohmmeter across either contact for this adjustment.



1. Adjustment, #8-32 hex locking nut
2. Range of adjustment
3. 11/32 in. open end wrench
4. Operating button
5. Cutaway side view
6. Control contacts typical 69, 70 contacts open when operating button is depressed by cam
7. Cams
8. Control contact sets
9. Drive bracket

Figure 9-19 TS Control Contact Adjustment



1. Weight
2. Side wall of operator frame
3. 1/4 in. diameter rod

Note: Insert rod through sidewall and into weight to lock weight at appropriate adjustment position.

Figure 9-20 Rod in Weight

6. If adjustment of contacts 69-70 and 7-6 is necessary, proceed as follows. (This procedure is identical to the adjustment of contacts 71–72 and 9–8, except that the weight is positioned on the other side of the top-dead-center position.)

   a. Starting from the closed-on-emergency position, use the manual operator handle to rotate the weight until a rod can be inserted into the third hole (emergency adjustment hole) in the side of the weight.

   b. Insert a 1/4 in. diameter rod through the hole in the sidewall and into the third hole in the side of the weight. See Figure 9-20.

   c. Adjust the left control contact cam so that the contacts just break. Use a continuity lamp or meter across either contact for this adjustment.

   Note: IMPORTANT After final adjustment, verify that all control contacts are open when the switch is positioned at TDC.

7. Insert the 1/4 in. diameter rod into the center hole in the side of weight. Use a continuity lamp to verify that all contacts are open in this position. Measure 1 1/8 in. max stroke between the leather washer and coil frame (Figure 9-18). If necessary, turn the hex nut to obtain the proper stroke (Figure 9-19).

8. After contacts have been set, remove the rod and make sure the transfer switch is fully closed on normal (bottom).

   Note: Be sure to remove the rod from the weight to prevent coil burn out.

9. Reinstall the transfer switch. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

9.5 TS Control Contact Replacement

Under normal conditions the TS control contacts do not require replacement over the life of the transfer switch. If replacement becomes necessary, proceed as follows:

1. Disconnect all power to the transfer switch as instructed in the Test and Adjustment Procedure.

2. Disconnect the drive link; refer to Figure 9-21 below. Remove the lever by removing the two #8-32 hex head screws and nuts. Store the loose pivot pin and loose hardware for safekeeping.

   Note: Do not pull on the wires. Pry off connectors with a screw driver. Pulling may damage crimped wire connections.

3. Check to verify that the wires connected to the control contact assembly are marked so that they can be identified after being disconnected. Add labels if necessary. Disconnect the labeled wires from the control contact assembly.

4. Remove three 8-32 hex head screws from the mounting feet and remove the control contact assembly.

5. Install the new control contact assembly and tighten screws securely.

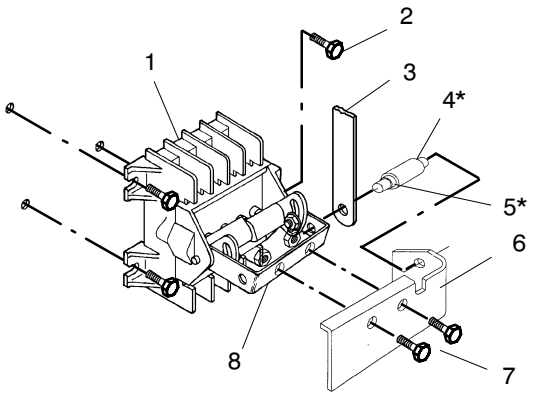
   Note: Do not overtighten retaining screws; excessive pressure may cause binding.

6. Reconnect the drive link. Install the pivot pin between the link and lever (link must ride on shoulder of pivot pin). Then attach the lever to the drive bracket by installing the two 8-32 hex head screws and nuts.

7. Manually operate the drive linkage with the manual operator handle. The action should be smooth without any binding. Be sure the cams properly operate the pushbuttons on the control and auxiliary contact assemblies.

8. Reconnect the eight labeled wires to their proper terminals.

9. Check the control contact adjustment. Refer to the Test and Adjustment Procedure in Section 9.4.



1. TS contact assembly
2. Three hex head mounting screws
3. Link
4. Pivot pin
5. Shoulder
6. Lever
7. #8-32 hex head screws
8. Drive bracket

* Insert stepped end of pivot pin into link so that the link rides on the shoulder.

Figure 9-21 TS Control Contact Assembly

Notes

This section explains how to replace the transfer switch main contacts and operator coil in 600- and 800-amp programmed-transition bypass/isolation switches.

Bypass, isolate, and remove the transfer switch from the enclosure before working on it.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

10.1 Manual Operation

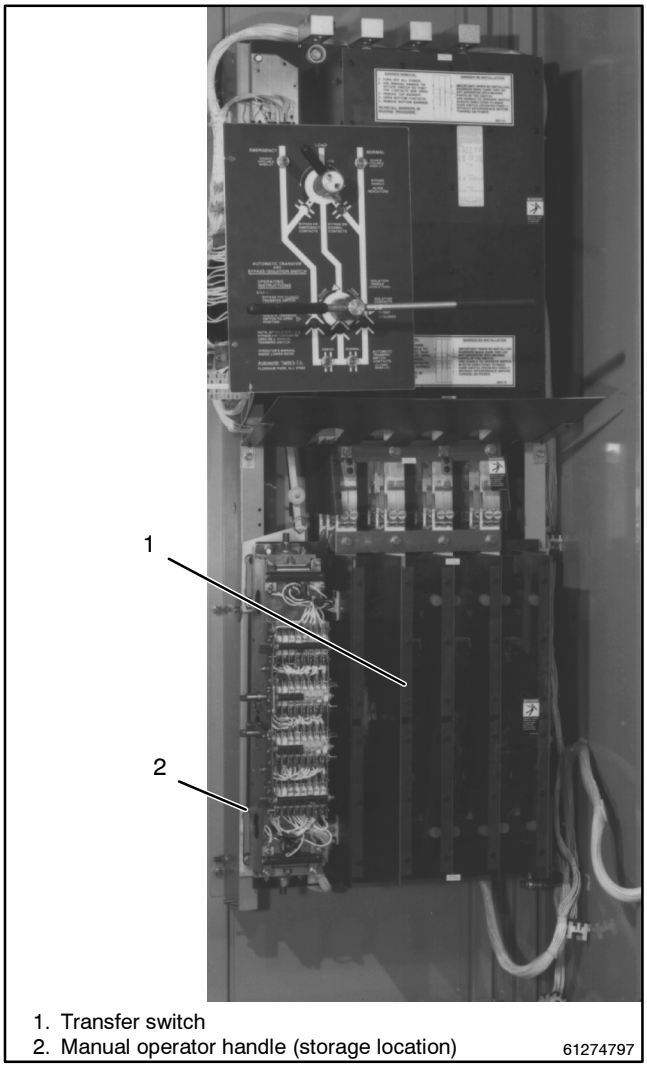
A detachable manual operator handle is provided *for maintenance purposes only.* The handle is stored on the coil frame on the left side of the switch. See Figure 10-1.

Note: To prevent the possibility of personal injury or property damage, do not manually operate the transfer switch until it is bypassed and isolated.

Install the manual handle onto the upper or lower shaft on the left side of the transfer switch. See Figure 10-2. Move the handle down and up to manually operate the transfer switch, as needed, in the following maintenance procedures.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.



1. Transfer switch
2. Manual operator handle (storage location)

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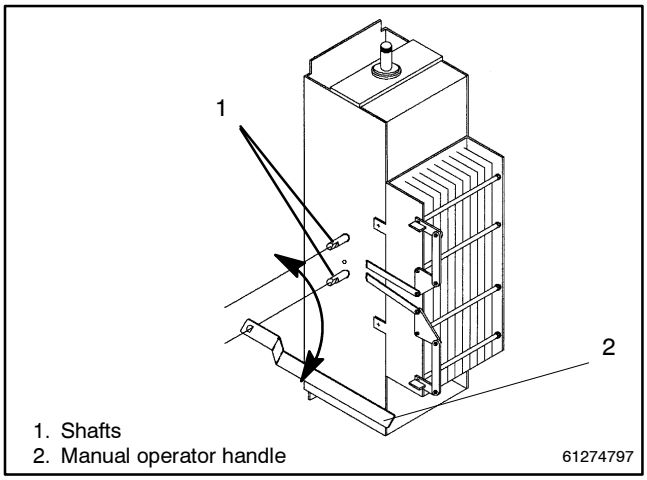
Figure 10-1 Bypass Switch, typical



1. Shafts
2. Manual operator handle

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Figure 10-2 Manual Operator Handle

10.1.1 Tools Needed

- Medium blade screwdriver
- Phillips screwdriver
- Offset screwdriver
- Needle-nose pliers
- Rod or drill, 1/4 in. diameter
- Nutdriver, 1/4 in.
- Nutdriver, 5/16 in.
- Nutdriver, 7/16 in.
- Nutdriver, 1/2 in.
- Nutdriver, 3/4 in.
- Hex key wrench, 1/8 in.
- Hex key wrench, 3/16 in.
- Open-end wrench, 5/16 in.
- Socket wrench, 7/16 in.
- Socket wrench, 1/2 in.
- Bench vise
- Voltmeter
- Ruler
- Loctite® 222
- Thread sealant
- Cotton swab or small brush

10.2 Main Contact Replacement

See the ATS Parts Catalog to identify the contact kits for your transfer switch.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

* Loctite is a registered trademark of the Loctite Corporation.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

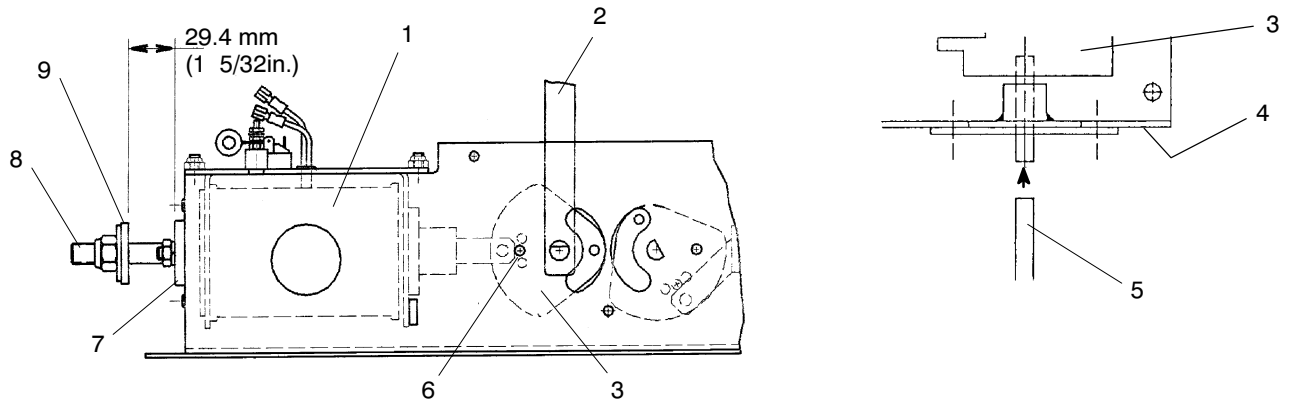
The barriers and arc chutes must be removed to gain access to the main contacts.

Procedure to Remove Barriers and Arc Chutes

1. Remove the barrier cover. Use a Phillips screwdriver to loosen only four screws (two on each side). Then pull the barrier cover straight out.

2. Remove all arc chutes. Use a screwdriver to remove two nylon retainer nuts and fiber clamp piece on each chute. Then carefully pull the arc chute away from the panel.

3. Put the switch in the center position (TDC). Use the manual handle to open the contacts until a 1/4 in. diameter rod (drill) can be inserted into the center hole in the side of the weight. It will hold the operator in the top-dead-center position and the contact shaft in a mid position. See Figure 10-3.



1. Coil
2. Manual operator handle
3. Weight
4. Sidewall of operator frame
5. Rod, 1/4 in. diameter. Insert rod through sidewall and into the center hole to lock weight in TDC (center) position.
6. Center hole
7. Retainer
8. Core stem
9. Leather washer

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Figure 10-3 Rod Inside of Solenoid Operator Weight (shown on its side)

10.2.1 Disassembly of Movable Contacts

The movable arcing and main contacts are mounted on the shaft assembly. The main contacts are screwed to the back side of the two finger blocks and to the shunts. The arcing contact assemblies, which extend from the ends of the main contacts, are the normal replacement parts. They *make* first and *break* last to protect the main contacts. See Figure 10-4.

Disassembly of Movable Arcing Contacts

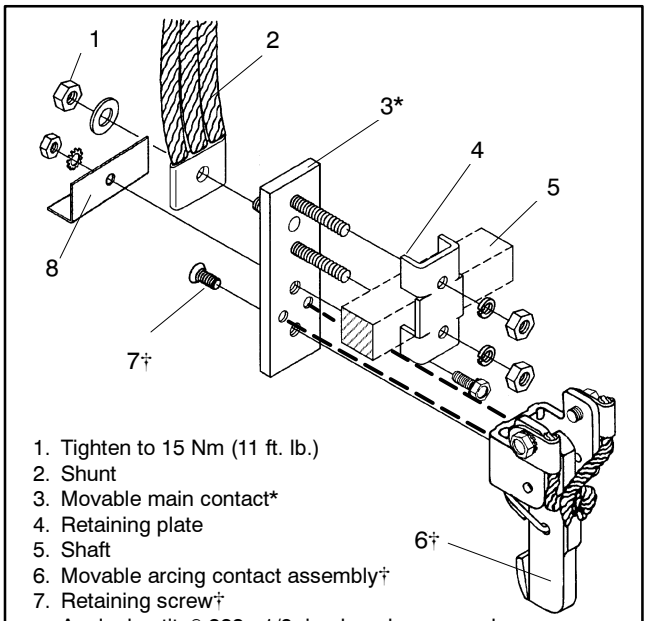
Remove the arcing contact assembly. Use a 1/8 in. hex key wrench to remove the retaining screw from the base of the arcing contact assembly.

Disassembly of Movable Main Contacts

1. Close the bottom main contacts. Remove the 1/4 in. rod (Figure 10-3) while using the manual operator handle to put the switch in the NORMAL position (bottom contacts closed).

2. Disconnect the main shunts. Use a 1/2 in. socket wrench to remove the large hex nut and flat washer to disconnect the shunt from the movable main contact.

3. Remove the movable main contacts. Use a 7/16 in. nutdriver to remove the two hex nuts and lock washers securing the movable main contact to the shaft. Use a 7/16 in. socket wrench to hold the nut securing the L insulator behind the main contact while removing the screw. Then remove the movable main contact.



1. Tighten to 15 Nm (11 ft. lb.)
2. Shunt
3. Movable main contact*
4. Retaining plate
5. Shaft
6. Movable arcing contact assembly†
7. Retaining screw†
   Apply Loctite® 222; 1/8 in. hex key wrench; tighten to 3.6 Nm (32 in. lb.)
8. L insulator with hex nut and shake washer

* Indicates parts included in main contact kit.
† Indicates parts included in arcing contact kit.

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Figure 10-4 Movable Contacts

10.2.2 Reassembly of Movable Contacts

Reassembly of Movable Main Contacts

1. Install the new movable main contacts. See Figure 10-4. Place the new movable main contact behind the shaft and install the retaining plate. Secure the parts with two hex nuts with lock washers. Install the L insulator behind the main contact and secure it with bolt and flat washer (front) and lock washer and hex nut (back). Use a 7/16 in. nutdriver and socket wrench to tighten the hardware.

Note: Be sure to install the L insulator behind the main contact.

2. Close the bottom main contacts. Use the manual operator handle to remove the spacer and to put the switch in the NORMAL position (bottom contacts closed).

3. Reconnect the main shunts. Attach the main shunt to the back of the movable main contact on the threaded stud and secure it with the large hex nut with flat washer. Use a 1/2 in. socket wrench to tighten to 15 Nm (11 ft. lb.).

Reassembly of Movable Arcing Contacts

1. Install the new arcing contact assembly on the main contact. Apply Loctite ® 222 thread sealant to threads of retaining screw. Install the retaining screw through the main contact into the base of the arcing contact and use a 1/8 in. hex wrench to tighten to 3.6 Nm (32 in. lb.)

2. Check the main contact gap. When installing a new arcing contact assembly, a gap of 4 mm (5/32 in.) between the main contacts is automatically obtained when the arcing contacts just touch. However, if a minor adjustment is necessary to obtain this gap, bend the adjustment tab on the arcing contact assembly. Refer to Figure 10-5 for instructions on tab adjustment.

   Note: Recheck any adjustment by manually operating the switch a few times and rechecking the gap between the main contacts.

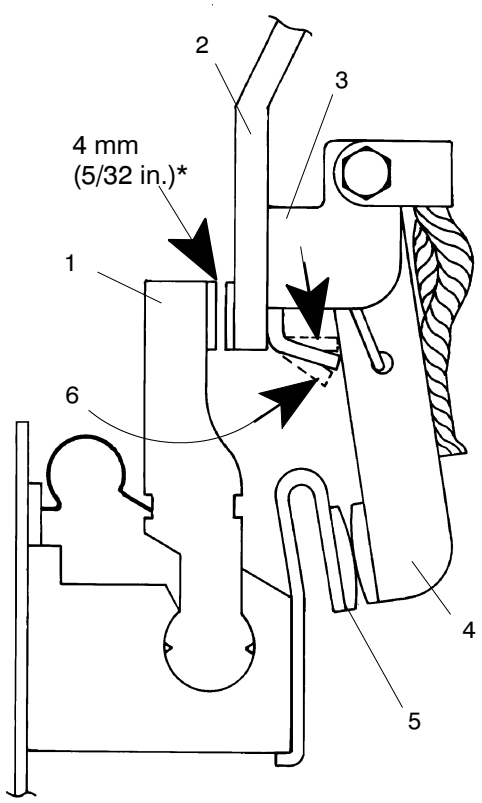
3. Install all arc chutes. Slide the arc chute (arc splitters toward the panel) between the long threaded rods. Place the arc chute retainer onto the arc chute. Use a blade screwdriver to gently tighten the two nylon retainer nuts on both sides of arc chute. Do not overtighten these nuts.

