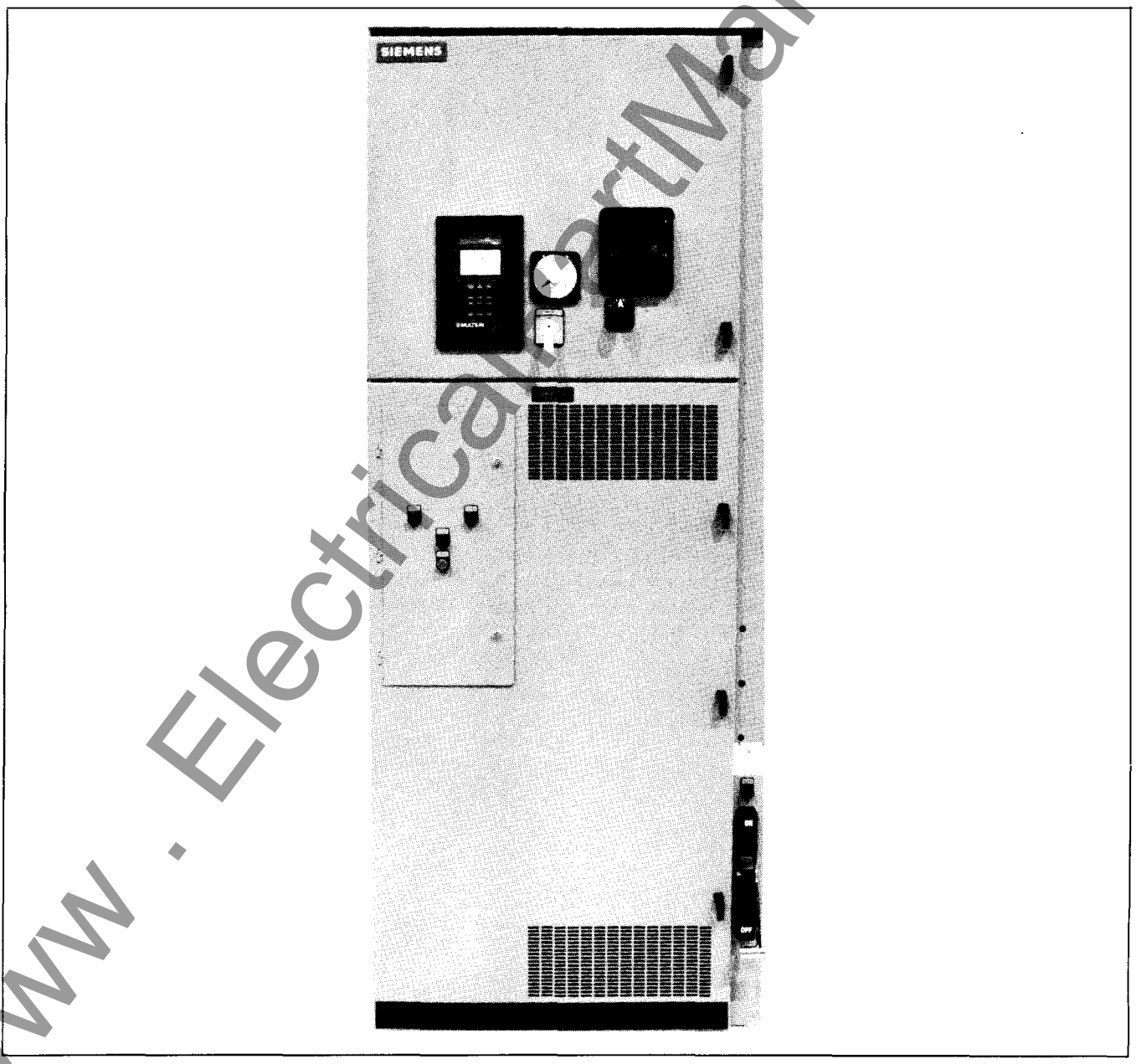
SIEMENS

Series 81000™
720 Amp Vacuum Controller
Type 90H6
(Distribution Voltage 2400-4800 VAC; Utilization Voltage 2300-4600 VAC)

Instructions
Installation
Operation
Maintenance
MVC-9038



⚠WARNING

There is a hazard of electric shock or burn whenever working in or around electrical equipment.

Turn off power supplying this equipment before any adjustments, servicing, wiring, parts replacement, or before any act requiring physical contact with the electrical working components of this equipment is performed.

The successful and safe operation of medium voltage motors controllers is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements can lead to personal injury and the failure and loss of the controller as well as damage to other property.

Qualified Person

For the purpose of this manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

(a) Is qualified and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

(b) Is qualified in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices.

Danger

For the purpose of this manual and product labels, **DANGER,** indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

Warning

For the purpose of this manual and product labels, **WARNING**, indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution

For the purpose of this manual and product labels, **CAUTION** indicates minor personal injury or property damage can result if proper precautions are not taken.

Siemens' medium voltage controllers are built in accordance with the latest applicable provisions of the National Electrical Code, Underwriters' Laboratories Standards and Procedures, NEMA Standards, and the National Electrical Safety Code. These publications and this instruction manual should be thoroughly read and understood prior to beginning any work on this equipment.

These instructions are prepared as a supplement to the Series 81000™ Controller Instruction Manual, MVC-9018. The instructions contained herein are specific to controllers rated 720 amperes at 5000 volts maximum. For instructions for contactors rated other than 720 amperes at 5000 volts, refer to MVC-9028. Read MVC-9018 and these instructions before beginning any work on this equipment.

SInce individual controllers are designed for specific applications, the components and functions are dictated by the purchaser's specifications. Separate instructions covering components are not included in this publication, but are available upon request. The purchaser should read these instructions and determine applicability to his particular controller by referring to the nameplate data on the controller and to the electrical diagrams supplied with the controller.

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NOTE

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statement contained herein do not create new warranties or modify the existing warranty.

General

Siemens Series 81000™ vacuum controllers rated 720 amps are constructed using a fixed mounted Type 90H6 vacuum contactor and a drawout carriage containing the main power fuses and control power transformer. The standard size for each controller, illustrated in **Figure 1**, is 36 inches (914mm) wide by 36 inches (914mm) deep by 90 inches (2286mm) high.

The contactor and drawout fuse carriage occupy the lower 60 inch (1524mm) medium voltage compartment in the structure. The upper 30 inch (762mm) space contains the optional horizontal bus in the rear and can be used to mount additional low voltage control devices in the front. A low voltage panel can also be mounted on the lower 60 inch (1524mm) door to house control devices.

The medium voltage compartment contains the carriage cell module upon which the racking mechanism, shutter mechanism, line and load connections, and mechanical and electrical interlocks are mounted. Also mounted in the medium voltage compartment are the current transformers and outgoing motor terminals.

In order to open the medium voltage compartment door, the contactor must be de-energized and the drawout fuse carriage must be completely racked out and the door unlatched. A mechanical interlock prevents racking the fuse carriage in or out without first de-energizing and opening the contactor. Low voltage doors may be opened without disconnecting power, but this must be done with extreme caution.

Series 81000 720 amp controllers can be connected together in a line-up with power distributed by a common horizontal bus. Each vertical section containing a 720 amp controller is fed by a vertical bus connecting the horizontal bus to the line stabs of the controller. Both the horizontal and vertical bus are isolated from the front by barriers.

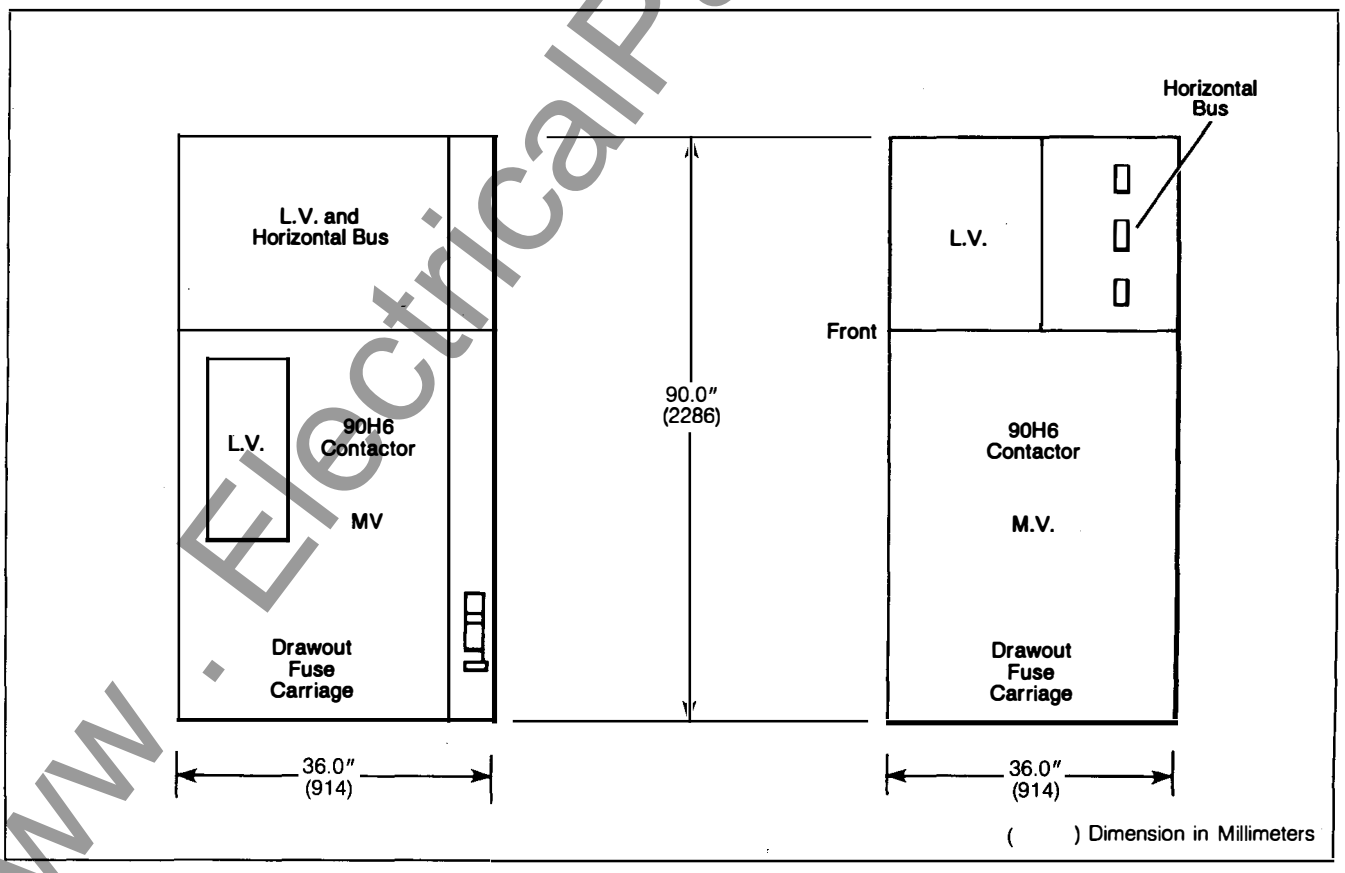


Figure 1. Typical Construction

Series 81000 720 amp controllers are rated in accordance with **Tables 1** through **3**.