* Loctite is a registered trademark of the Loctite Corporation.

4. Check the clearance between the contacts and the arc chutes. Use the manual operator handle to slowly open and close the contacts while checking that they do not hit the arc chutes.

5. Install the barrier cover. Use the manual operator handle to put the switch in the NORMAL position (bottom contacts closed, top contacts open). Then reinstall the barrier cover and tighten the four Phillips head screws (two on each side).

Note: Operate the switch manually to be sure there is no misalignment or binding before operating it electrically.



1. Stationary main contact
2. Movable main contact
3. Bracket
4. Movable arcing contact*
5. Stationary arcing contact*
6. Adjustment tab:
   To increase gap, bend tab away from bracket. To decrease gap, bend tab toward bracket.

* With 4 mm (5/32 in.) gap at the main contacts, the arcing contacts should just touch.

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Figure 10-5 Arcing Contact Adjustment (side view)

10.2.3 Disassembly of Stationary Contacts

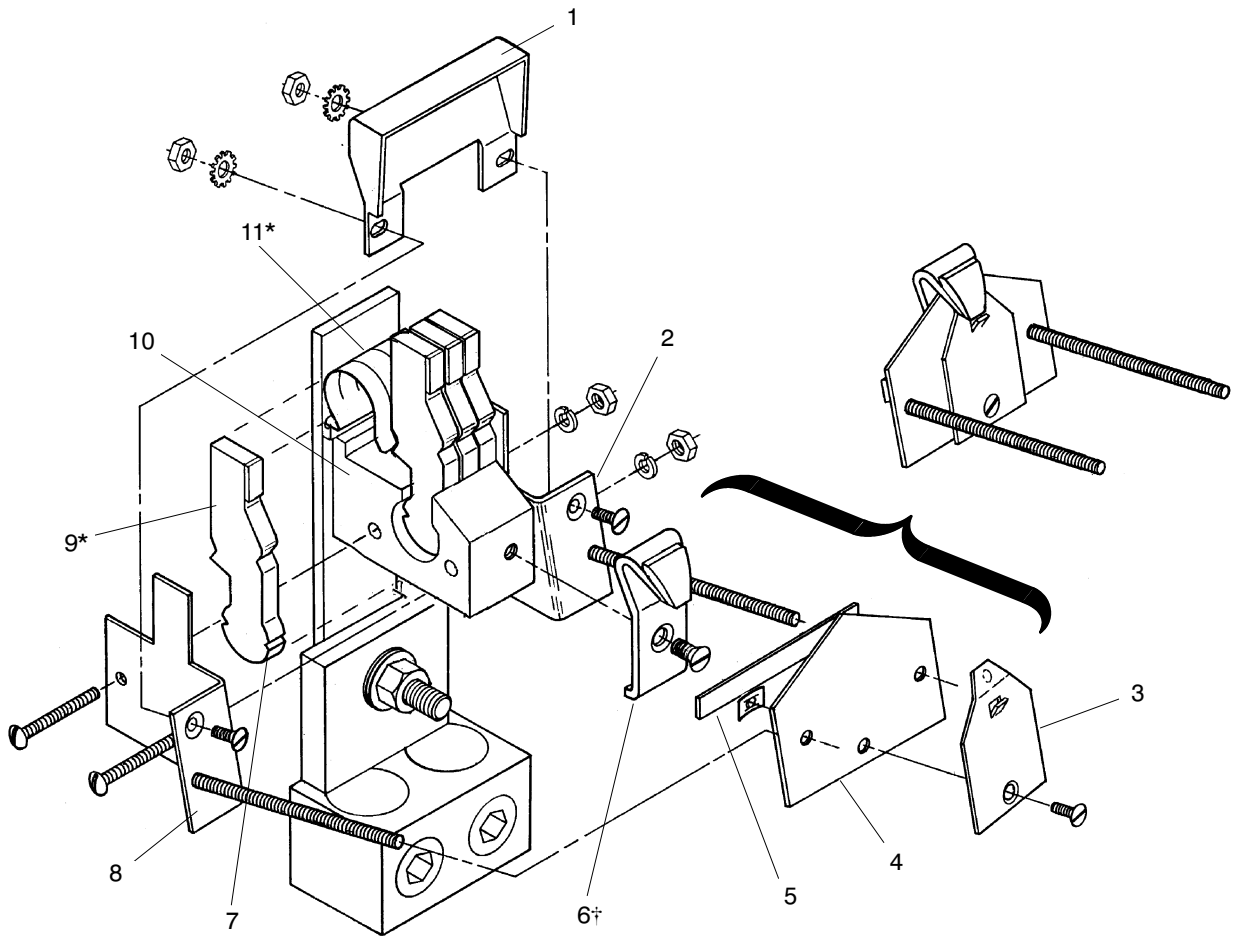
The stationary arcing and main contacts are mounted on the contact pivot blocks. The main contacts are held in the contact pivot blocks by the arc chute mounting brackets. The arcing contacts, which are screwed to the front of the contact pivot blocks, are the normal replacement parts. They 'make' first and 'break' last to protect the main contacts. See Figure 10-6.

Disassembly of Stationary Arcing Contacts

1. Remove the arc runner plate. Use a medium blade screwdriver to remove the flathead screw. Place your finger behind the plate to catch the spring nut. Then slide the arc runner plate out from under the arcing contact to remove it.

2. Remove the two insulator pieces. Carefully work the large insulator piece out from under the arcing contact while pulling it off the two long threaded rods. *Do not bend the insulator severely because it must be reused.* Also remove the thin insulator shim.

3. Remove all stationary arcing contacts. Use a medium blade screwdriver to remove the flathead screw, then remove the arcing contact.



1. Insulator tray
2. Right arc chute mounting bracket
3. Arc runner
4. Large insulator piece
5. Small insulator piece
6. Stationary arcing contact†
7. Apply conductive lubricant to main contact hinge joints
8. Left arc chute mounting bracket
9. Stationary main contact segment*
10. Contact pivot block
11. Stationary main contact leaf spring*

* Indicates parts included in main contact kit.
† Indicates parts included in arcing contact kit.

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Figure 10-6 Stationary Contacts

Disassembly of Stationary Main Contacts

1. Remove the insulator trays. Use a medium blade screwdriver to remove the two flathead screws from the arc chute mounting brackets, then remove the insulator tray.

2. Remove the arc chute mounting brackets. Use a 5/16 in. open end or box wrench and an offset screwdriver to remove the two nuts from the screws through the contact pivot block. Then remove both arc chute mounting brackets.

3. Remove stationary main contacts and springs. Use a pair of needle-nose pliers to release the spring leaves from the individual contact segments and work the main contacts out of the pivot block. *Do not damage the inside of the contact pivot block.* Then remove the contact spring.

10.2.4 Reassembly of Stationary Contacts

Reassembly of Stationary Arcing Contacts

1. Install the new stationary arcing contacts. Apply a few drops of Loctite® 222 thread sealant to the threads of the large flat head screw. Then attach each new contact to the pivot block by using a medium blade screwdriver to install the large flat head screw. Tighten the screw.

2. Install two insulator pieces. Slide the large insulator piece onto the two long threaded rods. Carefully work the pointed side of the insulator under the arcing contact while pushing the insulator in. Insert the thin insulator shim behind the large insulator before pressing it all the way in. Position the thin insulator shim close to the threaded rods.

3. Install the arc runner plate. Hold the thin insulator shim in place close to the threaded rods while sliding the arc runner plate under the arcing contact. The arc runner plate should fit snugly and its tab must touch the tip of the arcing contact. Secure the arc runner plate to the large insulator piece with the small flat head screw and spring nut.

* Loctite is a registered trademark of the Loctite Corporation.

Reassembly of Stationary Main Contacts

1. Apply conductive lubricant to hinge joints. Use a cotton swab or small brush to apply conductive lubricant (Dynaloy 495) to the inside of the contact pivot blocks. Also apply a thin film of conductive lubricant to the curved surface of each new main contact segment.

Note: Failure to apply conductive lubricant to the main contact hinge joints will cause overheating.

2. Install new contact segments and springs. Place a new contact spring into the spring base insulator and hold it in place with one hand. With your other hand carefully install a new contact segment into the contact pivot block. Depress the contact spring leaves to work the contact into the center. In a similar manner install the remaining contact segments from either side of the pivot block. Carefully use a pair of needle-nose pliers to position the spring leaves close to the pivot block in the notch in each contact.

3. Install the arc chute mounting brackets. Place left and right arc chute mounting brackets on either side of the contact pivot block. Then insert two long #8-32 screws through the brackets and pivot block. Secure the brackets with lockwashers and nuts, and use a 5/16 in. open end or box wrench and an offset screwdriver to tighten the two nuts.

4. Check the contact deflection. Press in on each stationary main contact to verify freedom of movement and spring pressure. If there is binding check the position of the spring leaves and conductive lubrication.

5. Install the insulator trays. Place the insulator tray mounting tabs behind the arc chute mounting brackets. Fasten the insulator tray with two #6-32 flathead screws with lockwashers and nuts. Use a screwdriver to tighten the screws.

10.3 Operator Coil Replacement

Refer to the ATS Parts Catalog, for instructions to obtain replacement parts for your switch.

10.3.1 Removal of Coil Assembly

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

Note: To prevent the possibility of fatal electrical shocks and burns, bypass, isolate, and remove the transfer switch before working on it. Refer to the Operation and Installation Manual.

Two solenoid operators are used: One drives the normal source contact shaft, the other drives the emergency contact shaft. The solenoid operators face in opposite directions. These instructions (and Figure 10-7 through Figure 10-13) are for the upper solenoid operator.

The coil assembly is mounted in the operator assembly on the left side of the panel. It must be removed to a work bench for disassembly. See Figure 10-7, Figure 10-8, and Figure 10-9.

1. Put the transfer switch in the Emergency position. Use the manual operator handle (Figure 10-2) if necessary to close the top contacts.

2. Disconnect the rectifier and resistor (Figure 10-7). Carefully pull off the two white power wires and the two black coil leads from the square rectifier mounted on the coil assembly. Do not remove the blue varistor. Then remove the two hex nuts to disconnect the two white wires from the resistor (one on each end).

3. Remove the retaining screw (Figure 10-7) and link pin (Figure 10-8). Use a 3/16 in. hex key wrench to remove the hex socket head screw from the weight. Then use a screwdriver to pry out the link pin in the left side of the weight.

4. Remove the coil assembly (Figure 10-9). Use a 7/16 in. nutdriver or wrench to remove four hex nuts from the operator frame. Then remove the coil assembly to a work bench.

10.3.2 Coil Removal

The solenoid coil is held in the coil frame by the core tube assembly. See Figure 10-10.

1. Remove the core tube assembly. Use a 1/2 in. nutdriver or wrench to remove the upper and lower hex nuts and lock washers from the end of the coil frame. Then pull out the core tube assembly.

2. Remove the coil from the coil frame. Slide the grommet with coil leads out of the slot. Use a 5/16 in. nutdriver or wrench to loosen (only) three coil-clamping SEMS head screws (lower end of coil frame), then pull out the coil and end washer.

Note: To avoid damage, do not tighten the vise on the core or core tube!

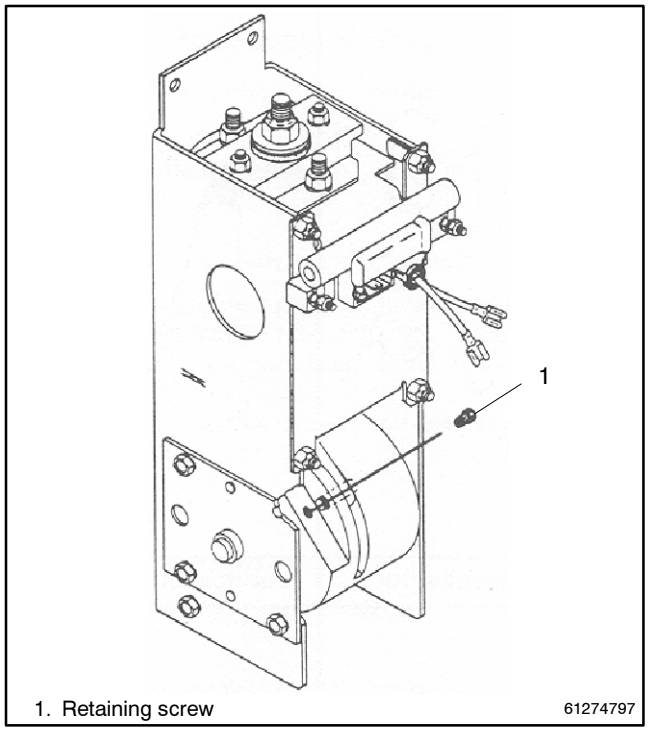


Figure 10-7 Retaining Screw

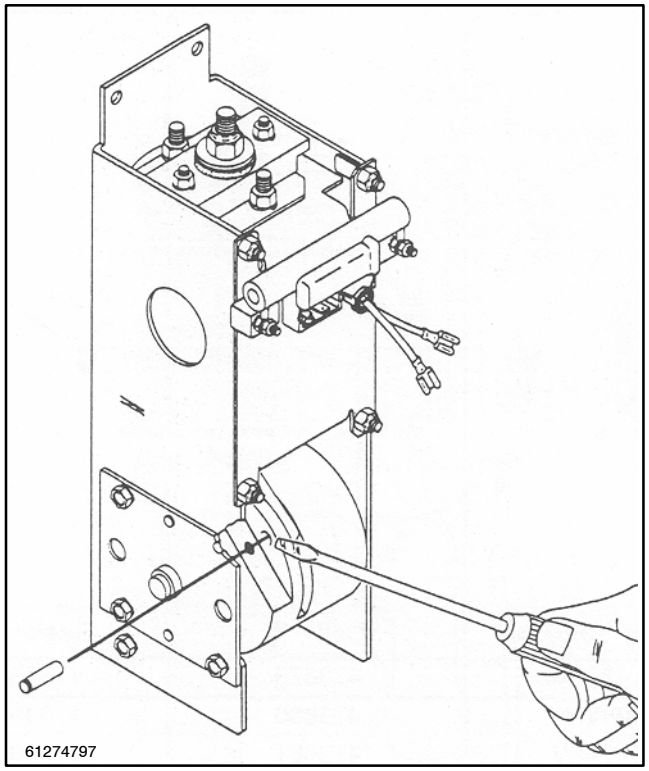


Figure 10-8 Link Pin

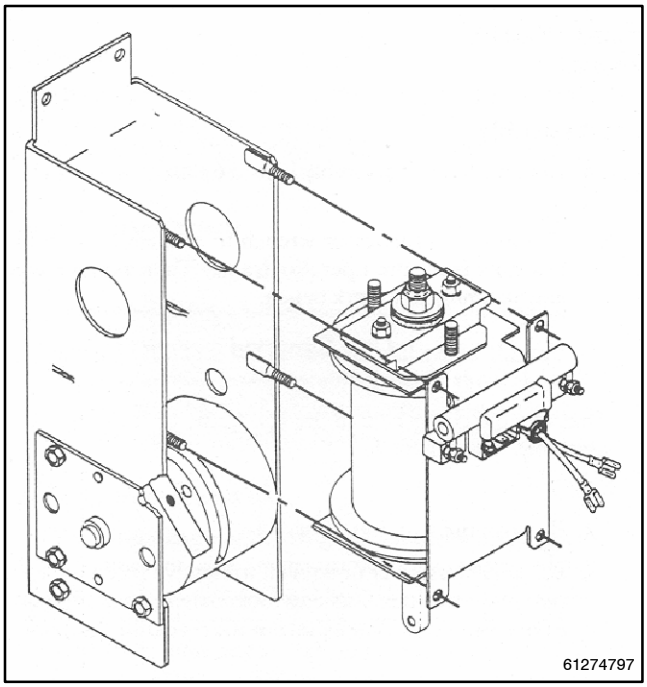


Figure 10-9 Removal of Coil Assembly from Operator Frame

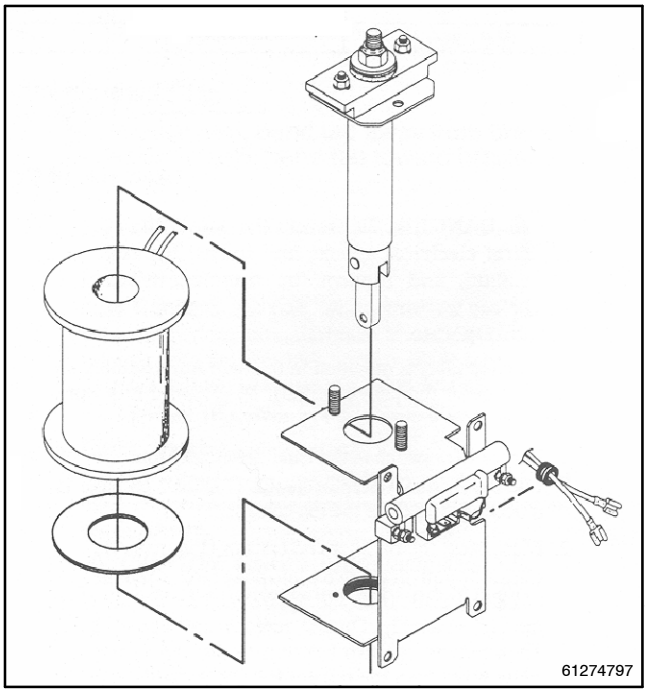


Figure 10-10 Removal of Coil and Core Tube Assembly

10.3.3 Core Tube and Core Disassembly

Disassembly of the core tube assembly is normally not required. If, however, the coil has overheated and has damaged the core tube assembly, rebuilding it is necessary. You will need an assistant to help you reassemble it, and you need to reset the stroke. See Figure 10-11 and Figure 10-12.