For detailed ratings applicable to a particular controller, refer to the nameplate on the front of the enclosure.

Table 1. Controller Maximum Ratings.

Contactor Type	Enclosed Continuous Ampere Rating	Interrupting Capacity		kV Impulse Level (BIL)
		Controller Without Fuses	Controller With Fuses MVA	
90H6	720	10kA	200@2300V 350@4000V 400@4600V	60

Table 2. Maximum Rating for Motor Loads.

Horsepower Rating at Utilization Voltage					
2300V, 3-Phase			4000-4600V, 3-Phase		
Syn. Motors		Induction Motors	Syn. Motors		Induction Motors
0.8PF	1.0PF		0.8PF	1.0PF	
3000	3500	3000	5500	6000	5500

Table 3. Maximum Rating for Transformer Loads.

Transformer Loads			
Maximum 3-Phase kVA at Distribution Voltage			Maximum Power Fuse Rating
2400V	4160V	4800V	
2000	3500	4000	600E

Isolation and Automatic Shutter Mechanisms

Non-load break finger type stab assemblies mounted on the drawout fuse carriage provide the means for manual isolation of the power circuit, in accordance with NEMA Standards requirements. When the carriage is racked out, the finger assemblies isolate both line and load sides of the power fuses.

A shutter mechanism which covers the line stabs is driven directly by the racking mechanism. As the handle of the racking mechanism is moved to the ON position, the insulated shutter uncovers the line stabs just prior to engagement of the fuse carriage line and load stab fingers. In the reverse operation, when the handle is moved to the OFF position, the shutter covers the line stabs after the fingers have disengaged, effectively isolating all live high voltage parts.

Labels on the stationary part of the shutter clearly indicate if the isolating means (carriage) is OPENED (disengaged).

Racking Mechanism and Mechanical Interlocks

Racking of the drawout fuse carriage is accomplished by a compound four-bar mechanism operated by an external enclosure mounted handle. The racking handle can be locked with up to three padlocks in the OFF position.

Mechanical and electrical interlocks are provided in association with the racking mechanism to perform the following functions:

Medium Voltage Compartment Door Interlock

The racking handle is interlocked, **Figure 2**, with the door such that the handle cannot be moved to the ON position with the door open.

Door-Handle Interlock

The door-handle interlock, (2), prohibits closing or opening the medium voltage compartment door except when the racking handle is in the OFF position. The flat profile on the end of the handle shaft will not allow the door-handle interlock to pass in or out unless the handle is OFF. Refer to **Figure 2**.

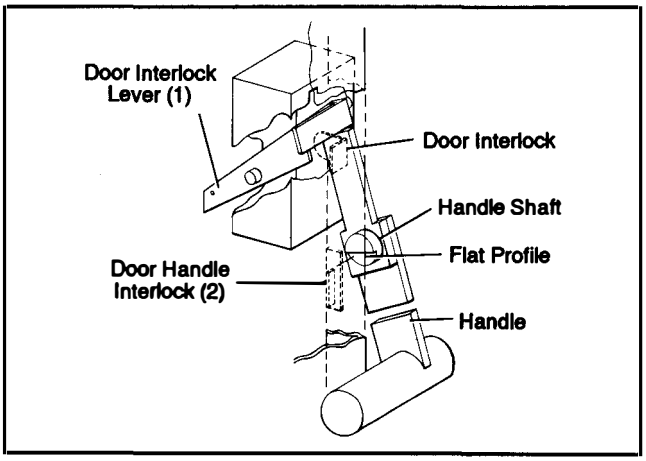


Figure 2. Door Interlock and Door-Handle Interlock.

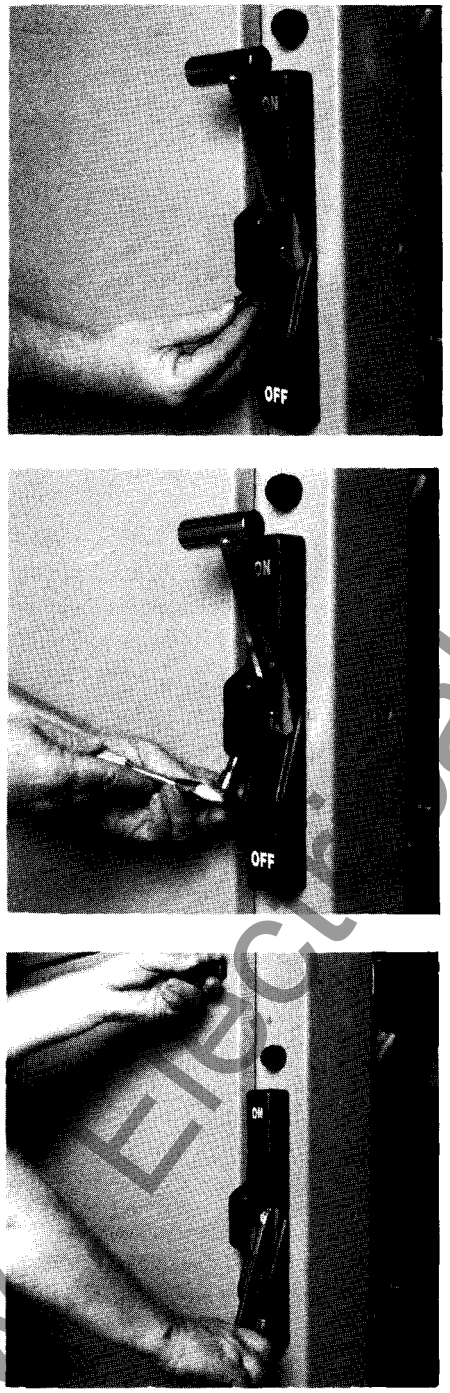


Figure 3. Procedure for Defeating the Door-Handle Interlock

⚠WARNING

Accidental contact with energized components can cause electric shock, burn or electrocution.

The door-handle interlock may be circumvented only by authorized and qualified personnel.

To prevent serious injury or death resulting from accidental contact with energized components, disconnect and lockout incoming power and control voltage sources before attempting to circumvent the interlock.

Never attempt to circumvent the interlock if the red carriage engagement light is on.

The interlock may be circumvented only by authorized and qualified personnel requiring access to the unit in case of emergency.

The interlock can be circumvented by removing a plastic cap from the underside of the racking handle housing, then by removing the Allen-Head set screw. The handle may then be moved to the OFF position allowing the door to be opened. Refer to **Figure 3.**

To restore the controller to normal operation after correcting the malfunction, reverse the procedure used to circumvent the interlock.

Contactor Interlock (Refer to **Figure 4**)

To prevent accidental insertion or removal of the fuse carriage when the contactor is closed, a contactor interlock is provided. This is important as the stab fingers on the fuse carriage are not rated to make or break any current other than the very low magnetizing current of the control power transformer.

An interlock lever moves to engage the notches in the racking cam when the vacuum contactor is closed. This lever is driven by a cable which is in turn driven by the movable armature on the contactor.

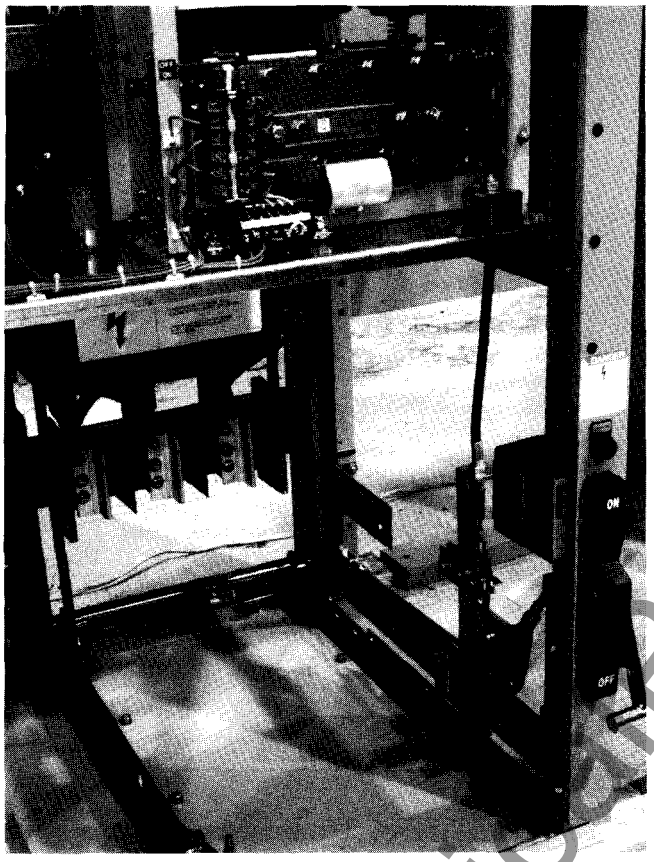


Figure 4. Contactor Interlock

Mechanical Latch (Refer to **Figure 5**)

The mechanical latch is mounted on the left hand side of the guide plate on which the drawout fuse carriage rolls out. It serves to locate and hold the fuse carriage in the disengaged (test) position.

The latch is released by manually pivoting the latch assembly upward and rolling the carriage out of the enclosure.

Detent Lever

This lever is provided to prevent relative motion between carriage stab fingers and stationary stab terminals, **Figure 6**, Slight initial force on the racking handle is required to free the detent lever when moving it from the ON to the OFF position.

Carriage Engagement Warning Light

A red warning light, mounted above the racking handle housing, is energized only when the drawout fuse carriage is fully engaged and incoming power is present, independent of the condition of the contactor or door, **Figure 7**, When the handle is moved to the OFF position, the red warning light should always go out, indicating the fuse carriage is fully disengaged and isolated from the stab assembly.

If the racking handle is moved to OFF and the red light stays on, the racking mechanism is not operating properly and the carriage is still engaged. **Do not attempt to open the medium voltage door**. Disconnect and lock out all incoming power and refer to the "Troubleshooting" section.

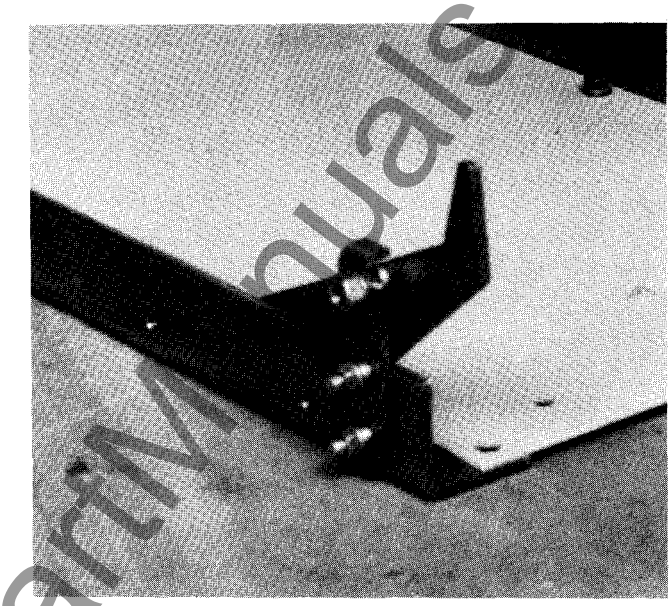


Figure 5. Mechanical Latch

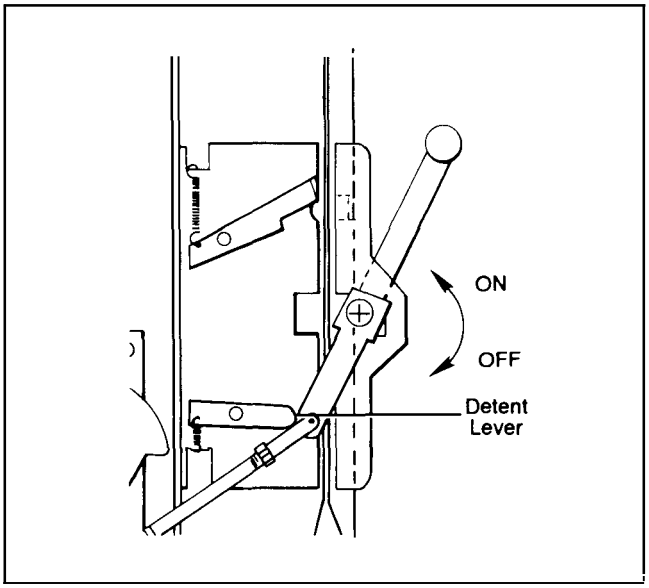


Figure 6. Detent Lever

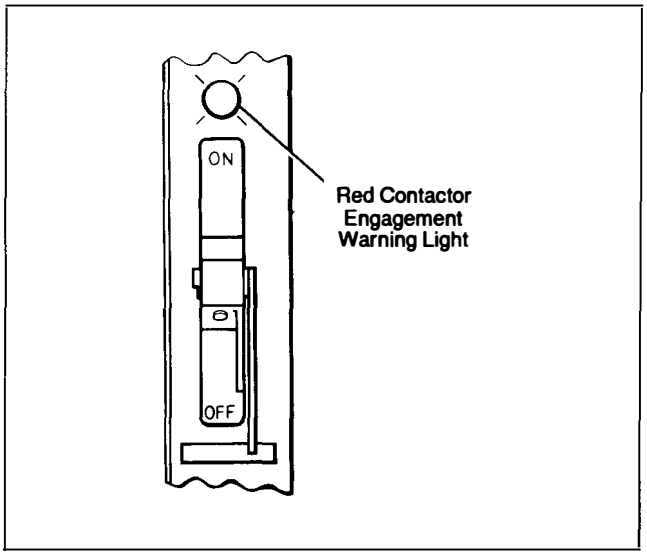


Figure 7. Carriage Engagement Warning Light

⚠ WARNING

Accidental contact with energized components can cause electric shock, burn or electrocution.

If red warning light remains on after moving racking handle to OFF, disconnect and lock out all incoming power and refer to "Troubleshooting" section in the Series 81000 Controller Instruction Manual, MVC-9018. Do not open medium voltage compartment door until power has been removed.

A push-to-test feature is provided to test the carriage engagement warning light using customer-supplied test power. A routine test of the light should be included in the controller maintenance plan.

Line Switch Interlock (LSI)

All control power derived from the secondary of the control power transformer is carried from the drawout carriage to the low voltage control panel through a set of contact fingers mounted on the rear of the carriage.

These contact fingers, along with the mating contact block which is stationary-mounted on the guide plate, make up the Line Switch Interlock (LSI). **Figure 8.**

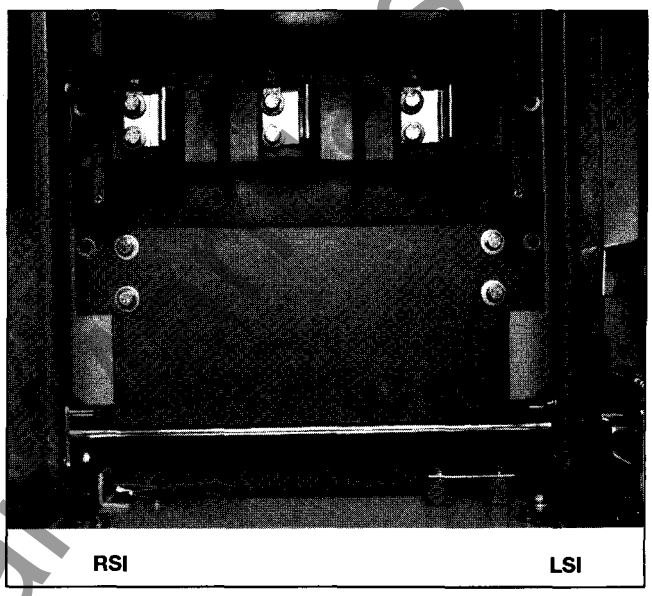


Figure 8. Line Switch Interlock (LSI) and Racking Switch Interlock (RSI)

The function of this interlock is to break all load on the transformer secondary winding prior to disengagement of the main power stabs as the carriage is racked out.

Racking Switch Interlock (RSI)

The Racking Switch Interlock (RSI) is a micro-switch mounted on the rear of the guide plate, **Figure 8**, which functions to prevent operation of the contactor on test power when the fuse carriage is racked in (ON). As the racking handle is moved from OFF to ON the normally closed RSI contact opens and isolates the test source from the control circuit.

Power Fuses

Current limiting power fuses are mounted on a drawout carriage which may be completely removed from the enclosure for servicing. All fuses used in 720 amp controllers are bolt-in type.

ANSI "R" or "X" rated fuses are used for motor starting duty and "E" rated fuses are used for transformer feeders.

Minimum melting and maximum clearing time curves for motor starting fuses are shown in **Figures 9** and **10**.

Current limiting characteristics of motor starting fuses are shown in **Figure 11**.

Motor fuse selection guide and maximum permissible motor accelerating times are shown in **Figures 12** and **13**.

Overload Relay

For information on thermal overload relays, refer to the "Overload Relay" section in the Series 81000 Controller Instruction Manual, MVC-9018.

Type 90H6 Vacuum Contactor

Siemens Type 90H6 720 amp vacuum contactors provide the advantage of long mechanical and electrical life with low maintenance and are essentially immune to adverse atmospheric environments. They are suitable for loads of all types including three-phase motors, transformers and capacitors.

The contactor has three main poles, each sealed in a vacuum interrupter, and the auxiliary contacts are enclosed in a dust-proof casing. Due to the fact that arc interruption is accomplished completely within the vacuum bottles, items such as arc chutes, blowout coils and pole plates are not required.

Stationary and movable power contacts are located inside the vacuum bottles with corrugated stainless steel bellows attached to the movable contacts to ensure a complete seal and integrity of the vacuum bottle.

Refer to **Figure 14** for a description of the major operating components of the Type 90H6 contactor.