Note: To prevent the possibility of personal injury, hold the core tube assembly securely away from yourself when removing the center hex nut; the spring exerts substantial outward force on the core and link.

Note: To avoid damage, do not tighten the vise on the core or core tube!

1. Remove the core and compression spring (Figure 10-11). Hold the link in a vise to secure the assembly. Use a 3/4 in. nutdriver or wrench to remove the center large hex nut from the threaded stem end of the core.

Note: When the center hex nut is removed, the assembly will suddenly release the core and spring from the lower end of core tube assembly.

2. Take apart the core tube assembly (Figure 10-12). Use a 1/2 in. nutdriver or wrench to remove the left and right hex nuts and lockwashers and pull the spring retainer off the core tube retaining plate. Then push the core tube through the retaining plate to remove it.

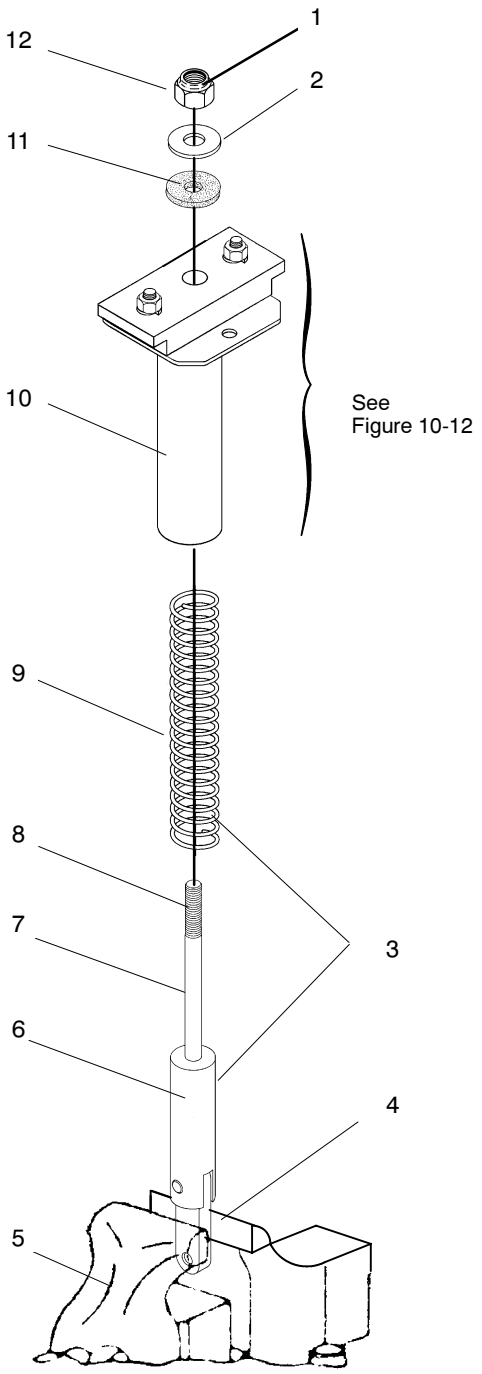
10.3.4 Core Tube and Core Reassembly

Replace damaged parts (core tube and core spring) and lubricate the core and core spring before reassembly. Use the lubrication kit shown in the ATS parts catalog listed in the Introduction to this manual.

You will need an assistant to help compress the spring while you install the hardware. See Figure 10-11 and Figure 10-12.

1. Put together the core tube assembly (Figure 10-12)). Insert the core tube through the retaining plate (flared end seats on top). Then install the spring retainer (recessed hole inward) onto the retaining plate and use a 1/2 in. nutdriver or wrench to tighten the two 5/16-18 hex nuts on 5/16 in. lock washers.

2. Lubricate the core and core spring. Use the contents of the Lubrication Kit to apply a thin coating onto the core surface and onto the core spring.



1. Stroke adjustment stop nut
2. Flat washer*
3. Lubricate surface
4. Link
5. Vise
6. Core
7. Core and link assembly
8. Stem
9. Compression spring*
10. Core tube assembly
11. Leather washer*
12. Hex nut with nylon insert*

* Indicates parts included in coil kit.

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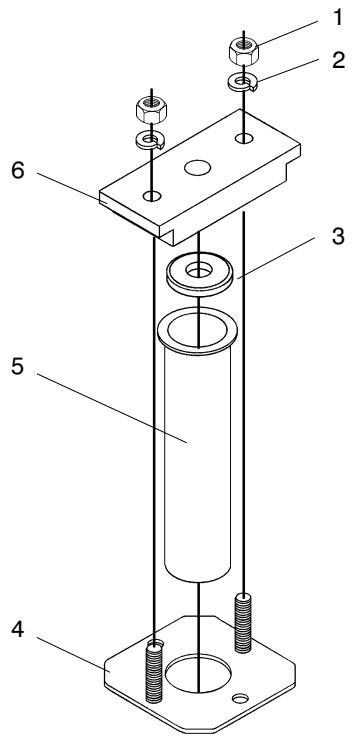
Figure 10-11 Core Tube and Core Disassembly



1. Split lock washer
2. Nylon guide washer*
3. Core tube retaining plate*
4. Core tube*
5. Spring retainer
6. Hex nut

* Indicates parts included in coil kit.

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Figure 10-12 Core Tube Assembly

Note: To prevent the possibility of personal injury, hold the core tube assembly securely away from yourself when installing the center hex nut; the spring exerts substantial outward force on the core and link.

3. Assemble the core, spring, and core tube assembly (Figure 10-11). With the link held securely in a vise, set the lubricated core spring onto the core stem. Check to see if the nylon guide washer is still inside the spring retainer; if it is not, place it inside the spring retainer.

   Have an assistant push the core tube assembly onto the spring and hold it down (guide the threaded core stem through the center hole) while you add the threaded leather washer, flat washer, and 1/2-13 hex nut onto the core stem. Use a 3/4 in. nutdriver or wrench to tighten the nut. The nut must be adjusted later for proper stroke of 28.6 mm (1 1/8 in.).

10.3.5 Coil Installation

Replace the damaged coil before reassembly. See Figure 10-10.

1. Install the replacement coil. With the coil leads up and to the right, insert the new coil with a coil washer on the bottom into coil frame Then run the coil leads through the grommet and slide it into the slot (right side of coil frame).

2. Install the core tube assembly. Insert the core tube assembly down through the hole in the coil frame and use a 1/2 in. nutdriver or wrench to tighten the upper and lower hex nuts with lock washers on the coil frame.

3. Tighten the coil-clamping screws. Use a 5/16 in. nutdriver or wrench to tighten the three SEMS head screws on the bottom of the coil frame.

10.3.6 Installation of Coil Assembly

The coil assembly can now be reinstalled onto the operator assembly on the left side of the switch panel. See Figure 10-7, Figure 10-8, and Figure 10-9.

1. Install the coil assembly onto the operator frame (Figure 10-9). Place the coil assembly onto the four studs on the operator frame and align the link into the slotted weight. Use a 7/16 in. nutdriver or wrench to tighten the four hex nuts.

2. Install the link pin and retaining screw (Figure 10-8). Insert the link pin (groove side out)

into the left side of the weight and through the link. Then install the hex socket head retaining screw into the weight and use a 3/16 in. hex key wrench to tighten it.

3. Reconnect the resistor/rectifier on the coil frame (Figure 10-7). Replace the resistor (if necessary) and reconnect the two white wires with ring lugs to each end and install and tighten the hex nuts. Replace the rectifier (if necessary) and carefully reconnect the four wires with push-on lugs to the rectifier terminals as follows: connect the two white power wires to the AC terminals (~), and connect the two black coil leads to the DC terminals (red dot and no dot, polarity does not matter). Be sure the blue snubber is still installed between the DC terminals. See Figure 10-13.

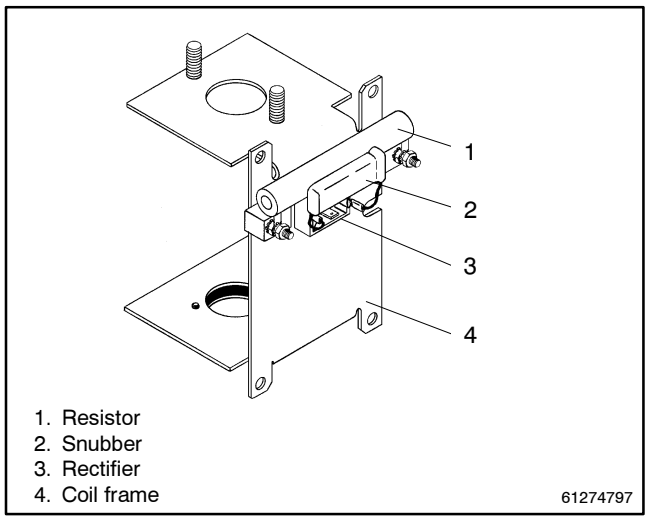


Figure 10-13 Rectifier and Resistor

4. Manually operate the transfer switch. Use the manual operator handle (Figure 10-2) to manually operate the transfer switch. It should operate smoothly without any binding. If not, recheck the alignment of parts and the lubrication of the solenoid operator. Close the bottom contacts and remove the manual handle.

5. Reinstall the transfer switch. Refer to the bypass/isolation switch Operation and Installation Manual for instructions.

Notes

Section 11 1600–3000 Amp Open-Transition Switches and 1000–3000 Amp Bypass/Isolation Switches

This section explains how to replace the arcing and main contacts and the solenoid assemby in 1600–3000 amp automatic transfer switches and 1000–3000 amp bypass/isolation switches (lower assembly).

⚠ DANGER

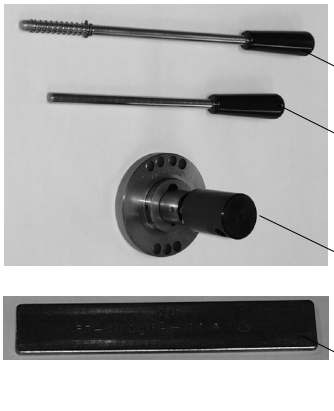
Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Special Tools Needed

Contact your supplier of DDC/MTU Power Generation parts to order the tools shown in Figure 11-1.



1. Maintenance handle GM25404
2. Adjusting pin GM25405
3. Adjusting hub GM25406
4. Main contact shim gauge GM25407

6127216

Figure 11-1 Special Tools

Other Tools Needed

- Small and large blade screwdrivers
- Ratchet drive, 3/8 in., and extensions, 6 in. and 12 in.
- Sockets, 3/8 in. and 1/2 in.
- Open-end/box wrenches, 5/16 in. and 1/2 in.
- Torque wrench (0–50 in. lb. minimum)
- Hex key (Allen) wrench, 5/32 in.
- Ohmmeter (or continuity tester)
- Needle nose and regular pliers

11.1 Maintenance Handle

A detachable manual operator handle is provided on the frame of the transfer switch *for maintenance purposes only*. After the transfer switch is isolated and pulled out (drawn out and totally deenergized), this handle can be used to change the position of the contacts and operator mechanism. The windows in the left side of the transfer switch frame indicate which contacts are open and closed.

1. Bypass, isolate, and pull out the transfer switch**.** Follow the procedure explained in *Section 3* of the *operation manual*. Verify that no electrical power is present at the pulled-out transfer switch.

2. Install the hub and maintenance handle**.** Locate and remove the maintenance handle and hub stored on the lower part of the transfer switch frame. Then install the hub onto the center operator shaft and insert the handle into the hole in the side of the hub.

3. To manually operate the deenergized transfer switch to the opposite position, grasp the maintenance handle firmly and turn either clockwise or counterclockwise. See Figure 11-3. Then remove the handle and hub.

11.2 Main Contact Inspection and Replacement

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

The movable contact assemblies (two for each pole) are located above and below the operator mechanism.

1. Bypass, isolate, and pull out the transfer switch**.** Follow the procedure explained in the Bypass/Isolation Switch Operation and Installation Manual. See Figure 11-2. Verify that no electrical power is present at the pulled-out transfer switch.

2. Open the contacts that will be replaced (if not already open) by using the detachable maintenance handle. See Figure 11-3.

3. Remove the interphase barriers (one per pole). Use a blade screwdriver to loosen two round-head screws holding each barrier to the arc chutes. Slide the barrier away from the operator mechanism until the keyholes in barrier clear the two round-head screws, then remove the barrier. See Figure 11-4.

4. Carefully remove the arc chutes**.** Use a 5/8 in. nutdriver to remove two long insulator nuts. Then carefully pull the arc chute outward (off the long threaded rods). Place the arc chutes in a safe place. See Figure 11-5.

   Note: The arc chutes are fragile. To prevent breakage, avoid jarring them and do not use any tool to pry them loose. If they become cracked, replace them. See Figure 11-6.

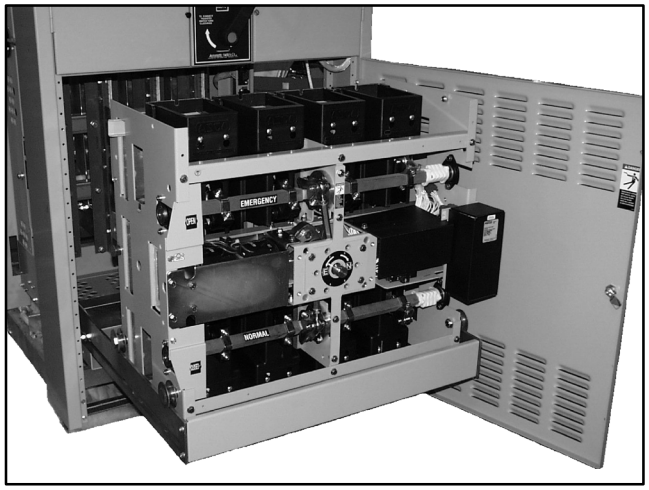


Figure 11-2 Isolated and Pulled-Out Transfer Switch

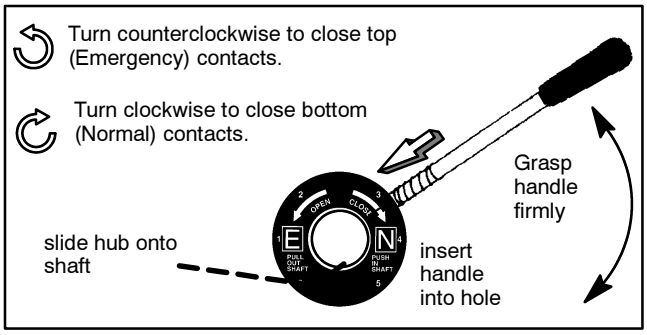


Figure 11-3 Maintenance Handle On Operator Shaft

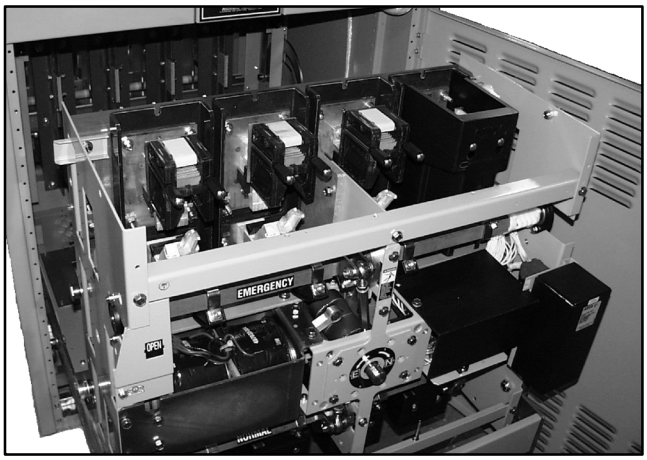


Figure 11-4 Interphase Barriers Removed

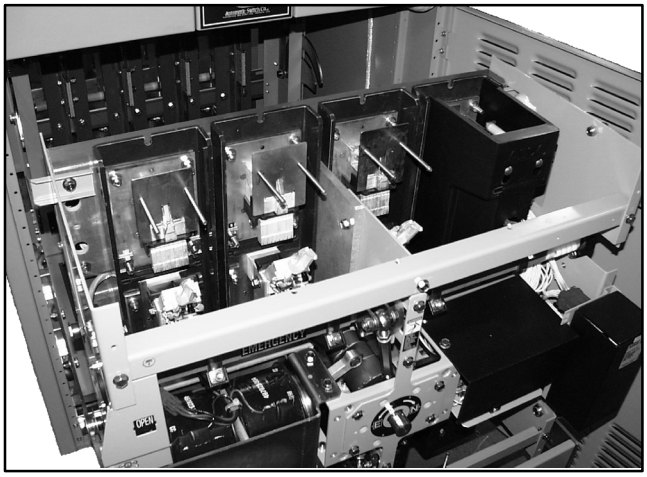
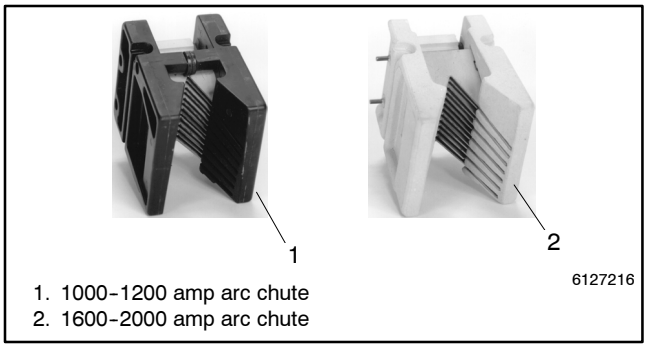
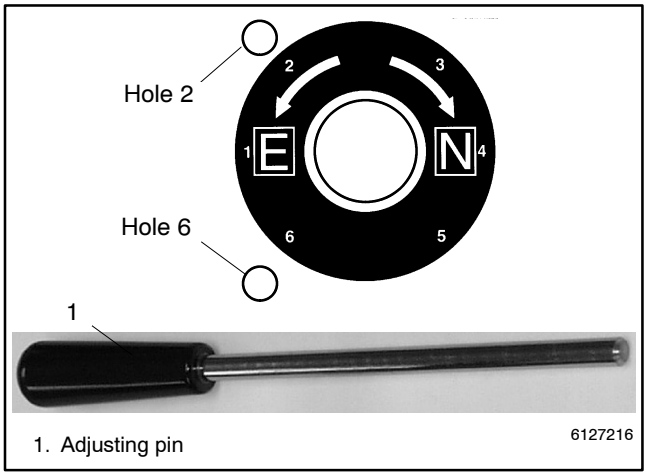


Figure 11-5 Arc Chutes Removed



1. 1000–1200 amp arc chute
2. 1600–2000 amp arc chute

Figure 11-6 Replacement Arc Chutes



1. Adjusting pin

Figure 11-7 Pin the Weight to the Frame. See Step 5.