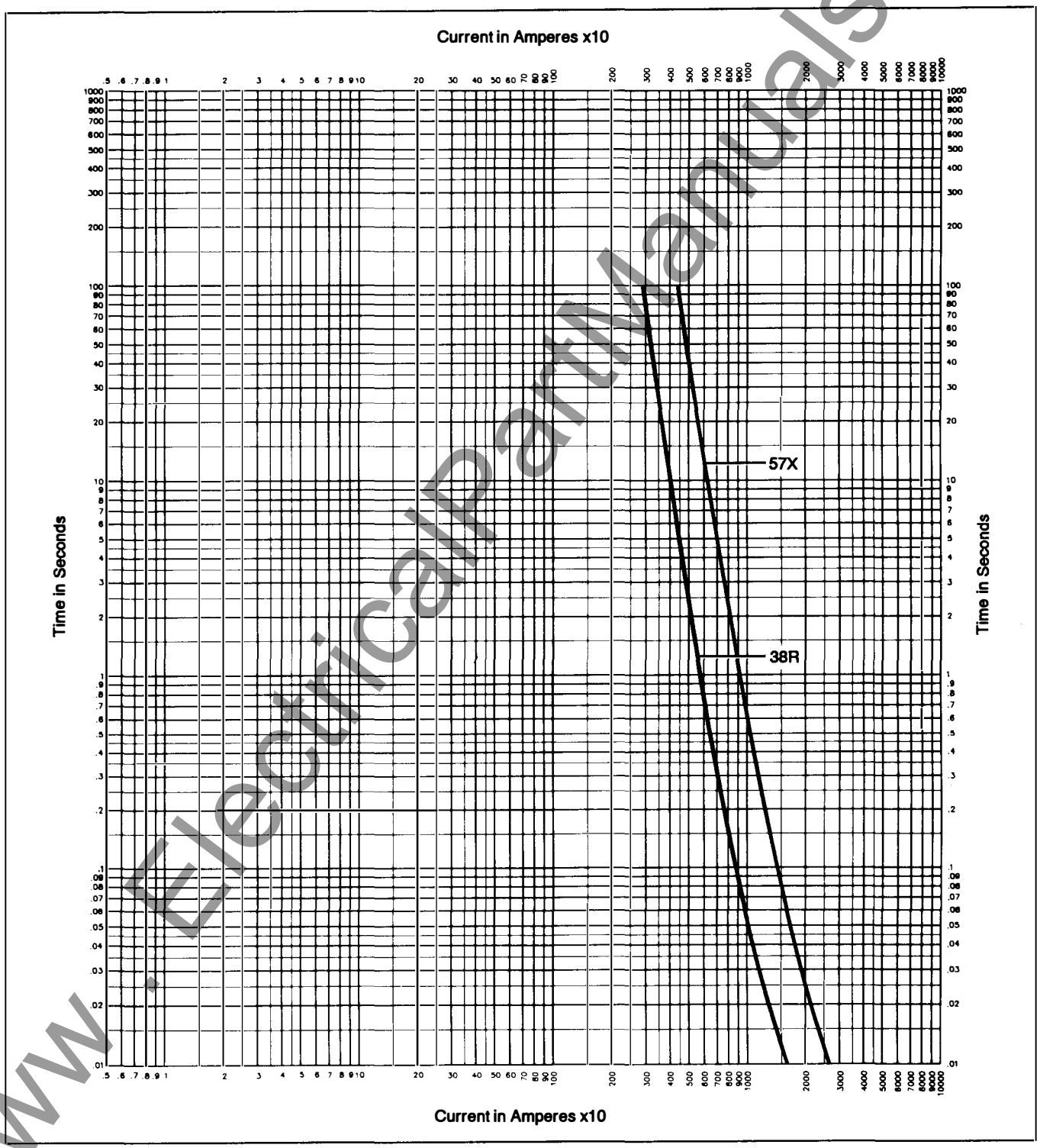


Figure 9. Minimum Melting Time-Current Curves 38R and 57X Fuses.

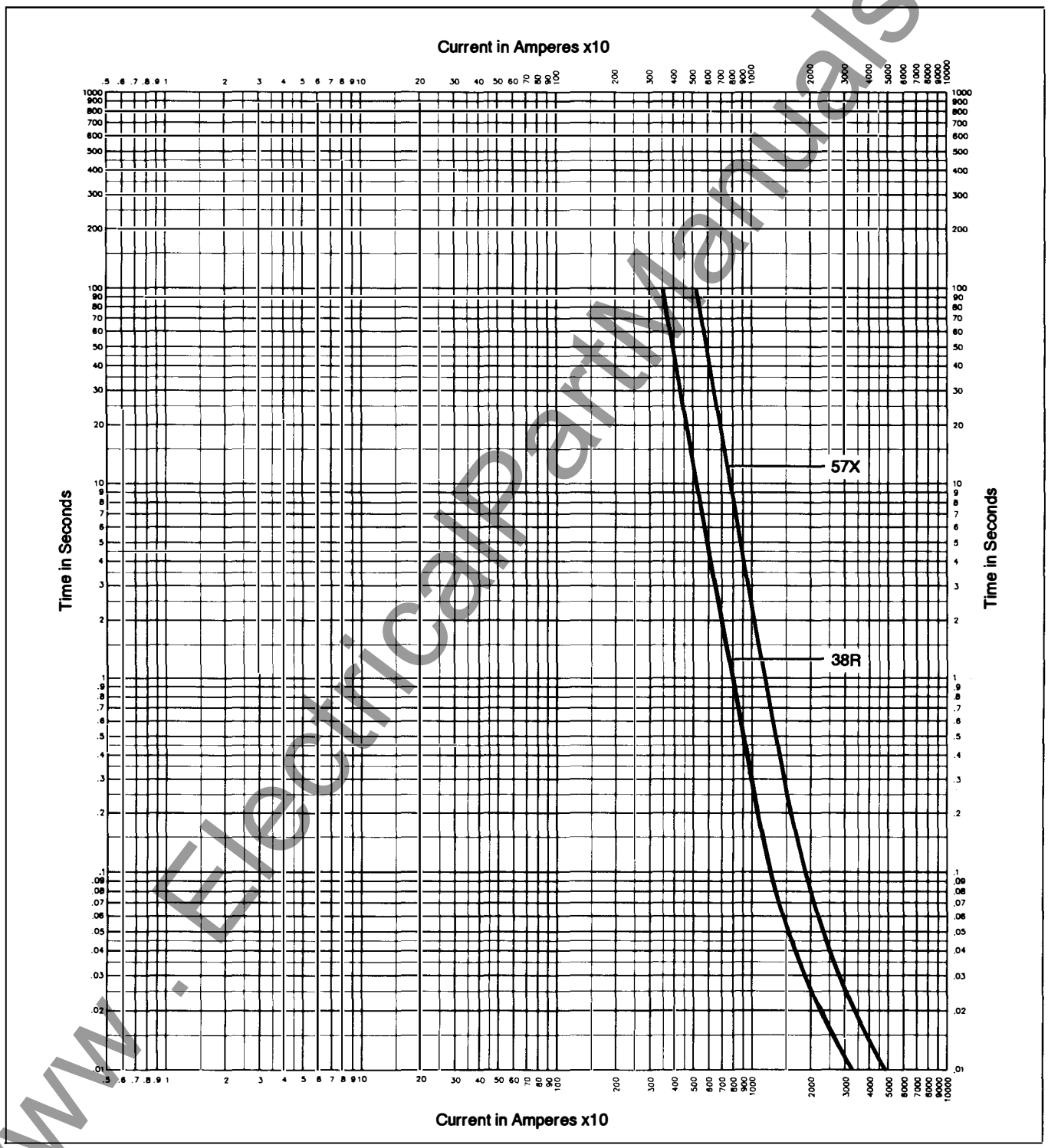


Figure 10. Total Clearing Time-Current Curves 38R and 57X Fuses.

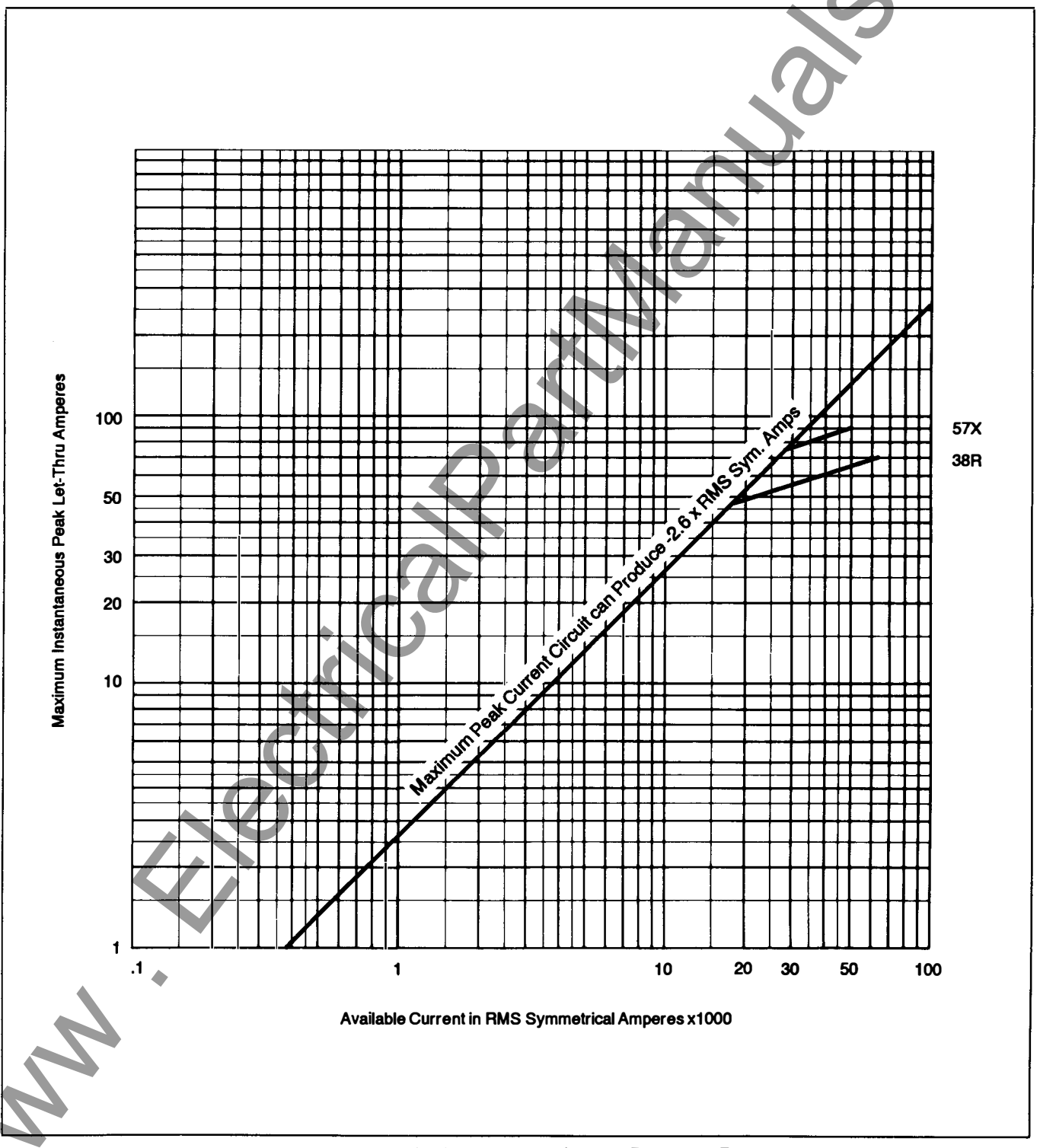


Figure 11. Current-Limiting Characteristics 38R and 57X Fuses.

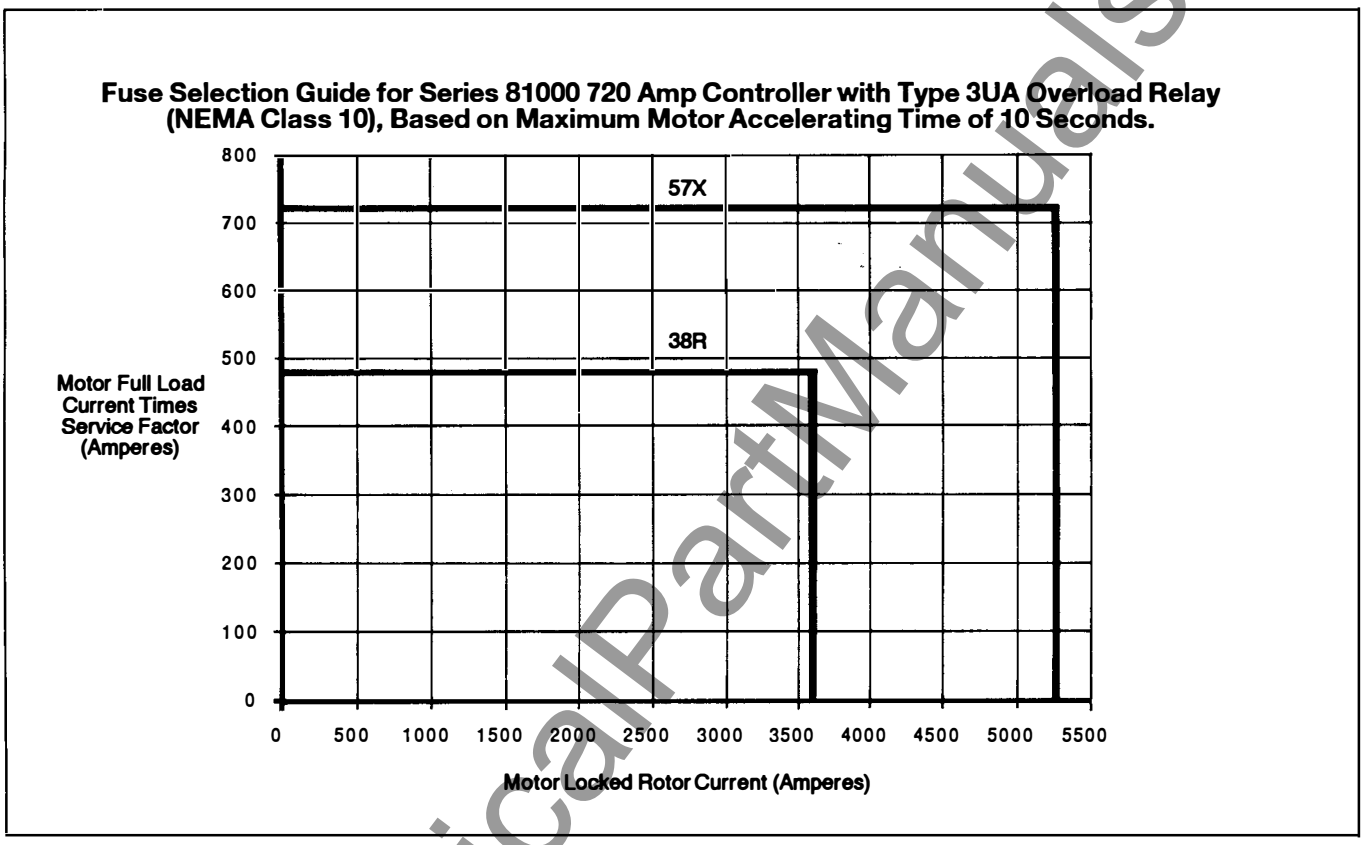


Figure 12. Fuse Selection Guide

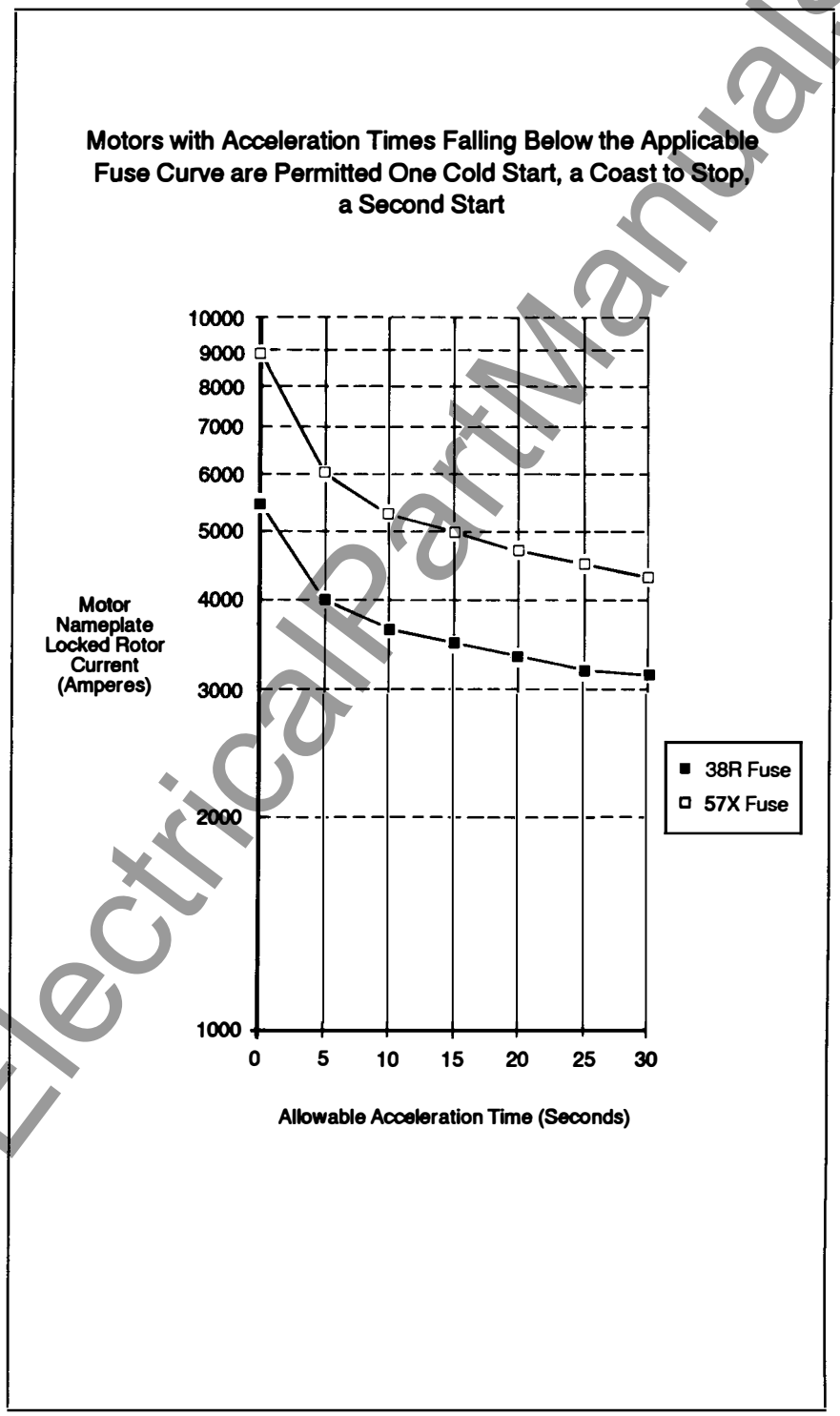


Figure 13. Maximum Allowable Motor Acceleration Times

1. Insulating Barrier
2. Vacuum Interrupter
3. Upper Terminal
4. Lower Terminal
5. Shunt Lead Wire
6. Insulating Flange
7. Resetting Spring
8. Main Coil
9. Resistor
10. Adjusting Nut
11. Operating Lever
12. Auxiliary Contact Block
13. Operating Shaft
14. Armature
15. Control Terminal Board
16. Resetting Spring Adjusting Bolts
17. Vacuum Interrupter Fixing Bolts
18. Clamp Nut
19. Resetting Spring Retaining Plate
20. Plate Fixing Bolts
21. Coil Retaining Screws
22. Armature Retaining Bolts
23. Armature Stopper