5. Pin the weight to prevent mechanism from moving**.** Fully insert the adjusting pin (see page 1) through the frame and into the weight. Only one of the holes lines up with the hole in the weight. If you are replacing the upper contacts, use the hole labeled 2; if you are replacing the lower contacts, use the hole labeled 6. See Figure 11-7.

   Note: To prevent the possibility of personal injury, be sure to pin the weight to the weight frame so that the mechanism cannot move.

11.2.1 Contact Inspection

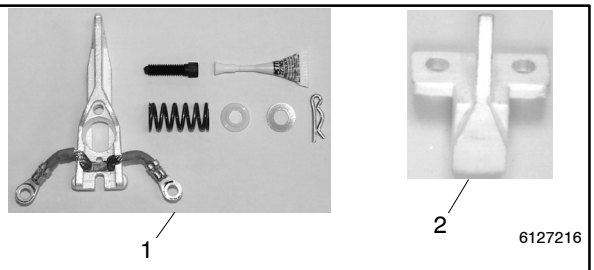
The main contacts are protected by arcing contacts. The arcing contacts make first and break last to avoid arcing at the main contacts. Check the contact adjustments annually (see page 6). Replace contacts when the contact material becomes severely worn. Discoloration is normal. Do not file contacts because it wastes material. Instead use light emery paper to clean up the contact surfaces.

11.2.2 Contact Replacement

Arcing Contacts only include just the arcing contacts that *make* first and *break* last during load transfer. See Figure 11-8.

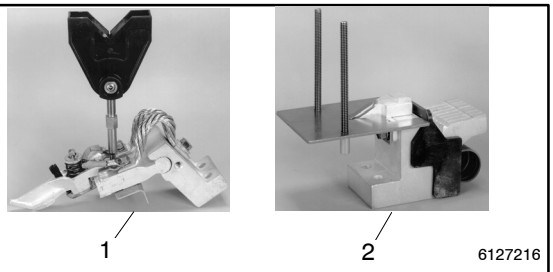
Main and arcing contact assemblies include the entire movable or stationary contact structure, including contacts, springs, shunts, conductive lubricant, and hardware. See Figure 11-9.

If *only* the arcing contacts require replacement, follow the procedure for Arcing Contact Replacement. If the main contacts require replacement, follow the procedure for Main and Arcing Contact Assembly Replacement.



1. Movable arcing contact
   (with adjustment screw, thread locker Loctite® 222, contact spring, spring retainer, washer, spring pin)
2. Stationary arcing contact

Figure 11-8 Replacement Arcing Contact Kit (One kit includes 1 movable and 1 stationary A 3-pole switch requires 6 kits.)



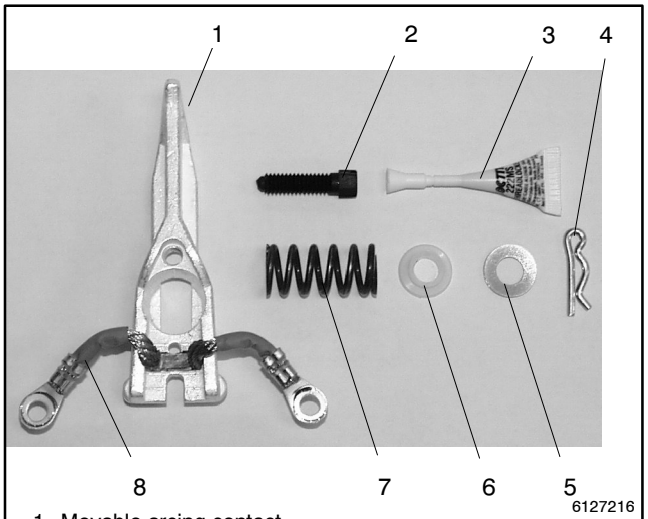
1. Movable main and arcing contact assembly (with thread locker Loctite® 222)
2. Stationary main and arcing contact assembly

Figure 11-9 Main and Arcing Contact Assemblies Kit (One kit includes 1 movable and 1 stationary. A 3-pole switch requires 6 kits.)

* Loctite is a registered trademark of the Loctite Corporation.

Arcing Contact Replacement

1. Remove the movable arcing contact**.** Use needlenose pliers and a screwdriver to remove the spring pin from the spring stud. Then remove the flat washer, spring guide, and contact spring. Next use a 3/8 in. socket wrench to remove two SEMS screws from the pigtails attached to the main movable contact. Now remove the arcing contact retainer and the movable arcing contact.



1. Movable arcing contact
2. Adjustment screw
3. Loctite® 222 service removable thread locker
4. Spring pin
5. Washer
6. Spring guide
7. Spring
8. Pigtails

Figure 11-10 Movable Arcing Contact and Hardware

2. Remove the stationary arcing contact**.** Use a 3/8 in. socket wrench to remove two SEMS screws holding the arcing contact (and arc chute support plate) to the main contact pivot block. Then remove the stationary arcing contact.

3. Install a new stationary arcing contact**.** Install a new stationary arcing contact and the arc chute support plate onto the main contact pivot block. Use a 3/8 in. socket wrench to secure it with two SEMS screws. Tighten both screws to 7.5 Nm (5.5 ft. lb.) torque. See Figure 11-11.

4. Install new movable arcing contact**.** Put two drops of Loctite® 222 (this service-removable threadlocker is provided in the kit) to the lead threads of the adjustment screw. Then install the adjustment screw through the new movable arcing contact until it protrudes 3.2 mm (1/8 in.). Now install the movable arcing contact onto the movable main contact so that the spring stud goes through the arcing contact and its pivot points fit into the two depressions (in the main contact). Finally, install the arcing contact spring, spring guide, flat washer, and spring pin. See Figure 11-10.

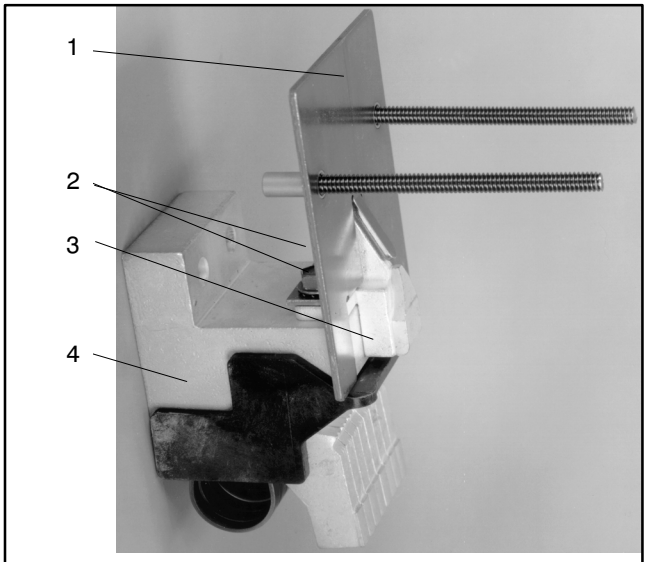
5. Reconnect the pigtails and shunts to the contact**.** Place the arcing contact retainer over the movable arcing contact and between the shunts and pigtails. Install two SEMS screws through the arcing pigtail lugs, arcing contact retainer, and main contact shunt lugs into the main movable contact. Use a 3/8 in. socket wrench to tighten the two screws to 7.5 Nm (5.5 ft. lb.) torque.

6. Adjust the arcing contacts**.** After all arcing contacts (both stationary and movable) have been installed, they must be adjusted. Proceed to Section 11.3.

   Note: Contact adjustment is required to prevent contact damage. Follow the adjustment procedures in Section 11.3.

Main and Arcing Contact Assembly Replacement

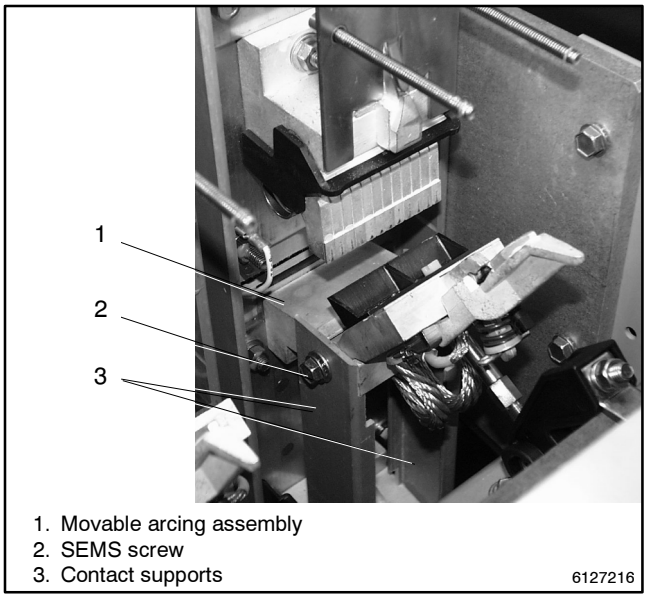
1. Remove the contact supports from both sides**.** Use a 1/2 in. box or open-end wrench to remove four SEMS screws (left and right, upper and lower). Then remove the two contact supports that run vertically between the Normal and Emergency movable contact assemblies (two for each pole). A 3 pole switch has 6 contact supports. See Figure 11-12.



1. Arc chute support plate
2. SEMS screws, two
3. Stationary arcing contact
4. Main contact pivot block

Figure 11-11 Stationary Arcing Contact

* Loctite is a registered trademark of the Loctite Corporation.



1. Movable arcing assembly
2. SEMS screw
3. Contact supports

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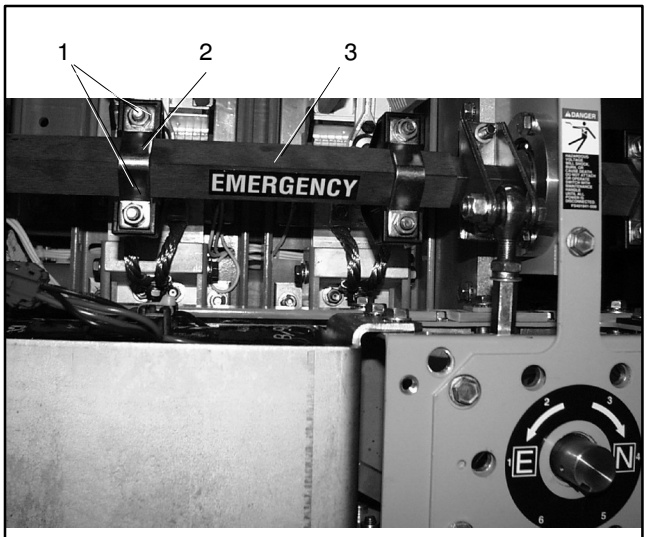
Figure 11-12 Contact Supports (Both Sides)

2. Disconnect the crank arm from the shaft**.** Use a 1/2 in. socket wrench to remove the two nuts with lock washers from each shaft clamp. Then remove the loose clamp from the shaft. Save all hardware. See Figure 11-13.

3. Remove the movable contact assembly**.** Use a 1/2 in. socket wrench with 12 in. extension to remove two nuts with lock washers from the base of each movable contact assembly. See Figure 11-14.

4. Remove the stationary contact assembly**.** Use a 3/8 in. socket wrench to remove the two SEMS screws from the top (or bottom) of each stationary contact assembly. Then use a 1/2 in. socket wrench with 12 in. extension to remove two nuts with lock washers from the base of each main stationary contact assembly. See Figure 11-15.



1. Nuts
2. Shaft clamp
3. Contact shaft

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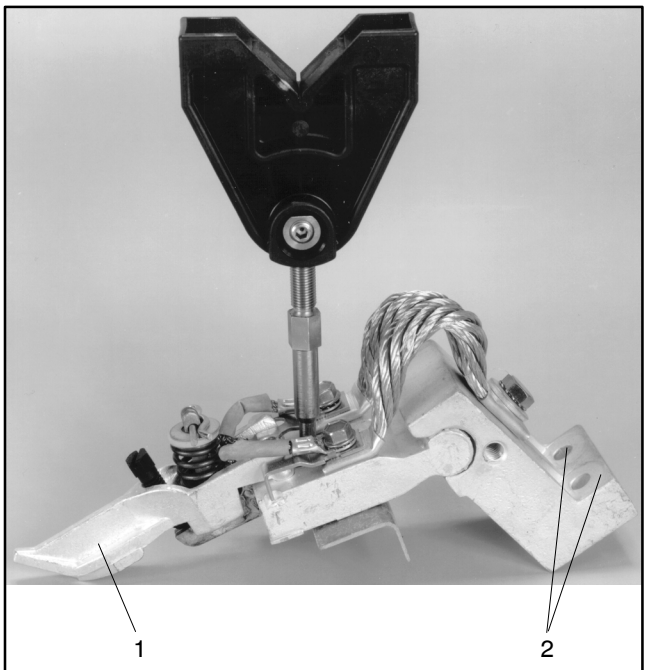
Figure 11-13 Movable Contact Shaft Clamps



1. Mounting holes, two
2. Movable arcing contact

Note: Crank arm attaches to the shaft

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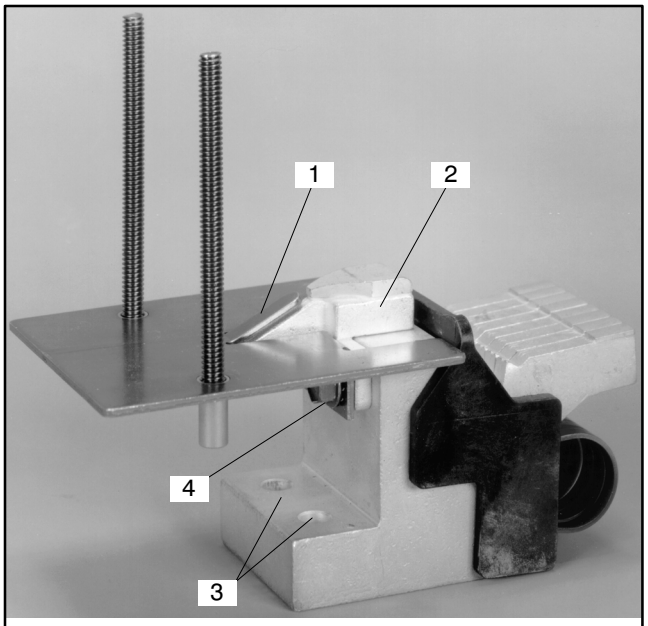
Figure 11-14 Movable Contact Assembly



1. Arc chute support plate
2. Stationary arcing contact
3. Mounting holes, two
4. SEMS screws, two

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Figure 11-15 Stationary Contact Assembly

5. Install the new stationary contact assembly**.** Position the *new* main stationary contact assembly onto the two 5/16 in. studs. Use a 1/2 in. socket wrench with 12 in. extension to install two nuts with lock washers to secure the assembly. Tighten to 132 in. lb. (11 ft. lb.) torque.

6. Install the arc chute support plate and arcing contact**.** Use a 3/8 in. socket wrench to install two SEMS screws through the *new* arc chute plate and *new* stationary arcing contact to the top (or bottom) of each new stationary contact assembly. Tighten to 66 in. lb. (5.5 ft. lb.) torque.

7. Install insulators onto the new stationary contact assembly. See Figure 11-16.

8. Install the new movable contact assembly**.** Position the *new* movable contact assembly onto the two 5/16 in. studs. Use a 1/2 in. socket wrench with 12 in. extension to install two nuts with lock washers to secure the assembly. Tighten to 132 in. lb. (11 ft. lb.) torque.

9. Connect new movable contact assembly to shaft**.** Position the *new* movable contact assembly (black drive arm) under the shaft. Then position the metal half clamp over the front and install two bolts (from the opposite side). Use a 1/2 in. wrench to install two nuts with lock washers to secure each clamp. Tighten the clamp nuts to 132 in. lb. (11 ft. lb.) torque.

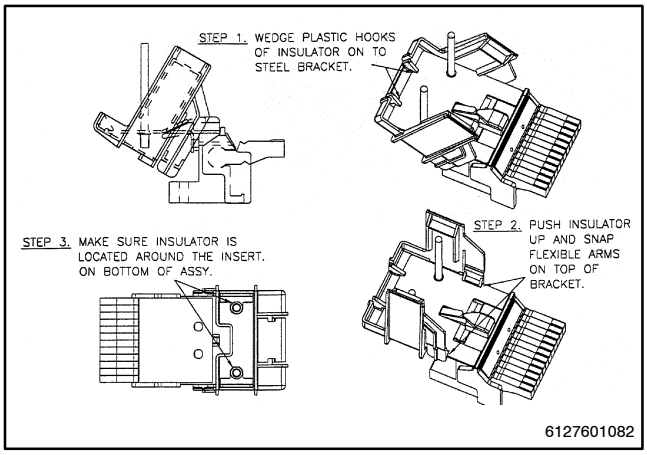


Figure 11-16 Insulators, 2600–3000 Amp Models

10. Adjust the arcing and main contacts**.** After all movable and stationary contact assemblies have been installed, they must be adjusted. Proceed to Section 11.3.

Note: Contact adjustment is required to prevent contact damage. Follow the adjustment procedures in Section 11.3.

11.3 Main and Arcing Contact Adjustment

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Check the contact adjustment once a year. After contacts are replaced contact adjustment is required before the transfer switch can be reenergized. Adjustment includes: A–Stationary Arcing Contact Alignment and B–Arcing Contact Lead Adjustment.

Contact Adjustment Procedure

1. Bypass, isolate, and pull out the transfer switch**.** Follow the procedure explained in the operation manual. Verify that no electrical power is present at the pulled-out transfer switch. See Figure 11-2.

2. Use the maintenance handle (if necessary). Open the contacts that will be adjusted (if not already open) by using the detachable maintenance handle. See Figure 11-3.

3. Remove the barriers**.** Use a blade screwdriver to loosen only two round-head screws holding each barrier to the arc chutes. Slide the barrier away from the operator mechanism until the keyholes in the barrier clear the two round-head screws, then remove the barrier. See Figure 11-4.

4. Carefully remove the arc chutes**.** Use a 5/8 in. nutdriver to remove two long insulator nuts. Then carefully pull the arc chute outward (off the long threaded rods). Place the arc chutes in a safe place to prevent breakage. See Figure 11-5.

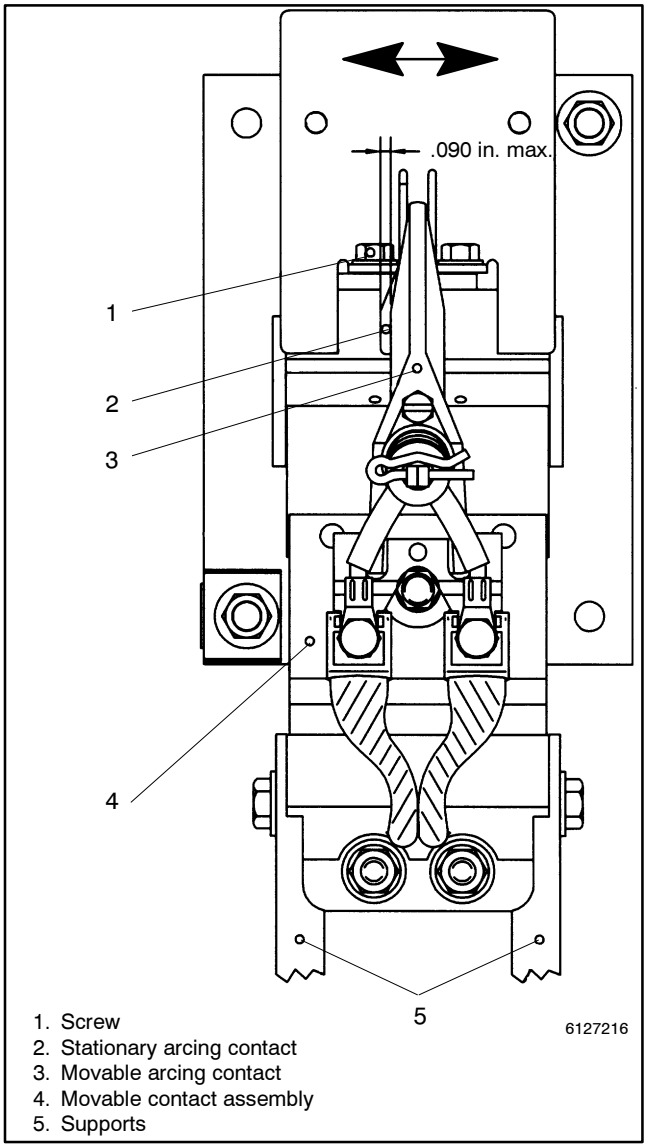
A–Stationary Arcing Contact Alignment

A maximum horizontal offset of 2.29 mm (0.090 in.) is allowed between the movable and stationary arcing contacts. See Figure 11-17. If adjustment is needed follow these steps:

1. Loosen the screws and move the stationary arcing contact**.** Use a 3/8 in. socket wrench to loosen the two SEMS screws, then move the stationary contact left or right to approximately center it under the movable arcing contact.

2. Retighten the stationary arcing contact screws**.** Use the maintenance handle to open and close the contacts to recheck contact alignment. Use a 3/8 in. socket wrench to retighten the two nuts to 66 in. lb. (5.5 ft. lb.) torque.

Note: To prevent arc chute breakage, be sure that the stationary arcing contact alignment is set correctly.



1. Screw
2. Stationary arcing contact
3. Movable arcing contact
4. Movable contact assembly
5. Supports

Figure 11-17 Stationary Arcing Contact Alignment

B-Arcing Contact Lead Adjustment

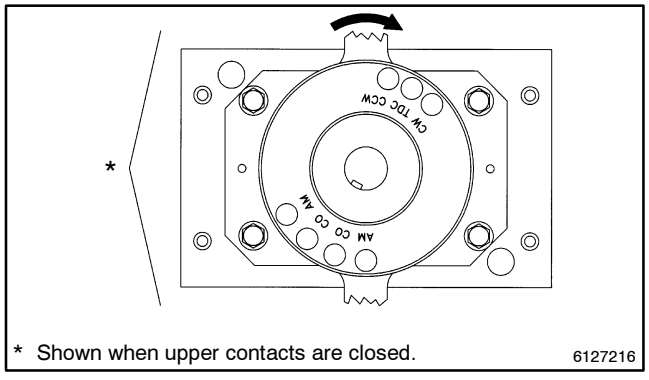
The arcing contacts must lead the main contacts on closing by 2 to 3 mm (0.08 to 0.12 in.). To set this contact gap (at the main contacts) use the adjusting hub, adjusting pin, and maintenance handle from the contact adjustment handle kit. To check and/or change the adjustment, follow these steps (see Figure 11-18 through Figure 11-22).

1. Install the adjusting hub and maintenance handle**.** Insert the maintenance handle completely into the hub (compress the handle spring) and grasp it firmly. Use the maintenance handle to close the contacts that you are checking or adjusting (if they are not already closed). See Figure 11-2.

   Note: To prevent the possibility of personal injury, be sure to fully pin the weight to the weight frame so that the mechanism cannot move while you are adjusting the contacts.

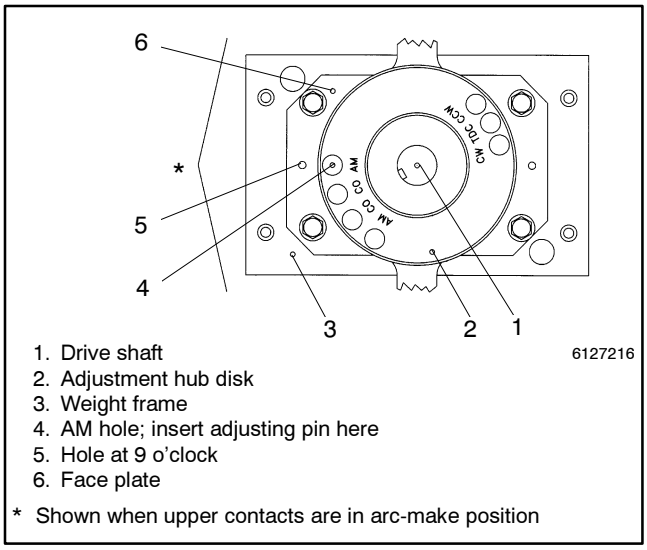
2. For closed upper contacts, pin the weight as shown in Figure 11-19**.** Turn the maintenance handle clockwise 30° until the AM hole is in the 9 o'clock position. Fully insert the adjusting pin into hole *AM* to lock the upper contact shaft in the ARC MAKE position. See Figure 11-18 (before) and Figure 11-19 (after).

3. For closed lower contacts, pin the weight as shown in Figure 11-21**.** Turn the maintenance handle counterclockwise 30° until the AM hole is in the 9 o'clock position. Fully insert the adjusting pin into hole AM to lock the lower contact shaft in the ARC MAKE position. See Figure 11-20 (before) and Figure 11-21 (after).



* Shown when upper contacts are closed. 6127216

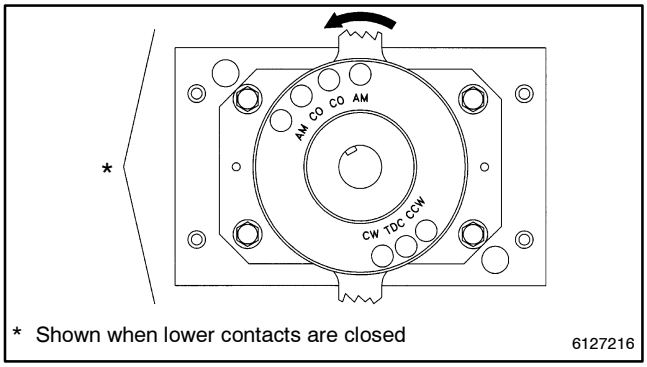
Figure 11-18 Pinning Weight For Upper Contacts (Before)



1. Drive shaft
2. Adjustment hub disk
3. Weight frame
4. AM hole; insert adjusting pin here
5. Hole at 9 o'clock
6. Face plate

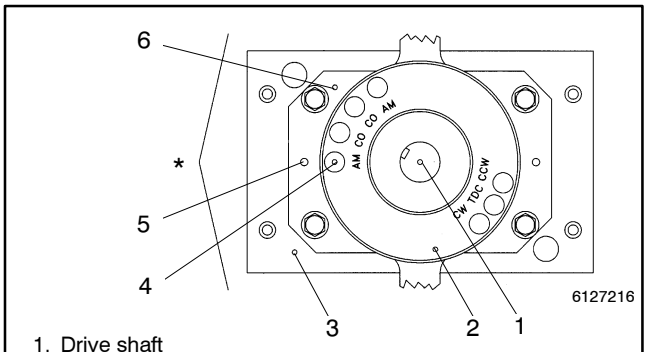
* Shown when upper contacts are in arc-make position 6127216

Figure 11-19 Pinned Weight For Upper Contacts (After)



* Shown when lower contacts are closed 6127216

Figure 11-20 Pinning Weight For Lower Contacts (Before)



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1. Drive shaft
2. Adjustment hub disk
3. Weight frame
4. AM hole; insert adjusting pin here
5. Hole at 9 o'clock
6. Face plate

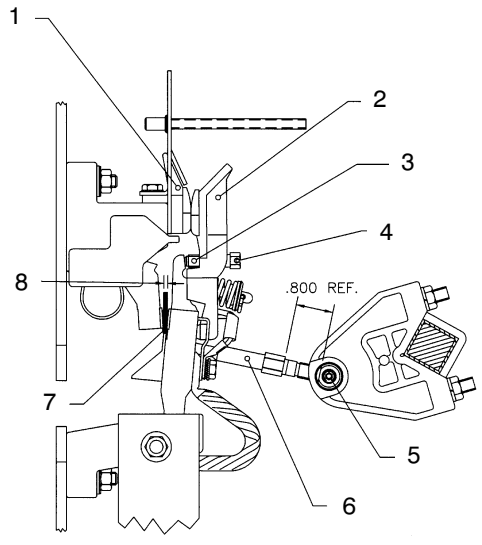
* Shown when lower contacts are in arc-make position

Figure 11-21 Pinned Weight For Lower Contacts (After)

4. Measure and adjust the movable arcing contact screws**.** Check that *all* nylon adjustment screws protrude 3 mm (1/8 in.) through the far side of *all* movable arcing contacts. If adjustment is necessary, use a blade screwdriver or 11/32 in. nutdriver to turn the adjustment screw. See Figure 11-22.

5. Check that the main contacts are open approx. 3 mm (1/8 in.). With the main contacts locked in the AM position (Figure 11-19 or Figure 11-21), verify that *all* main contacts are open approximately 3 mm (1/8 in.) on the shaft being adjusted. If any main contact is *not* open at least 3 mm (1/8 in.), use a 5/32 in. hex key (Allen) wrench to loosen the set screw in the side of the crank arm. Then use a 7/16 in. open-end wrench to turn the movable contact drive rod counterclockwise until that main contact is open 3 mm (1/8 in.). See Figure 11-22.

6. Insert the main contact shim gauge (GM25407) and adjust the drive rod**.** With the main contacts locked in the AM position (Figure 11-19 or Figure 11-21), insert the shim gauge between the movable and stationary main contacts. The shim should fit finger tight (this shim gauge is the arcing contact lead dimension). To decrease the gap, turn the drive rod clockwise; to increase the gap, turn the drive rod counterclockwise. *Recheck all gaps*. See Figure 11-22.



1. Stationary arcing contact
2. Movable arcing contact
3. Nylon stop screw protusion
4. Nylon stop screw
5. Set screw
6. Drive rod
7. Shim gage (0.001 in.)
8. Arc lead gap

6127216

Figure 11-22 Arcing Contact Lead Alignment

7. Adjust the movable arcing contact adjustment screws**.** After *all* main contacts on the shaft are set for the lead gap, adjust the arcing contacts. Turn each nylon adjustment screw until the arcing contacts *just touch* (no gap, no deflection). All arcing contacts on the same shaft should touch at approximately the same time. *Recheck all gaps.* Figure 11-22.

8. Carefully unpin the weight as follows**:** After *all* contacts are checked and adjusted, insert the maintenance handle *completely* into the hub (handle spring compressed). Firmly grasp and hold the maintenance handle while you remove the adjusting pin. When the adjusting pin is pulled out, the weight releases suddenly and forcibly turns the handle to the closed contact position.

   Note: To prevent the possibility of personal injury, fully insert the maintenance handle into the hub and grasp and hold it firmly when you remove adjusting pin. Gently allow the contacts to close.

   Note: To prevent coil burnout in the solenoid assembly, be sure to remove the adjusting pin so that the mechanism is free to operate.

9. Manually operate the switch and recheck adjustments**.** Use the maintenance handle (see Figure 11-2) to manually operate the transfer switch several times. Then repeat steps 3 through 8. When you are finished with all contact adjustments, remove the hub and maintenance handle and store them on the lower frame in the place provided.

10. Carefully reinstall the arc chutes**.** Carefully slide the arc chute (with the arc splitters toward the contacts and the recess for nuts outward) between the two long threaded rods. Reinstall the two long insulator nuts (round shoulder in) and use a 5/8 in. nutdriver to GENTLY tighten until snug. Do not overtighten these nuts. See Figure 11-4 and Figure 11-5.

    Note: Handle the arc chutes gently to prevent breakage. Do not clamp the arc chutes too tightly (hand tighten the insulator nuts only).

11. Reinstall the barriers**.** Install the barrier over the arc chute and slide it toward the operator mechanism until the two round-head screws align in the keyholes in the barrier. Then use a blade screwdriver to tighten the two round-head screws to secure the barrier to the arc chute insulator nuts. See Figure 11-4.

11.4 Solenoid Assembly Replacement

Solenoid assemblies include the entire solenoid with frame, coils, core tube, core spring, core and link. Solenoid assemblies must be matched to the transfer switch voltage rating. Refer to the transfer switch Parts Catalog for the part number for the appropriate solenoid assembly for your transfer switch.

The solenoid assembly is located in the left front of the transfer switch. See Figure 11-23.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Solenoid Assembly Replacement Procedure

1. Bypass, isolate, and pull out the transfer switch**.** Follow the procedure explained in *Section 3* of the *operation manual*. Verify that no electrical power is present at the removed transfer switch.

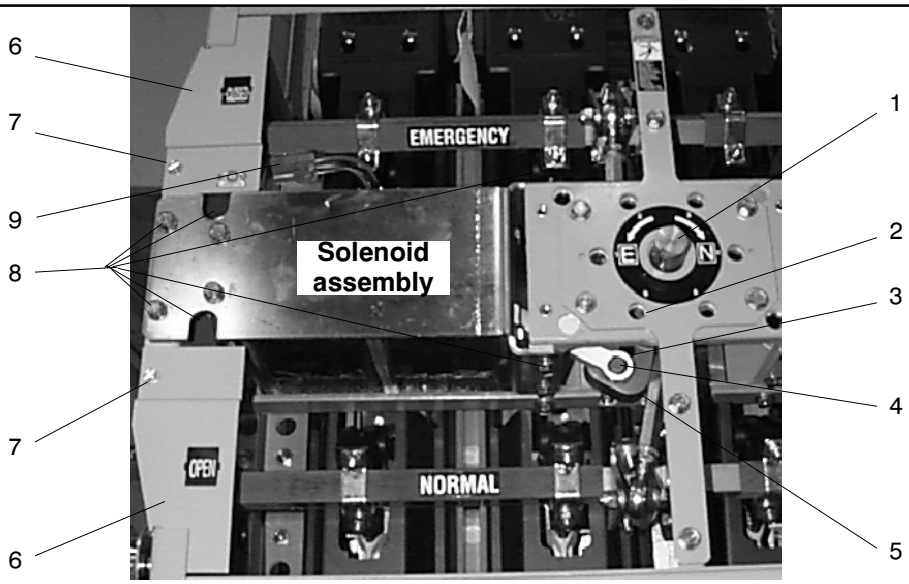
2. Manually operate the switch to the EMERGENCY position. After the transfer switch is pulled out completely, use the maintenance handle (Figure 11-2) to turn the weight so that the core link is down, as shown in Figure 11-23 (Normal contacts are in the *OPEN* position). Refer to *Section 2* of the *operation manual*.

3. Disconnect the solenoid assembly. Squeeze the plug latches and separate the inline wire harness plug to the coils to disconnect them.

4. Remove both shaft indicator plates (left side). Use a 3/8 in. socket wrench to remove two screws.

5. Pin the weight to prevent the mechanism from moving. Insert the adjusting pin (see page 1) through the weight frame and into the weight. Use the hole labeled **6** on the round label; it is the bottom left hole adjacent to the center operator shaft (in the 7 o'clock position). See Figure 11-24.

   Note: To prevent the possibility of personal injury, be sure to pin the weight to the frame so that the mechanism cannot move while removing the solenoid assembly.