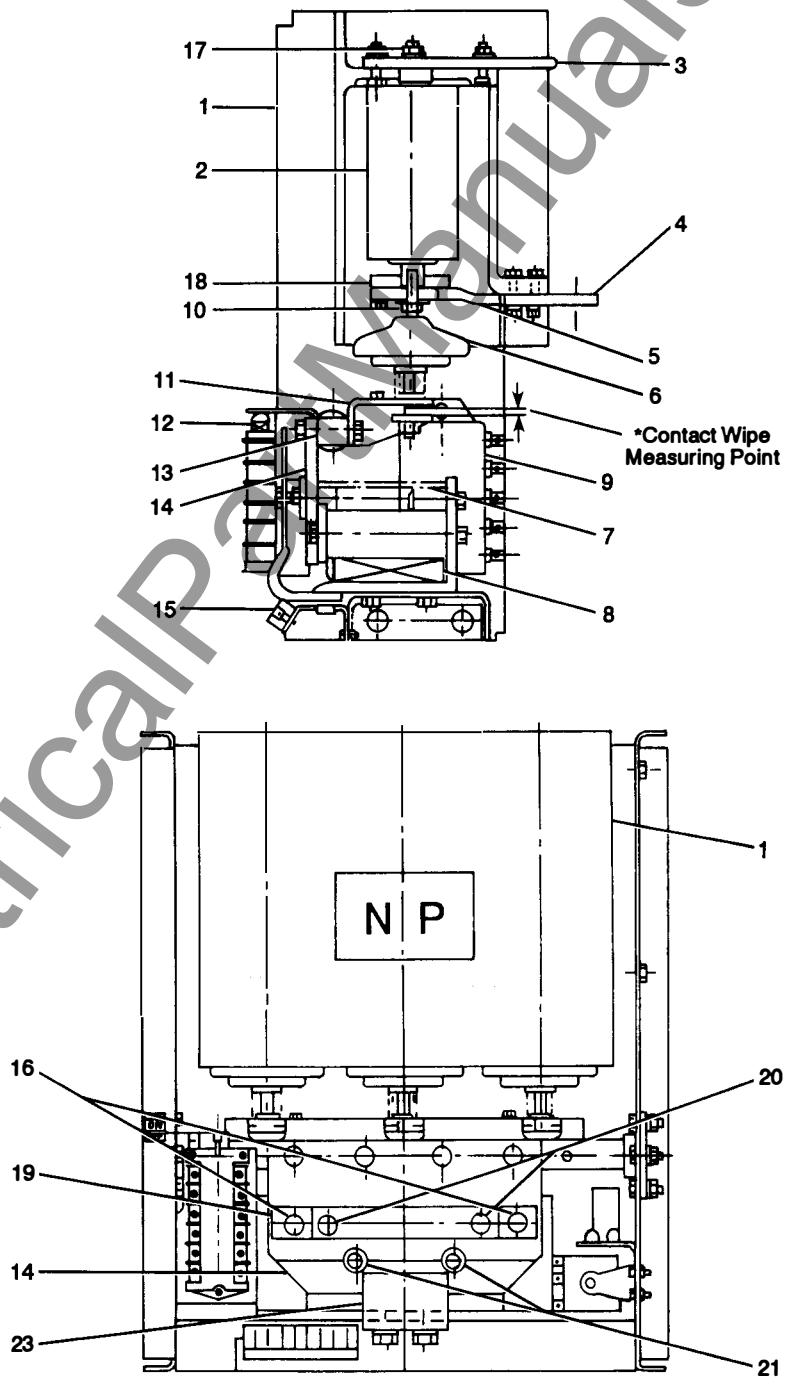
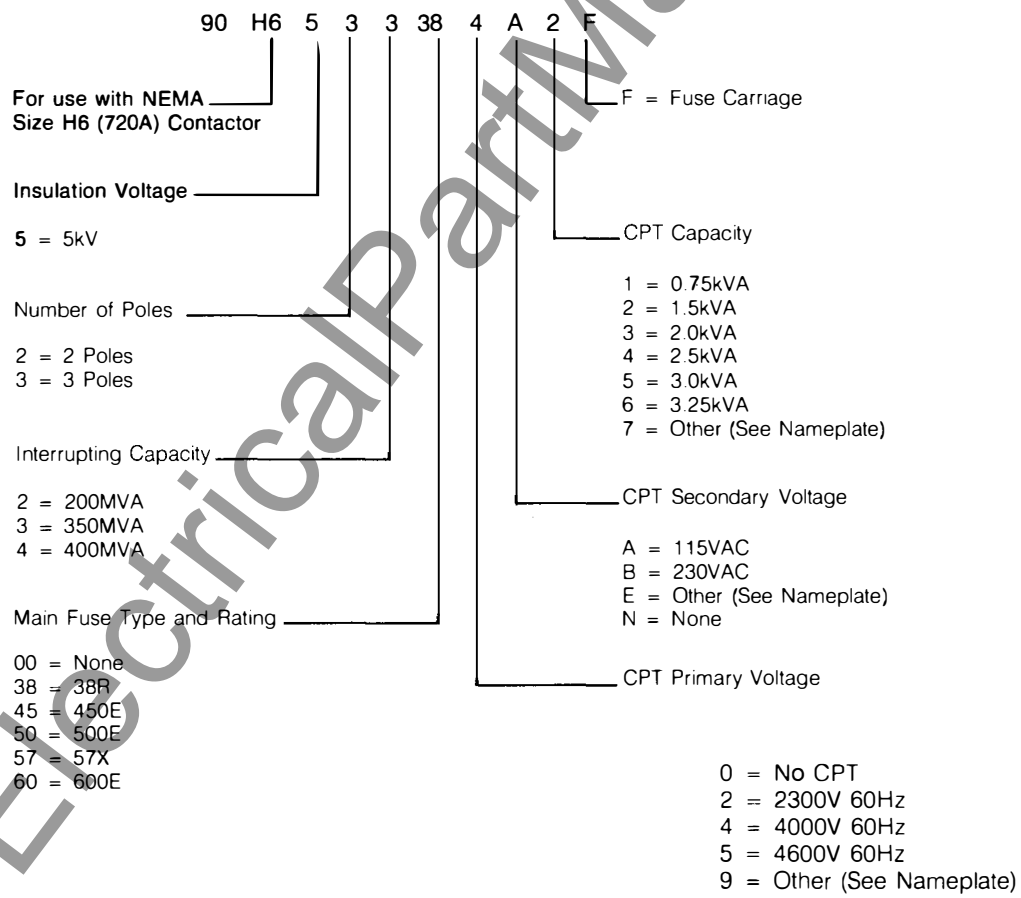


Figure 14. Major Operating Components of Type 90H6 Contactor

Nomenclature

Nomenclature

Fuse carriages can be identified through the nomenclature description shown below:



Example:

Carriage Cat. No. 90H6533384A2F is a three pole fuse carriage designed for use with a Series 81000 720 amp, 5kV vacuum controller. It has an interrupting capacity of 350MVA at 4000 volts using motor starting fuses rated 38R. It is equipped with a 1.5kVA control power transformer with a 4000VAC primary and 115VAC secondary.

Receiving, Handling and Storage

Refer to the appropriate sections in the instruction manual for Series 81000 Controllers, MVC-9018, for instructions regarding the receiving, handling and storage of Series 81000 720 amp vacuum controllers.

Site Preparation and Mounting

Installation should be in accordance with the National Electrical Code, ANSI and NFPA 70 Standards.

The controller should be installed in a clean, dry, heated place with good ventilation. It should be readily accessible for cleaning and inspection and should be carefully set up and leveled on its supporting foundation and secured in place. If the mounting site is not flat and level, the controller must be shimmed where necessary to prevent distortion of the frame. Shims should be applied adjacent to the anchor bolt locations shown in **Figure 15** or **16**.

Installation of the controller on an unlevel surface distorts the enclosure and will make it difficult or impossible to open and close doors.

The controller should be secured in place by bolting or welding to the foundation. Refer to **Figure 15** and **16** for anchor bolt locations. The bolt pattern is dependent on whether or not sill channels are furnished. The group arrangement drawing for each controller details the anchor bolt locations.

Expandable inserts in pre-drilled holes or imbedded "L" bolts are recommended. Wooden plugs driven into holes in masonry or concrete are not recommended for anchoring inserts and should never be used. The bolt size must be 1/2". Welding the steel base or sill channels to a steel floor plate is an alternate mounting method especially recommended in areas subject to seismic activity.

Grouting the sill channels as indicated in **Figure 17** is another method of fastening. This method requires the foundation to be grooved as shown to accept the sill channels. The actual groove dimensions must be coordinated with the floor plan layout on the group arrangement drawing included in the controller information packet.

General Pre-Installation Inspection

1. Check all parts for secure mounting and good electrical connections. Inspect visually for good condition.
2. Inspect frame for dents and other damage. Swing doors to make sure they pivot easily.
3. Operate the racking mechanism to ensure free and smooth operation. Inspect the stab assembly and shutter mechanism.
4. Check bolt-in fuses on carriage for tight connections.
5. Check control circuit plug and receptacle for bent pins and other damage.
6. Make sure that cable clamps and insulators are in good condition.