1. Operator shaft
2. Hole 6 for pinning weight to weight frame
3. Core link
4. Post on weight
5. Weight
6. Shaft indicator plate
7. Mounting screw
8. Mounting bolts, 8 ea. **Note:** Two longer bolts are used in the rear
9. Coil harness plug

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Figure 11-23 Location of the Solenoid Assembly and Related Parts in the Drawn-Out (Removed) Transfer Switch

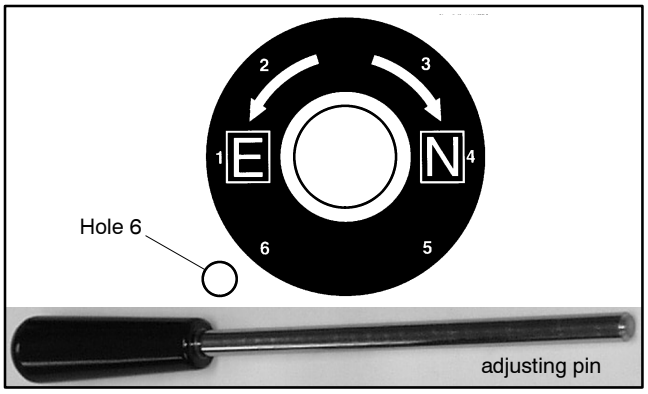


Figure 11-24 Pin The Weight To The Frame. See Step 5.

6. Remove the solenoid assembly.

   Note: The solenoid assembly weighs about 16 kg (35 lb.).

   First use a 1/2 in. socket wrench with 6 in. extension (minimum) to remove the *two* left rear hex-head bolts. Then use a 1/2 in. socket and/or open-end wrench to remove the *six* other bolts (2 on the left, 4 on the right). Then carefully pull out the solenoid assembly (unhook the core link from the post on the weight) and swing out the left side first. See Figure 11-25.

7. Install the replacement solenoid assembly. Position the solenoid assembly with the core link facing right and the coil wire harness plug on top. Install the new solenoid assembly (put in the right side first) and hook the link onto the post on the weight. Use a 1/2 in. socket wrench with 6 in. extension (min.) to reinstall *two* longer screws in the left rear. Then use a 1/2 in. socket and/or open-end wrench to reinstall *six* hex-head bolts (4 on the right above and below the flanges, 2 on the far left side front). Tighten all eight bolts to 15 Nm (11 ft. lb.) torque.

8. Reinstall the two shaft indicator plates (on the left). Use a 3/8 in. socket wrench to reinstall two screws.

9. Connect the new solenoid assembly. The inline wire harness plug and plug from the coils are keyed to go together only one way. Carefully connect the plugs and be sure that both latches *click*.

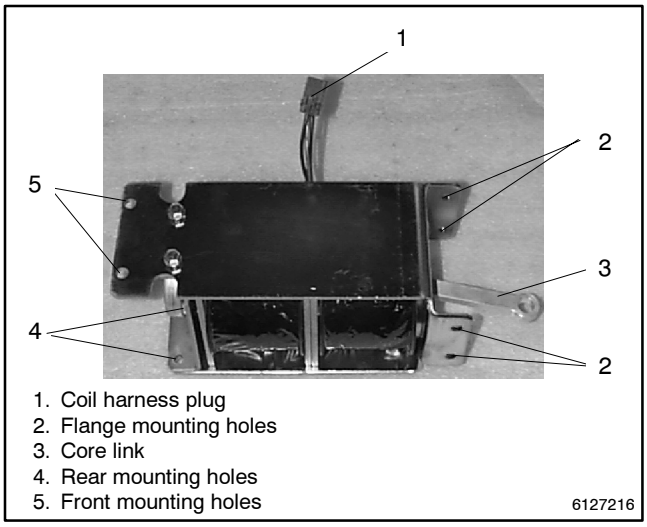


Figure 11-25 Solenoid Assembly

10. Unpin the weight to free the mechanism. Insert the maintenance handle *completely* into the hub (compress the handle spring). Firmly grasp and hold the maintenance handle while you remove the adjusting pin from hole 6. When the adjusting pin is pulled out, the weight releases suddenly and forceably turns the handle to the closed contact position.

    Note: To prevent the possibility of personal injury, fully insert the maintenance handle into the hub and grasp and hold it firmly when you remove the adjusting pin. Gently allow the contacts to close.

    Note: To prevent coil burnout in the new solenoid assembly, be sure to remove the adjusting pin so that the mechanism is free to operate again.

11. Manually operate the transfer switch. Use the maintenance handle (see Figure 11-2) to operate the transfer switch several times. It should operate smoothly without any binding. If it does not, check to be sure that the solenoid is installed correctly. When you are finished with all contact adjustments, remove the hub and maintenance handle and store them on the lower frame in the place provided.

12. Check the main contact adjustments. Before returning the transfer switch to service, the main contact adjustments must be checked. Refer to Section 11.3. When you are finished with all contact adjustments, remove the hub and maintenance handle and store them on the lower frame in the place provided.

    Note: To prevent possible damage to the transfer switch and interruption to the load, check the main contact adjustments after replacing the solenoid assembly.

13. Return the transfer switch to service**.** After you verify that the control and main contact adjustments are correct, you can return the transfer switch to service. Follow the procedure explained in the Operation Manual.

12.1 Purpose

This section explains how to test and adjust the TS coil control contacts in 4000-amp transfer switches.

The TS control contacts control the duration of time that power is applied to the main solenoid operator (TS coil). To assure proper operation, it is important that the contacts open at the proper time during the stroke of the solenoid. Improper adjustment will cause failure to operate at reduced voltages, failure of the main contacts to seat properly, and solenoid failure.

Only experienced electricians should test and adjust the switch. All standard safety practices must be observed.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

12.2 Manual Operation

A detachable manual operator handle is provided for maintenance purposes only. The handle is stored on the transfer switch. See Figure 12-1.

Note: Do not manually operate the switch until all power and control circuits are disconnected.

Note: The engine start circuit closes when the transfer switch is operated to the emergency side. This will cause the emergency generator set to start and run if not disconnected beforehand.

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position, disconnecting power to the generator engine starting battery charger, if installed, and disconnecting all generator engine start batteries, negative (–) leads first.
2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch.
3. Insert the manual handle into the hole in the rotating weight (Figure 12-4). Move the handle down and up to manually operate the switch, as needed, in the service procedures.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

12.3 Coil Control Contact Test and Adjustment

The TS control contacts are factory-set using an adjustable power supply so that the switch can operate satisfactorily over a wide voltage range of 80 to 110% of the nominal system voltage. To accommodate minor variances in friction and tolerances, it is not unusual for the control contact settings to vary from switch to switch.

The adjustments are factory-sealed and usually do not require any change over the life of the switch. If it should become necessary to check adjustments in the field, an approximation can be made by following the instructions in the following procedure. The adjustments can vary to the extremes and still provide acceptable operation. However, it is important that the TS control contacts always open ***BEFORE*** top-dead-center is reached by the solenoid core.

Coil Control Contact Test and Adjustment Procedure

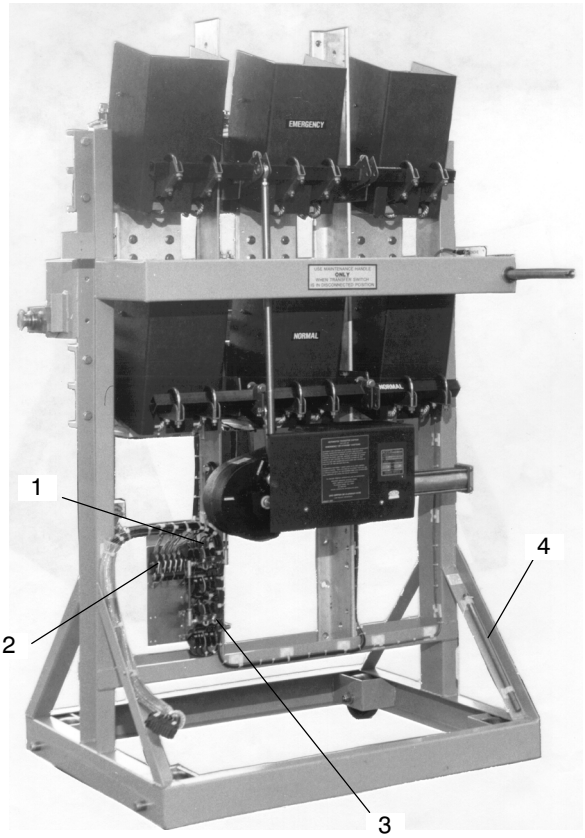
⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator engine starting battery charger, if installed; and disconnecting all generator engine start batteries, negative (–) leads first.
2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch.
3. Use a voltmeter to verify that no voltage is present at the switch terminal lugs on both power sources.
4. Locate the TS control contact assembly; see Figure 12-1.
5. To check the settings of the TS control contacts, proceed as follows (refer to Figure 12-2):
   a. Two sets of contacts interrupt the control current to the solenoid operator coil (TS) in each direction (transfer to emergency and retransfer to normal). The pairs of coil clearing contacts do not have to operate simultaneously, but both must break the circuit ***BEFORE*** the main solenoid operator core reaches top-dead-center (TDC) position. See the table in Figure 12-3 for control contact positions.
   b. With the power disconnected, use a multimeter (or a lamp-type continuity tester) across each contact to determine when the control contacts open while slowly turning the manual operator handle (see Figure 12-4 and section on **Manual Operation** for instructions).



1. TS control contact assembly
2. Miniature switches
3. Auxiliary contacts
4. Manual operator handle (storage location)

61274789

Figure 12-1 4000 amp transfer switch.

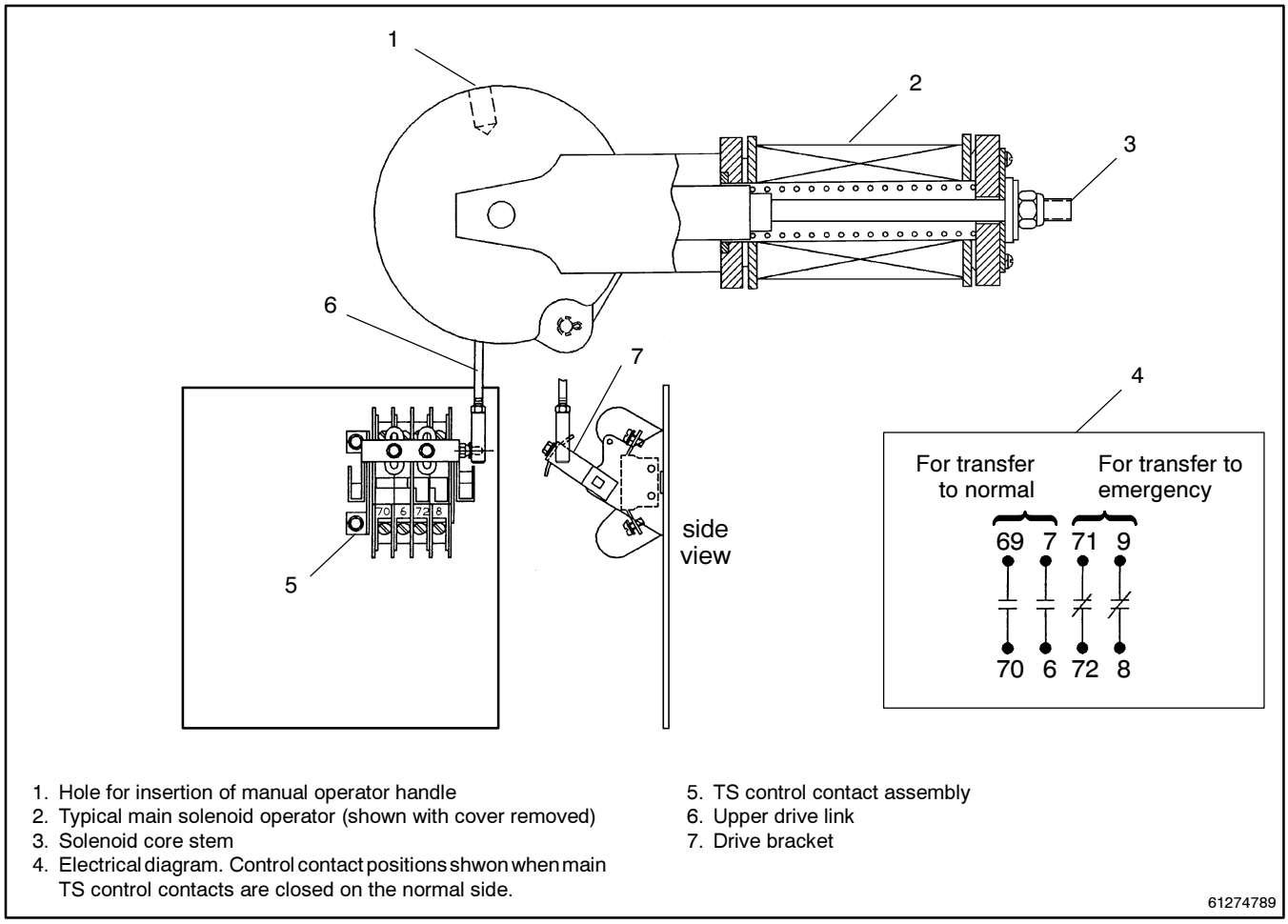


Figure 12-2 Typical TS Control Contact Arrangement.

Condition	Control Contacts 71-72 & 9-8	Control Contacts 69-70 & 7-6
Main contacts closed-on N	Closed	Open
Main contacts closed-on E	Open	Closed
During transfer from N to E	Open before TDC	Close after TDC
During transfer from E to N	Close after TDC	Open before TDC
N- Normal Position **E**-Emergency Position		
TDC- Top Dead Center of solenoid core.		

Figure 12-3 Control Contact Positions

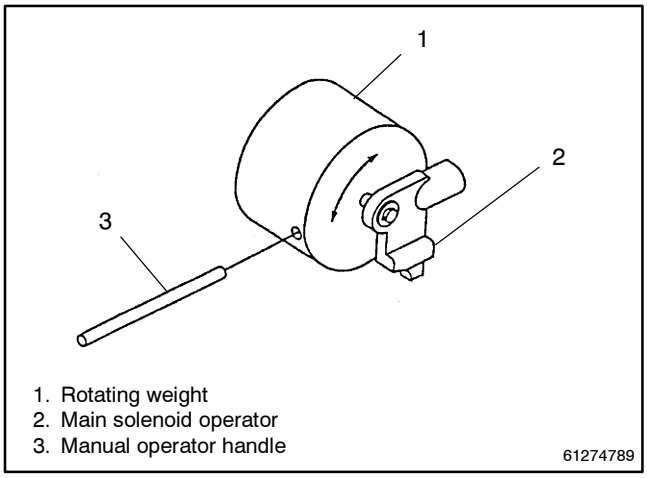


Figure 12-4 Manual operator handle.

6. If adjustment of contacts 71-72 and 9-8 is necessary, proceed as follows. Refer to Figure 12-5 and Figure 12-6.

   a. Make sure the main contacts of the transfer switch are closed on normal. Use the manual operator handle to change the contact position, if necessary.

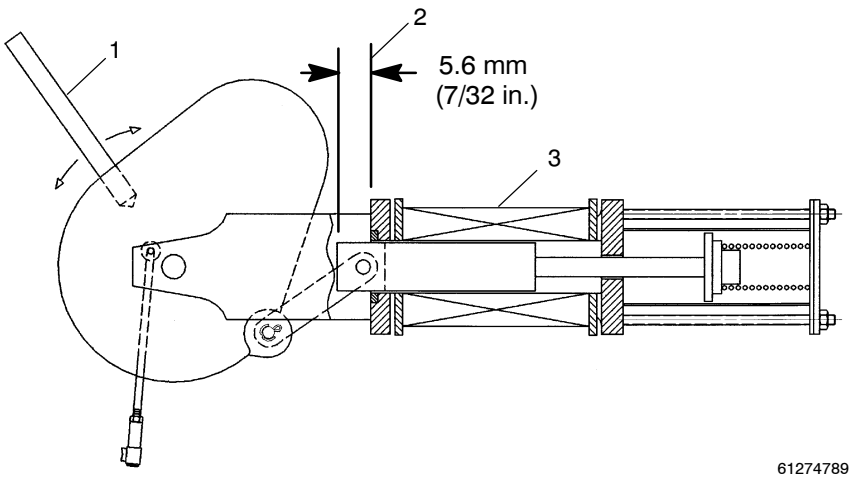
   b. Starting from the closed-on-normal position, use the manual operator handle to rotate the weight until the core has moved up to the indicated dimensions. See Figure 12-5.

   c. At this point adjust the right side control contact cam adjusting arm so that the contacts just break: Use a 1/4 in. nutdriver to loosen the hex-head locking screw. Move the cam adjusting arm so that the contacts just break. Then tighten the locking screw. See Figure 12-6.

7. Rotate the manual handle so that the weight is over center on the opposite side *(EMERGENCY)*. Then rotate the weight to the same core position in Figure 12-5 except coming from the emergency side. Perform the adjustment described in step 6 on the two opposite control contacts, 69-70 and 7-6.

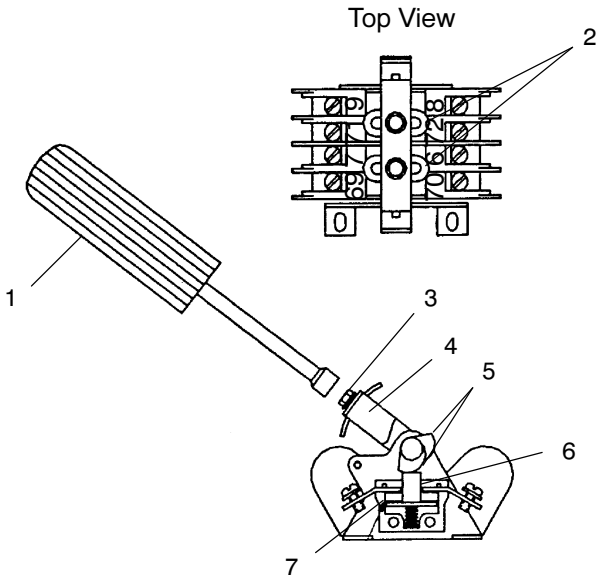
8. Reconnect power supplies to the transfer switch.

9. Reconnect the generator engine starting battery cables, negative (-) leads last; reconnect power to the generator engine starting battery charger, if installed; and move the generator set master switch to the AUTO (automatic) position. The generator set may start and run until the ATS time delay engine cooldown (TDEC) expires.



1. Manual operator handle
2. Solenoid core extension 5.6 mm (7/32 in.)
3. Typical main solenoid operator (shown with cover removed)

Figure 12-5 Establishing Solenoid Stroke Position for Control Contact Actuation.



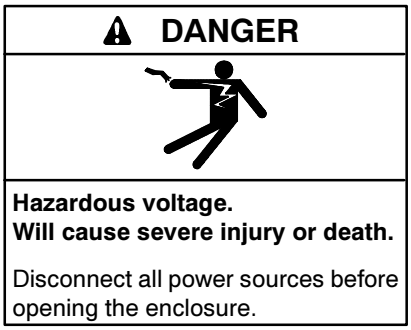
1. 1/4 in. nutdriver
2. Control contact cam adjusting arms (shown in midpoint position)
3. #8-32 hex head locking screw
4. Drive bracket
5. Cams
6. Operating button
7. Control contacts 71-72 (typical). Contacts open when the operating button is depressed by the cam.

Figure 12-6 TS Control Contact Adjustment

12.4 TS Control Contact Replacement

Under normal conditions the TS control contacts do not require replacement over the life of the transfer switch. If replacement becomes necessary, use the following procedure.

Control Contact Replacement Procedure



Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1. Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator engine starting battery charger, if installed; and disconnecting all generator engine start batteries, negative (-) leads first.
2. Disconnect all power sources before opening the transfer switch enclosure by opening upstream circuit breakers or switches to the transfer switch.
3. Use a voltmeter to verify that no voltage is present at the switch terminal lugs on both power sources.
4. Refer to Figure 12-7. Disconnect the upper drive link between the weight and the control contact assembly by prying the link off the ball joint with a screwdriver.
5. Label the wires connected to the control contact assembly so they can be identified after being disconnected.
6. Disconnect the labeled wires from the control contact assembly.
7. Disconnect the lower drive link connected to the auxiliary contact assembly by removing the #10-32 shoulder screw, lockwasher, and hex nut from the left side of the drive bracket. Then reinstall the hardware into the loose link for safekeeping.
8. Remove three #8–32 screws from the mounting feet and remove the control contact assembly.
9. Install the new control contact assembly onto mounting plate and secure it with three #8–32 screws.
10. Reconnect the lower drive link to the drive bracket. When assembled properly there will be free play between the drive bracket and the head of the shoulder screw.
11. Manually operate the drive linkage. The action should be smooth without any binding. Be sure the cams properly operate the pushbuttons on the control and auxiliary contact assemblies.
12. Reconnect the eight labeled wires to the proper terminals.
13. Connect the upper drive link to the left side of the drive bracket on the control contact assembly. Recheck for binding and interference.
14. Check the control contact adjustment. See Section 12.3.

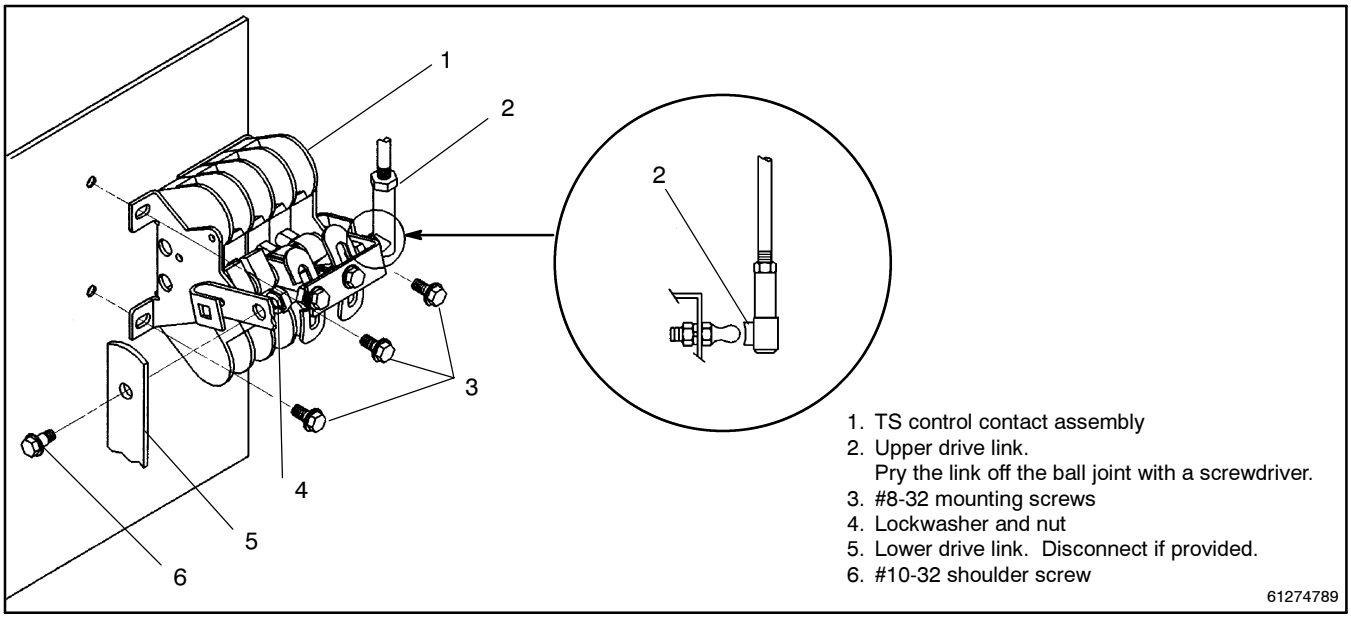


Figure 12-7 Replacing TS Control Contacts

Appendix A Abbreviations

The following list contains abbreviations that may appear in this publication.

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
API	American Petroleum Institute
approx.	approximate, approximately
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
A/V	audiovisual
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CARB	California Air Resources Board
CB	circuit breaker
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
cogen.	cogeneration
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dBA	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
dia.	diameter
DI/EO	dual inlet/end outlet
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
DIP	dual inline package
DPDT	double-pole, double-throw
DPST	double-pole, single-throw
DS	disconnect switch
DVR	digital voltage regulator
E, emer.	emergency (power source)
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example *(exempli gratia)*
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
fglass.	fiberglass
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lbs.	foot pounds (torque)
ft./min.	feet per minute
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temperature, high engine temperature
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lbs.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	iron pipe
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard

k	kilo (1000)
K	kelvin
kA	kiloampere
KB	kilobyte (2^{10} bytes)
kg	kilogram
kg/cm^2	kilograms per square centimeter
kgm	kilogram-meter
kg/m^3	kilograms per cubic meter
kHz	kilohertz
kJ	kilojoule
km	kilometer
kOhm, kΩ	kilo-ohm
kPa	kilopascal
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt ampere
kVAR	kilovolt ampere reactive
kW	kilowatt
kWh	kilowatt-hour
kWm	kilowatt mechanical
L	liter
LAN	local area network
L x W x H	length by width by height
lb.	pound, pounds
lbm/ft^3	pounds mass per cubic feet
LCB	line circuit breaker
LCD	liquid crystal display
ld. shd.	load shed
LED	light emitting diode
Lph	liters per hour
Lpm	liters per minute
LOP	low oil pressure
LP	liquefied petroleum
LPG	liquefied petroleum gas
LS	left side
L_{wa}	sound power level, A weighted
LWL	low water level
LWT	low water temperature
m	meter, milli (1/1000)
M	mega (10^6 when used with SI units), male
m^3	cubic meter
m^3/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCM	one thousand circular mils
MCCB	molded-case circuit breaker
meggar	megohmmeter
MHz	megahertz
mi.	mile
mil	one one-thousandth of an inch
min.	minimum, minute
misc.	miscellaneous
MJ	megajoule
mJ	millijoule
mm	millimeter
mOhm, mΩ	milliohm
MOhm, MΩ	megohm
MOV	metal oxide varistor
MPa	megapascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
MW	megawatt
mW	milliwatt
μF	microfarad
N, norm.	normal (power source)
NA	not available, not applicable
nat. gas	natural gas
NBS	National Bureau of Standards
NC	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	newton meter
NO	normally open
no., nos.	number, numbers
NPS	National Pipe, Straight
NPSC	National Pipe, Straight-coupling
NPT	National Standard taper pipe thread per general use
NPTF	National Pipe, Taper-Fine
NR	not required, normal relay
ns	nanosecond
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OF	overfrequency
opt.	option, optional
OS	oversize, overspeed
OSHA	Occupational Safety and Health Administration
OV	overvoltage
oz.	ounce
p., pp.	page, pages
PC	personal computer
PCB	printed circuit board
pF	picofarad
PF	power factor
ph., ∅	phase
PHC	Phillips head crimptite (screw)
PHH	Phillips hex head (screw)
PHM	pan head machine (screw)
PLC	programmable logic control
PMG	permanent-magnet generator
pot	potentiometer, potential
ppm	parts per million
PROM	programmable read-only memory
psi	pounds per square inch
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTV	room temperature vulcanization
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SCR	silicon controlled rectifier
s, sec.	second
SI	*Systeme international d'unites,* International System of Units
SI/EO	side in/end out
sil.	silencer
SN	serial number
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec, specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
TD	time delay
TDC	top dead center
TDEC	time delay engine cooldown
TDEN	time delay emergency to normal
TDES	time delay engine start
TDNE	time delay normal to emergency
TDOE	time delay off to emergency
TDON	time delay off to normal
temp.	temperature
term.	terminal
TIF	telephone influence factor
TIR	total indicator reading
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
w/o	without
wt.	weight
xfmr	transformer

Appendix B Common Hardware Application Guidelines

Use the information below and on the following pages to identify proper fastening techniques when no specific reference for reassembly is made.

Bolt/Screw Length: When bolt/screw length is not given, use Figure 1 as a guide. As a general rule, a minimum length of one thread beyond the nut and a maximum length of 1/2 the bolt/screw diameter beyond the nut is the preferred method.

Washers and Nuts: Use split lock washers as a bolt locking device where specified. Use SAE flat washers with whiz nuts, spiralock nuts, or standard nuts and preloading (torque) of the bolt in all other applications.

See Appendix C, General Torque Specifications, and other torque specifications in the service literature.

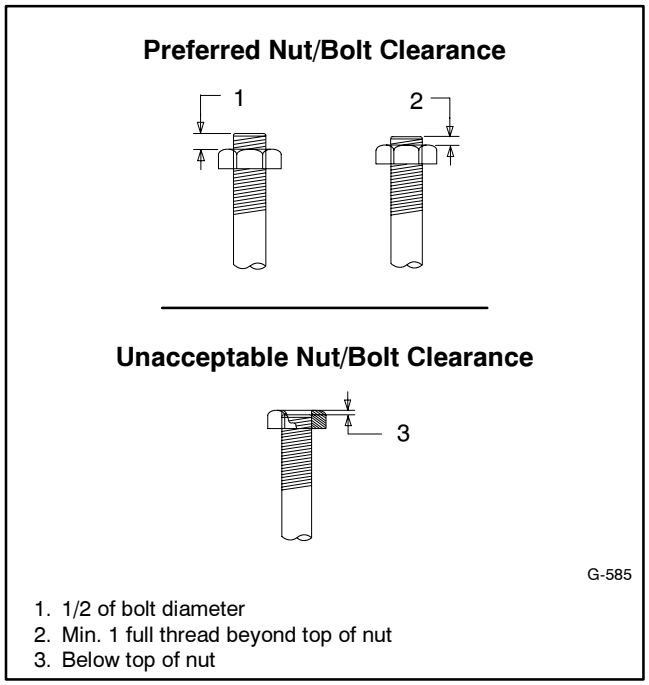


Figure 1 Acceptable Bolt Lengths

Steps for common hardware application:

1. Determine entry hole type: round or slotted.
2. Determine exit hole type: fixed female thread (weld nut), round, or slotted.

   For round and slotted exit holes, determine if hardware is greater than 1/2 inch in diameter, or 1/2 inch in diameter or less. Hardware that is *greater than 1/2 inch* in diameter takes a standard nut and SAE washer. Hardware *1/2 inch or less* in diameter can take a properly torqued whiz nut or spiralock nut. See Figure 2.
3. Follow these SAE washer rules after determining exit hole type:
   a. Always use a washer between hardware and a slot.
   b. Always use a washer under a nut (see 2 above for exception).
   c. Use a washer under a bolt when the female thread is fixed (weld nut).
4. Refer to Figure 2, which depicts the preceding hardware configuration possibilities.

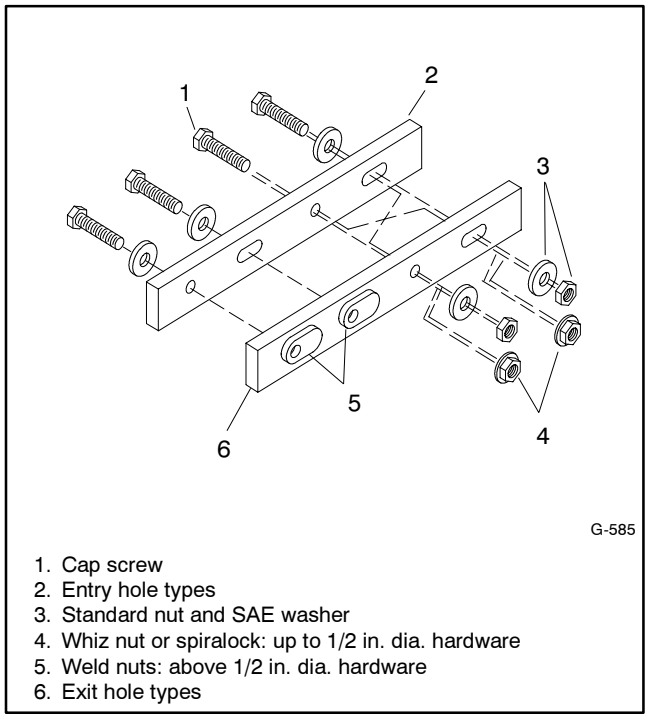


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

Use the following torque specifications when service literature instructions give no specific torque values. The charts list values for new plated, zinc phosphate, or oiled threads. Increase values by 15% for nonplated threads. All torque values are +0%/–10%.

American Standard Fasteners Torque Specifications

Size	Torque Measurement	Assembled into Cast Iron or Steel			Assembled into Aluminum
		Grade 2	Grade 5	Grade 8	Grade 2 or 5
8-32	Nm (in. lb.)	1.8 (16)	2.3 (20)	—	1.8 (16)
10-24	Nm (in. lb.)	2.9 (26)	3.6 (32)	—	2.9 (26)
10-32	Nm (in. lb.)	2.9 (26)	3.6 (32)	—	2.9 (26)
1/4-20	Nm (in. lb.)	6.8 (60)	10.8 (96)	14.9 (132)	6.8 (60)
1/4-28	Nm (in. lb.)	8.1 (72)	12.2 (108)	16.3 (144)	8.1 (72)
5/16-18	Nm (in. lb.)	13.6 (120)	21.7 (192)	29.8 (264)	13.6 (120)
5/16-24	Nm (in. lb.)	14.9 (132)	23.1 (204)	32.5 (288)	14.9 (132)
3/8-16	Nm (ft. lb.)	24.0 (18)	38.0 (28)	53.0 (39)	24.0 (18)
3/8-24	Nm (ft. lb.)	27.0 (20)	42.0 (31)	60.0 (44)	27.0 (20)
7/16-14	Nm (ft. lb.)	39.0 (29)	60.0 (44)	85.0 (63)	—
7/16-20	Nm (ft. lb.)	43.0 (32)	68.0 (50)	95.0 (70)	—
1/2-13	Nm (ft. lb.)	60.0 (44)	92.0 (68)	130.0 (96)	—
1/2-20	Nm (ft. lb.)	66.0 (49)	103.0 (76)	146.0 (108)	—
9/16-12	Nm (ft. lb.)	81.0 (60)	133.0 (98)	187.0 (138)	—
9/16-18	Nm (ft. lb.)	91.0 (67)	148.0 (109)	209.0 (154)	—
5/8-11	Nm (ft. lb.)	113.0 (83)	183.0 (135)	259.0 (191)	—
5/8-18	Nm (ft. lb.)	128.0 (94)	208.0 (153)	293.0 (216)	—
3/4-10	Nm (ft. lb.)	199.0 (147)	325.0 (240)	458.0 (338)	—
3/4-16	Nm (ft. lb.)	222.0 (164)	363.0 (268)	513.0 (378)	—
1-8	Nm (ft. lb.)	259.0 (191)	721.0 (532)	1109.0 (818)	—
1-12	Nm (ft. lb.)	283.0 (209)	789.0 (582)	1214.0 (895)	—

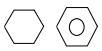
Metric Fasteners Torque Specifications, Measured in Nm (ft. lb.)

Size (mm)	Assembled into Cast Iron or Steel			Assembled into Aluminum
	Grade 5.8	Grade 8.8	Grade 10.9	Grade 5.8 or 8.8
M6 x 1.00	5.6 (4)	9.9 (7)	14.0 (10)	5.6 (4)
M8 x 1.25	13.6 (10)	25.0 (18)	35.0 (26)	13.6 (10)
M8 x 1.00	21.0 (16)	25.0 (18)	35.0 (26)	21.0 (16)
M10 x 1.50	27.0 (20)	49.0 (35)	68.0 (50)	27.0 (20)
M10 x 1.25	39.0 (29)	49.0 (35)	68.0 (50)	39.0 (29)
M12 x 1.75	47.0 (35)	83.0 (61)	117.0 (86)	—
M12 x 1.50	65.0 (48)	88.0 (65)	125.0 (92)	—
M14 x 2.00	74.0 (55)	132.0 (97)	185.0 (136)	—
M14 x 1.50	100.0 (74)	140.0 (103)	192.0 (142)	—
M16 x 2.00	115.0 (85)	200.0 (148)	285.0 (210)	—
M16 x 1.50	141.0 (104)	210.0 (155)	295.0 (218)	—
M18 x 2.50	155.0 (114)	275.0 (203)	390.0 (288)	—
M18 x 1.50	196.0 (145)	305.0 (225)	425.0 (315)	—

Appendix D Common Hardware Identification

Screw/Bolts/Studs	
Head Styles	
Hex Head or Machine Head	
Hex Head or Machine Head with Washer	
Flat Head (FHM)	
Round Head (RHM)	
Pan Head	
Hex Socket Head Cap or Allen™ Head Cap	
Hex Socket Head or Allen™ Head Shoulder Bolt	
Sheet Metal Screw	
Stud	
Drive Styles	
Hex	
Hex and Slotted	
Phillips®	
Slotted	
Hex Socket	

Nuts	
Nut Styles	
Hex Head	
Lock or Elastic	
Square	
Cap or Acorn	
Wing	
Washers	
Washer Styles	
Plain	
Split Lock or Spring	
Spring or Wave	
External Tooth Lock	
Internal Tooth Lock	
Internal-External Tooth Lock	

Hardness Grades	
American Standard	
Grade 2	
Grade 5	
Grade 8	
Grade 8/9 (Hex Socket Head)	
Metric	
Number stamped on hardware; 5.8 shown	

Allen™ head screw is a trademark of Holo-Krome Co.

Phillips® screw is a registered trademark of Phillips Screw Company.

Sample Dimensions

American Standard (Screws, Bolts, Studs, and Nuts)

1/4-20 x 1

- Length In Inches (Screws and Bolts)
- Threads Per Inch
- Major Thread Diameter In Fractional Inches Or Screw Number Size

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

- Length In Millimeters (Screws and Bolts)
- Distance Between Threads In Millimeters
- Major Thread Diameter In Millimeters

Plain Washers

9/32 x 5/8 x 1/16

- Thickness
- External Dimension
- Internal Dimension

Lock Washers

5/8

- Internal Dimension

Appendix E Common Hardware List

The Common Hardware List lists part numbers and dimensions for common hardware items.

American Standard

Part No.	Dimensions
Hex Head Bolts (Grade 5)	
X-465-17	1/4-20 x .38
X-465-6	1/4-20 x .50
X-465-2	1/4-20 x .62
X-465-16	1/4-20 x .75
X-465-18	1/4-20 x .88
X-465-7	1/4-20 x 1.00
X-465-8	1/4-20 x 1.25
X-465-9	1/4-20 x 1.50
X-465-10	1/4-20 x 1.75
X-465-11	1/4-20 x 2.00
X-465-12	1/4-20 x 2.25
X-465-14	1/4-20 x 2.75
X-465-21	1/4-20 x 5.00
X-465-25	1/4-28 x .38
X-465-20	1/4-28 x 1.00
X-125-33	5/16-18 x .50
X-125-23	5/16-18 x .62
X-125-3	5/16-18 x .75
X-125-31	5/16-18 x .88
X-125-5	5/16-18 x 1.00
X-125-24	5/16-18 x 1.25
X-125-34	5/16-18 x 1.50
X-125-25	5/16-18 x 1.75
X-125-26	5/16-18 x 2.00
230578	5/16-18 x 2.25
X-125-29	5/16-18 x 2.50
X-125-27	5/16-18 x 2.75
X-125-28	5/16-18 x 3.00
X-125-22	5/16-18 x 4.50
X-125-32	5/16-18 x 5.00
X-125-35	5/16-18 x 5.50
X-125-36	5/16-18 x 6.00
X-125-40	5/16-18 x 6.50
X-125-43	5/16-24 x 1.75
X-125-44	5/16-24 x 2.50
X-125-30	5/16-24 x .75
X-125-39	5/16-24 x 2.00
X-125-38	5/16-24 x 2.75
X-6238-2	3/8-16 x .62
X-6238-10	3/8-16 x .75
X-6238-3	3/8-16 x .88
X-6238-11	3/8-16 x 1.00
X-6238-4	3/8-16 x 1.25
X-6238-5	3/8-16 x 1.50
X-6238-1	3/8-16 x 1.75
X-6238-6	3/8-16 x 2.00
X-6238-17	3/8-16 x 2.25
X-6238-7	3/8-16 x 2.50
X-6238-8	3/8-16 x 2.75
X-6238-9	3/8-16 x 3.00
X-6238-19	3/8-16 x 3.25
X-6238-12	3/8-16 x 3.50
X-6238-20	3/8-16 x 3.75
X-6238-13	3/8-16 x 4.50
X-6238-18	3/8-16 x 5.50
X-6238-25	3/8-16 x 6.50
X-6238-14	3/8-24 x .75
X-6238-16	3/8-24 x 1.25
X-6238-21	3/8-24 x 4.00
X-6238-22	3/8-24 x 4.50

Part No.	Dimensions
Hex Head Bolts, cont.	
X-6024-5	7/16-14 x .75
X-6024-2	7/16-14 x 1.00
X-6024-8	7/16-14 x 1.25
X-6024-3	7/16-14 x 1.50
X-6024-4	7/16-14 x 2.00
X-6024-11	7/16-14 x 2.75
X-6024-12	7/16-14 x 6.50
X-129-15	1/2-13 x .75
X-129-17	1/2-13 x 1.00
X-129-18	1/2-13 x 1.25
X-129-19	1/2-13 x 1.50
X-129-20	1/2-13 x 1.75
X-129-21	1/2-13 x 2.00
X-129-22	1/2-13 x 2.25
X-129-23	1/2-13 x 2.50
X-129-24	1/2-13 x 2.75
X-129-25	1/2-13 x 3.00
X-129-27	1/2-13 x 3.50
X-129-29	1/2-13 x 4.00
X-129-30	1/2-13 x 4.50
X-463-9	1/2-13 x 5.50
X-129-44	1/2-13 x 6.00
X-129-51	1/2-20 x .75
X-129-45	1/2-20 x 1.25
X-129-52	1/2-20 x 1.50
X-6021-3	5/8-11 x 1.00
X-6021-4	5/8-11 x 1.25
X-6021-2	5/8-11 x 1.50
X-6021-1	5/8-11 x 1.75
273049	5/8-11 x 2.00
X-6021-5	5/8-11 x 2.25
X-6021-6	5/8-11 x 2.50
X-6021-7	5/8-11 x 2.75
X-6021-12	5/8-11 x 3.75
X-6021-11	5/8-11 x 4.50
X-6021-10	5/8-11 x 6.00
X-6021-9	5/8-18 x 2.50
X-6239-1	3/4-10 x 1.00
X-6239-8	3/4-10 x 1.25
X-6239-2	3/4-10 x 1.50
X-6239-3	3/4-10 x 2.00
X-6239-4	3/4-10 x 2.50
X-6239-5	3/4-10 x 3.00
X-6239-6	3/4-10 x 3.50
X-792-1	1-8 x 2.25
X-792-5	1-8 x 3.00
X-792-8	1-8 x 5.00

Part No.	Dimensions	Type
Hex Nuts		
X-6009-1	1-8	Standard
X-6210-3	6-32	Whiz
X-6210-4	8-32	Whiz
X-6210-5	10-24	Whiz
X-6210-1	10-32	Whiz
X-6210-2	1/4-20	Spiralock
X-6210-6	1/4-28	Spiralock
X-6210-7	5/16-18	Spiralock
X-6210-8	5/16-24	Spiralock
X-6210-9	3/8-16	Spiralock
X-6210-10	3/8-24	Spiralock
X-6210-11	7/16-14	Spiralock
X-6210-12	1/2-13	Spiralock
X-6210-15	7/16-20	Spiralock
X-6210-14	1/2-20	Spiralock
X-85-3	5/8-11	Standard
X-88-12	3/4-10	Standard
X-89-2	1/2-20	Standard

Washers

Part No.	ID	OD	Thick.	Bolt/ Screw
X-25-46	.125	.250	.022	#4
X-25-9	.156	.375	.049	#6
X-25-48	.188	.438	.049	#8
X-25-36	.219	.500	.049	#10
X-25-40	.281	.625	.065	1/4
X-25-85	.344	.687	.065	5/16
X-25-37	.406	.812	.065	3/8
X-25-34	.469	.922	.065	7/16
X-25-26	.531	1.062	.095	1/2
X-25-15	.656	1.312	.095	5/8
X-25-29	.812	1.469	.134	3/4
X-25-127	1.062	2.000	.134	1

Metric

Hex head bolts are hardness grade 8.8 unless noted.

Hex Head Bolts (partial thread)

Part No.	Dimensions
M931-05055-60	M5-0.80 x 55
M931-06040-60	M6-1.00 x 40
M931-06055-60	M6-1.00 x 55
M931-06060-60	M6-1.00 x 60
M931-06070-60	M6-1.00 x 70
M931-06070-SS	M6-1.00 x 70
M931-06075-60	M6-1.00 x 75
M931-06090-60	M6-1.00 x 90
M931-06150-60	M6-1.00 x 150
M931-08035-60	M8-1.25 x 35
M931-08040-60	M8-1.25 x 40
M931-08040-82	M8-1.25 x 40*
M931-08045-60	M8-1.25 x 45
M931-08050-60	M8-1.25 x 50
M931-08055-60	M8-1.25 x 55
M931-08055-82	M8-1.25 x 55*
M931-08060-60	M8-1.25 x 60
M931-08070-60	M8-1.25 x 70
M931-08070-82	M8-1.25 x 70*
M931-08075-60	M8-1.25 x 75
M931-08080-60	M8-1.25 x 80
M931-08090-60	M8-1.25 x 90
M931-08095-60	M8-1.25 x 95
M931-08100-60	M8-1.25 x 100
M931-08120-60	M8-1.25 x 120
M931-08130-60	M8-1.25 x 130
M931-08140-60	M8-1.25 x 140
M931-10040-82	M10-1.25 x 40*
M931-10040-60	M10-1.50 x 40
M931-10045-60	M10-1.50 x 45
M931-10050-60	M10-1.50 x 50
M931-10055-60	M10-1.50 x 55
M931-10060-60	M10-1.50 x 60
M931-10065-60	M10-1.50 x 65
M931-10070-60	M10-1.50 x 70
M931-10080-60	M10-1.50 x 80
M931-10090-60	M10-1.50 x 90
M931-10090-82	M10-1.50 x 90*
M931-10100-60	M10-1.50 x 100
M931-10110-60	M10-1.50 x 110
M931-10120-60	M10-1.50 x 120
M931-10130-60	M10-1.50 x 130
M931-10140-60	M10-1.50 x 140
M931-10180-60	M10-1.50 x 180
M931-12045-60	M12-1.75 x 45
M960-12050-60	M12-1.25 x 50
M960-12050-82	M12-1.25 x 50*
M931-12050-60	M12-1.75 x 50
M931-12055-60	M12-1.75 x 55
M931-12060-60	M12-1.75 x 60
M931-12065-60	M12-1.75 x 65
M931-12075-60	M12-1.75 x 75
M931-12080-60	M12-1.75 x 80
M931-12090-60	M12-1.75 x 90
M931-12100-60	M12-1.75 x 100
M931-12110-60	M12-1.75 x 110
M960-16090-60	M16-1.50 x 90
M931-16090-60	M16-2.00 x 90
M931-16100-60	M16-2.00 x 100
M931-20065-60	M20-2.50 x 65
M931-20120-60	M20-2.50 x 120
M931-20160-60	M20-2.50 x 160
M931-22090-60	M22-2.50 x 90
M931-22120-60	M22-2.50 x 120
M931-22160-60	M22-2.50 x 160
M931-24090-60	M24-3.00 x 90
M931-24120-60	M24-3.00 x 120
M931-24160-60	M24-3.00 x 160

Hex Head Bolts (full thread)

Part No.	Dimensions
M933-04006-60	M4-0.70 x 6
M933-05035-60	M5-0.80 x 35
M933-05050-60	M5-0.80 x 50
M933-06010-60	M6-1.00 x 10
M933-06014-60	M6-1.00 x 14
M933-06016-60	M6-1.00 x 16
M933-06020-60	M6-1.00 x 20
M933-06025-60	M6-1.00 x 25
M933-06040-60	M6-1.00 x 40
M933-06050-60	M6-1.00 x 50
M933-08012-60	M8-1.25 x 12
M933-08016-60	M8-1.25 x 16
M933-08020-60	M8-1.25 x 20
M933-08025-60	M8-1.25 x 25
M933-08030-60	M8-1.25 x 30
M933-08030-82	M8-1.25 x 30*
M933-10012-60	M10-1.50 x 12
M961-10020-60	M10-1.25 x 20
M933-10020-60	M10-1.50 x 20
M933-10025-60	M10-1.50 x 25
M961-10030-60	M10-1.25 x 30
M933-10030-60	M10-1.50 x 30
M933-10030-82	M10-1.50 x 30*
M961-10035-60	M10-1.25 x 35
M933-10035-60	M10-1.50 x 35
M933-12016-60	M12-1.75 x 16
M933-12020-60	M12-1.75 x 20
M933-12025-60	M12-1.75 x 25
M933-12025-82	M12-1.75 x 25*
M961-12030-60	M12-1.25 x 30
M933-12030-60	M12-1.75 x 30
M933-12035-60	M12-1.75 x 35
M961-12040-82	M12-1.25 x 40*
M933-12040-60	M12-1.75 x 40
M933-12040-82	M12-1.75 x 40*
M961-14025-60	M14-1.50 x 25
M933-14025-60	M14-2.00 x 25
M961-16025-60	M16-1.50 x 25
M933-16025-60	M16-2.00 x 25
M961-16030-82	M16-1.50 x 30*
M933-16030-82	M16-2.00 x 30*
M933-16035-60	M16-2.00 x 35
M961-16040-60	M16-1.50 x 40
M933-16040-60	M16-2.00 x 40
M933-16050-60	M16-2.00 x 50
M933-16050-82	M16-2.00 x 50*
M933-16060-60	M16-2.00 x 60
M933-18035-60	M18-2.50 x 35
M933-18050-60	M18-2.50 x 50
M933-18060-60	M18-2.50 x 60
M933-20050-60	M20-2.50 x 50
M933-20055-60	M20-2.50 x 55

Pan Head Machine Screws

M7985A-03010-20	M3-0.50 x 10
M7985A-03012-20	M3-0.50 x 12
M7985A-04010-20	M4-0.70 x 10
M7985A-04020-20	M4-0.70 x 20
M7985A-04100-20	M4-0.70 x 100
M7985A-05010-20	M5-0.80 x 10
M7985A-05012-20	M5-0.80 x 12
M7985A-05016-20	M5-0.80 x 16
M7985A-05100-20	M5-0.80 x 100
M7985A-06100-20	M6-1.00 x 100

Flat Head Machine Screws

M965A-04012-SS	M4-0.70 x 12
M965A-05012-SS	M5-0.80 x 12
M965A-05016-20	M5-0.80 x 16

Hex Nuts

Part No.	Dimensions	Type
M934-03-50	M3-0.50	Standard
M934-035-50	M3.5-0.50	Standard
M934-04-50	M4-0.70	Standard
M934-05-50	M5-0.80	Standard
M982-05-80	M5-0.80	Elastic Stop
M934-06-60	M6-1.00	Standard
M934-06-64	M6-1.00	Std. (green)
M6923-06-80	M6-1.00	Spiralock
M982-06-80	M6-1.00	Elastic Stop
M934-08-60	M8-1.25	Standard
M6923-08-80	M8-1.25	Spiralock
M982-08-80	M8-1.25	Elastic Stop
M934-10-60	M10-1.50	Standard
M934-10-60F	M10-1.25	Standard
M6923-10-80	M10-1.50	Spiralock
M6923-10-62	M10-1.50	Spiralock†
M982-10-80	M10-1.50	Elastic Stop
M934-12-60	M12-1.75	Standard
M934-12-60F	M12-1.25	Standard
M6923-12-80	M12-1.75	Spiralock
M982-12-80	M12-1.75	Elastic Stop
M982-14-80	M14-2.00	Elastic Stop
M6923-16-80	M16-2.00	Spiralock
M982-16-80	M16-2.00	Elastic Stop
M934-18-80	M18-2.5	Standard
M982-18-80	M18-2.50	Elastic Stop
M934-20-80	M20-2.50	Standard
M982-20-80	M20-2.50	Elastic Stop
M934-22-60	M22-2.50	Standard
M934-24-80	M24-3.00	Standard
M982-24-80	M24-3.00	Elastic Stop
M934-30-80	M30-3.50	Standard

Washers

Part No.	ID	OD	Thick.	Bolt/ Screw
M125A-03-80	3.2	7.0	0.5	M3
M125A-04-80	4.3	9.0	0.8	M4
M125A-05-80	5.3	10.0	1.0	M5
M125A-06-80	6.4	12.0	1.6	M6
M125A-08-80	8.4	16.0	1.6	M8
M125A-10-80	10.5	20.0	2.0	M10
M125A-12-80	13.0	24.0	2.5	M12
M125A-14-80	15.0	28.0	2.5	M14
M125A-16-80	17.0	30.0	3.0	M16
M125A-18-80	19.0	34.0	3.0	M18
M125A-20-80	21.0	37.0	3.0	M20
M125A-24-80	25.0	44.0	4.0	M24

* This metric hex bolt's hardness is grade 10.9.
† This metric hex nut's hardness is grade 8.

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ddcmtupowergeneration.com

MP-6127 9/02a