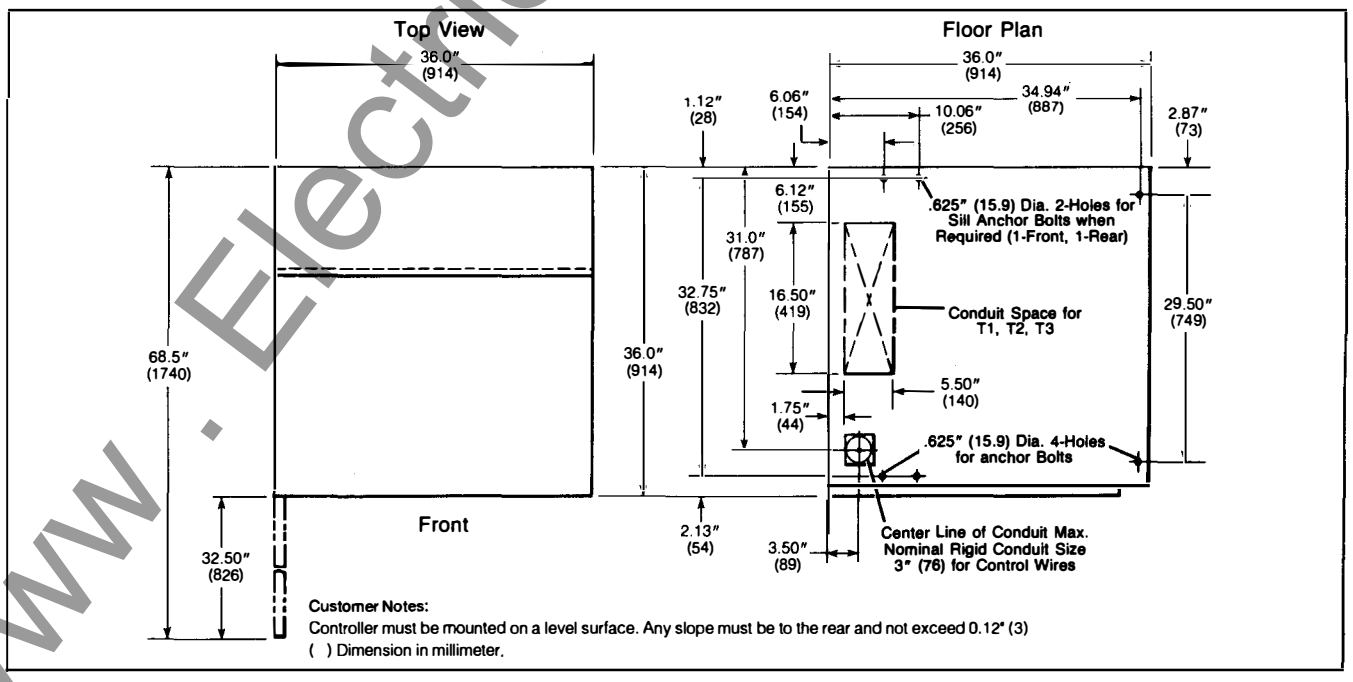


Figure 15. Anchor Bolt and Conduit Entry Locations—Bottom Entry of Load Cables

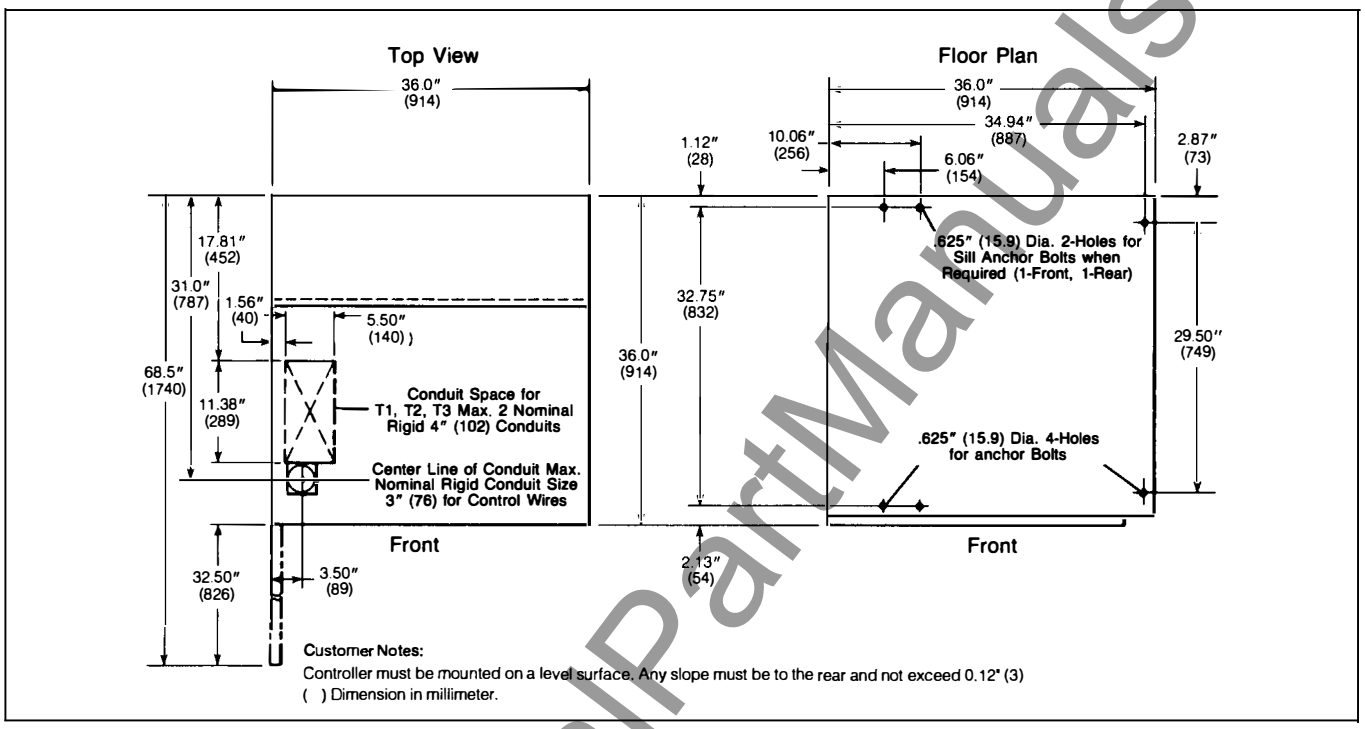


Figure 16. Anchor Bolt and Conduit Entry Locations—Top Entry of Load Cables

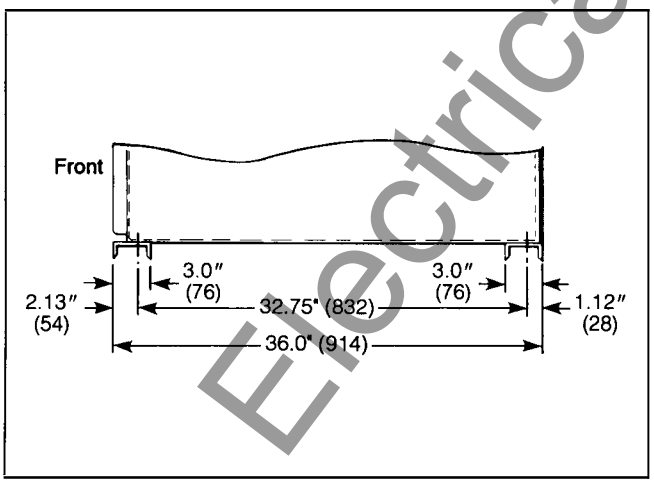


Figure 17. Typical Side View with Sill Channels when Required

Grounding

Each controller's frame must be grounded. This connection must be made before making any power connection. If a ground bus is furnished, the ground connection should be made to the ground bus. The control and instrumentation circuits are grounded to the enclosure. This connection can be temporarily removed for test purposes, but it must be reconnected before the controller is returned to operation.

Electrical Connection

To provide additional access for line and load cable connections, the fuse carriage should be removed. Be sure to disconnect the control plug before attempting to remove the carriage.

Line connections should be made first. Refer to **Figure 18** for details.

Load cable terminations are made directly to pads located near the current transformers on the left hand enclosure wall. Typical conduit space for top or bottom entry of load cables and control wires is given in **Figures 15** and **16**.

Fuse Carriage Installation

Correct installation of the fuse carriage is essential to proper controller operation. Before installing a fuse carriage in any medium voltage compartment, observe the following check list:

A. Check to see that the catalog number and power fuse rating on the carriage rating label match the information given on the medium voltage compartment rating label.

B. Check the following items on the carriage for agreement with the information given on the rating label:

1. Power fuse type and "R","X", or "E" rating.
2. Control power transformer kVA and voltage rating.
3. Control power transformer primary fuse "E" rating.

C. Do not attempt to install a drawout contactor from a Series 81000 controller in a 720 amp controller, or vise-versa.

⚠WARNING

Installation of the wrong carriage in the controller can cause a major malfunction resulting in equipment damage and possible serious personal injury.

Positively verify that the correct carriage is installed by following the steps outlined.

After it has been verified that the correct fuse carriage has been selected for a given medium voltage compartment, the carriage may be installed as follows:

1. Open the 60 inch high medium voltage compartment door. The racking handle must be in the OFF position and the red carriage engagement warning light must not be lit.
2. Position the carriage in front of the compartment with the stabs pointing into the cubicle in such a way that the rear wheels are lined up with the sides of the guide plate on the bottom of the enclosure.
3. Roll the carriage onto the guide plate and into the compartment until it stops. When the carriage is fully inserted, the mechanical latch will rotate to prevent it from rolling back out of the compartment.
4. Connect the control wiring harness plug to the carriage by inserting it in the receptacle located in the lower front.
5. Close and secure the medium voltage compartment door.

Power Cable Termination

For additional instructions on terminating power cables to the 720 amp controller, refer to the pertinent sections of the Series 81000 Instruction Manual, MVC-9018.

Site Altitude

The Type 90H6 vacuum contactor, as all vacuum contactors, is intended to close by utilizing differential pressure between the vacuum in the interrupters and atmospheric pressure. As a result, the pick-up voltage of the vacuum contactor becomes higher as the site altitude increases.

The pick-up voltage will increase approximately 3.5% for each 1000M (3300 ft.) increase in altitude. The contactor is factory-adjusted to pick-up at approximately 70% of rated voltage when located at 0-1000M site altitude.

For altitudes above 1000M, a slight adjustment of the two resetting springs (**Figure 14,** item 7) is necessary. To perform the adjustment, loosen the lock nuts which secure the return spring adjusting bolts (**Figure 14**, item 16) and turn the bolts equally counterclockwise. One turn of each bolt will produce a decrease in pick-up voltage of approximately 6%.

For example, suppose the contactor is located at 7200 ft. altitude. this corresponds to 2180M, or 1180M above the maximum factory adjusted altitude of 1000M. At a rate of change of 3.5% per 1000M, this would result in an increase in pick-up voltage of 3.5% times 1.18 or 4.13%. To compensate would therefore require an adjustment of the return spring adjusting bolts of approximately 2/3 turn counterclockwise.

Should the contactor be located below sea level, a similar adjustment procedure should be performed. All the above rules apply, except that the adjusting bolts must be turned clockwise instead of counterclockwise to compensate for increasing atmospheric pressure.

When the site altitude exceeds 2000M (6600 ft.) the electrical ratings of the vacuum controller are reduced and special application consideration must be given in accordance with NEMA Standard ICS 1-108. Both dielectric strength of the insulation and current carrying capacity are affected. If the site altitude exceeds 6600 ft. consult the factory for derating information.

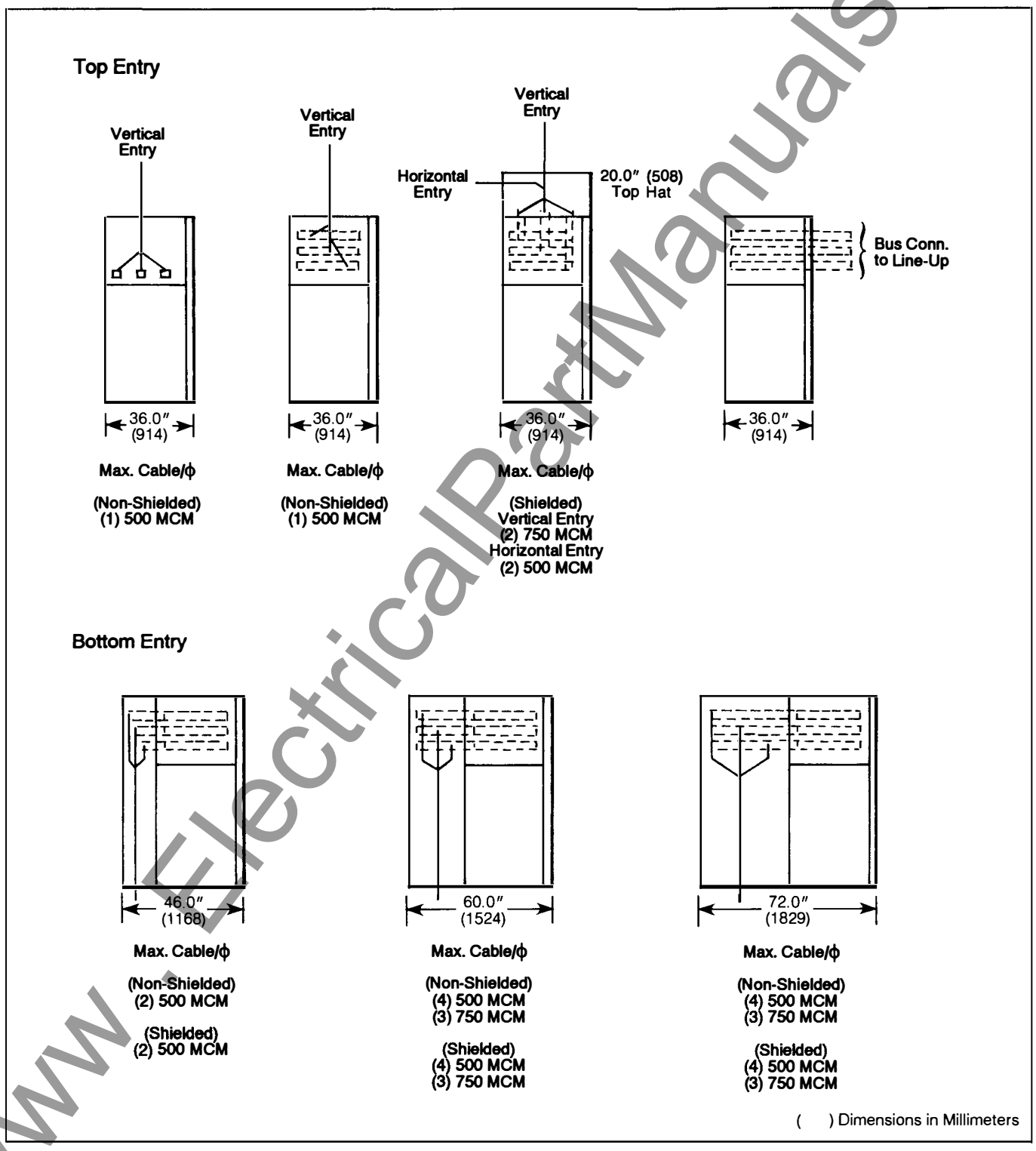


Figure 18. Methods of Line Connection to 720A Controller

Pre-Energization Check

After installation or maintenance, the following checklist should be followed:

1. Retighten all accessible connections in accordance with the torque values provided in **Table 5**, page 25.
2. Remove all blocks or other temporary holding means used for shipment from all component devices in the controller interior.
3. Check the integrity of the bus mounting means.
4. Check the enclosure to see that it has not been damaged in such a manner as to reduce electrical spacings.
5. Compare all circuits for agreement with the wiring diagrams which accompany the controller.
6. Make certain that external wiring is clear of bus, and all power wiring is physically secured to withstand the effects of the largest fault current which the power system is capable of delivering.
7. Verify that all ground connections have been made properly. If sections of the controller were shipped separately, they must be connected in a manner to assure a continuous ground path.
8. Check all devices for damage. Make necessary repairs or replacement prior to energizing.
9. Be sure that each motor is connected to its intended starter. Ensure that fuse rating is in agreement with the rating specified in the fuse carriage catalog number.
10. Manually exercise all operating mechanisms and devices where possible to make certain they are properly aligned and operate freely.
11. With all loads disconnected, exercise all electrically operated devices with control test power to determine they operate properly. Refer to the wiring diagrams supplied for the required control voltage, frequency and test power terminal designations required to test the contactor.
12. Test the ground fault protection system, if furnished, in accordance with the manufacturer's instructions.
13. Set all devices with adjustable current and voltage trip, if furnished, to the proper values.
14. Ensure that the overload relay current range and setting is in agreement with the full load current and service factor shown on the motor nameplate, taking into account the current transformer ratio.
15. Check that shorting links on current transformers, if furnished, are in the open position. Check each current transformer's secondary circuit for continuity.
16. To prevent possible damage to equipment or injury to personnel, check that all parts and barriers that may have been removed during installation and wiring have been properly reinstalled.
17. Before closing the enclosure, remove all metal clippings, scrap wire and other debris from the controller interior. If there is appreciable accumulation of dust or dirt, clean out the controller by using a brush, vacuum cleaner or clean, lint-free rags. Do not use compressed air as it will only redistribute the contaminants on other surfaces.
18. After all power and control connections are made and with incoming power disconnected, conduct an electrical insulation resistance test on the power circuit to ensure that the controller is free from short circuits and grounds.
19. Install covers, close doors and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.

Dielectric Test

⚠WARNING

Accidental contact with energized components can cause electric shock, burn or electrocution.

Dielectric testing is hazardous and should be conducted by qualified personnel. Refer to test device instructions for safety instructions.

A dielectric test at 2.25 times the nominal system voltage plus 2000 volts should be performed between all phases and from all phases to ground prior to energizing the equipment.

Be sure to disconnect any devices such as control power transformers which could be damaged by the test voltage.

A megger test at 1000 volts is a suitable alternative if a dielectric tester is unavailable.

Make sure that all current-carrying parts outside the contactor have adequate current-carrying capacity and are correctly insulated in accordance with the requirements of the National Electrical Code (NEC). All electrical connections should be made carefully per the wiring diagram furnished with the equipment. Tighten all lugs to recommended torque values. Use recommended crimping tools only if crimp lugs are supplied.

⚠WARNING

Excessive dielectric test voltages can cause harmful x-radiation to be emitted from vacuum bottles.

Vacuum-type interrupters can produce x-rays if they are subjected to sufficiently high voltages. The vacuum bottles used in Siemens Type 90H6 contactors will not produce harmful x-rays at applied voltages of 40 kV or less. High-potential dielectric tests should be limited to a maximum value of 13,250 volts RMS AC to allow an adequate safety margin for protection of personnel from x-radiation.

Energizing Equipment

⚠WARNING

There is a potential hazard of major equipment damage and personal injury when energizing the controller for the first time.

Only qualified personnel should energize the equipment.

Any problems detected in the pre-energization check procedure must have been corrected prior to energizing the controller.

1. There should be no load on the controller when it is energized. Turn off all downstream loads including those such as distribution equipment and other devices which are remote from the controller.
2. The equipment should be energized in sequence by starting at the source end of the system and working toward the load end. In other words, energize the incoming power to the controller or group of controllers, then close the incoming line load break switch if supplied, and then rack in the fuse carriage.
3. After all disconnect devices have been closed, loads such as motors may be operated.

Operating Data—Type 90H6 Contactor

Refer to **Table 4** for electrical operating data for the Type 90H6 vacuum contactor.

Surge Protection

For a detailed discussion on surge protection, refer to the section titled "Overvoltage Protection" in the Series 81000 Controller Instruction Manual, MVC-9018.

Switching overvoltages which occur when interrupting current with vacuum contactors are caused by two phenomena known as current chopping and multiple re-ignition. The term "current chopping" refers to the abrupt extinction of current near a natural sinusoidal current zero, which can result in higher than normal recovery voltages. "Multiple re-ignition" refers to the repeated interruption and re-establishment of the

current which can occur when the main contacts happen to part near a natural sinusoidal current zero.

Overvoltages caused by current chopping are not peculiar to vacuum interrupters and have been observed in most other interruption media. With the use of modern contact materials, overvoltages generated by current chopping no longer present a danger to motor insulation.

Multiple re-ignitions, on the other hand, combined with virtual chopping may cause damaging voltage transients if not controlled by the use of surge limiters. The probability of overvoltages due to multiple re-ignitions is only of concern at locked rotor currents of 600 amps or less.

Since an application with a motor having a locked rotor current of 600 amps or less is highly unusual for the 720 amp Type 90H6 contactor, surge protection is not normally recommended or necessary.

Table 4. Type 90H6 Contactor Operating Data

Description	115 Volt AC Supply	230 Volt AC Supply	125 Volt DC Supply	250 Volt DC Supply
Rated Control Voltage	115 Volts	230 Volts	125 Volts	250 Volts
Pick-Up Voltage	81 Volts	161 Volts	88 Volts	175 Volts
Closing Time	120 ms	120 ms	120 ms	120 ms
Opening Time	30 ms or less	30 ms or less	30 ms or less	30 ms or less
Inrush Current	10 Amps	5 Amps	10 Amps	5 Amps
Holding Current	1.3 Amps	0.65 Amps	1.3 Amps	0.65 Amps

⚠WARNING

Accidental contact with energized components can cause electric shock, burn or electrocution.

Disconnect and lock-out incoming power and control voltage sources before beginning work on this or any other electrical equipment.

Check all control circuit terminals with a voltmeter to make certain that the equipment is totally de-energized. Use only approved high voltage test equipment to check voltage on power terminals. Do not attempt to measure high voltage (over 600 volts) with a volt-ohm meter.

It is recommended that a safety ground be connected to the power bus after the system has been de-energized, and prior to working on the equipment. Follow the procedure outlined in the Pre-Energization Check section of this manual before power is restored.

General

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety related work practices of NFPA 70E, part II should always be followed when working on electrical equipment. Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments.

The customer must establish a periodic program to ensure trouble-free and safe operation. The frequency of inspection, periodic cleaning and preventive maintenance schedule will depend upon the operating conditions. NFPA Publication 70B "Electrical Equipment Maintenance" may be used as a guide to establish such a program. **A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.** The following items should be included in any maintenance checklist. For more details read the succeeding pages.

- Proper Installation of Phase Barriers
- Vacuum Bottles
- Main Coil
- Auxiliary Contacts
- Fuse Clips
- Terminals and Joints
- Cleaning
- Tightening Torques
- Mechanical and Electrical Operation of the Contactor

Maintenance of the vacuum contactor should only be performed with the contactor de-energized. Maintenance of the fuse carriage should be performed with the carriage completely withdrawn from the compartment.

Check for Wear of Main Contacts

Contact wear on the Type 90H6 contactor is measured by inserting a wear gauge as shown in **Figure 14**. The amount of wipe or overtravel of the movable contact in the interrupters will gradually decrease as wear occurs.

When the overtravel has decreased to a point where the wear gauge can no longer be inserted, the vacuum bottle has reached the end of its service life and must be replaced.

Inspect the vacuum bottles for wear once a year or every 50,000 operations, whichever occurs first.

Check for Vacuum Loss

It is highly unlikely that a vacuum bottle will ever suffer loss of vacuum. Vacuum bottles used in the Type 90H6 contactor have been designed and tested to maintain a high vacuum level for many years.

In the event that a vacuum bottle ever loses vacuum, it is still possible for the contactor to carry up to its rated continuous current, since contact pressure is maintained by an external compression spring. Even with one failed interrupter, the contactor can still interrupt approximately 90% of its rating, unless the fault is a ground fault which happens to occur on the failed pole.

Loss of vacuum can be detected in either of two ways. The first is to apply a high potential voltage across the open contacts of each bottle individually. If sufficient vacuum exists, the bottle should support 10kV RMS AC or 14kV DC applied for one minute.

⚠WARNING

Accidental contact with dielectric test equipment can cause shock, burn or electrocution.

Dielectric or megger testing should only be conducted by qualified personnel. Refer to Test Device instructions for safety instructions.

⚠WARNING

Excessive dielectric test voltages can cause harmful x-radiation to be emitted from vacuum bottles.

Do not exceed 13,250 volts RMS AC or 19 kV DC when performing dielectric tests.

⚠WARNING

High peak voltages can result in erroneous test results and x-radiation emitted from vacuum bottles causing personal injury.

Do not exceed the recommended test voltages when performing dielectric tests.

DC high potential test voltage sources using half wave conversion will apply peak voltages 3 times greater than the measured DC voltage. Do not use DC high potential voltage sources which employ half wave conversion circuits.

The second method to detect vacuum loss is to remove the suspect vacuum bottle and measure the amount of force necessary to separate the contacts by pulling on the movable end. A good interrupter should require approximately 20 lbs. to separate the contacts, whereas an interrupter which has lost vacuum will require only 4-5 lbs.

Pick-Up Voltage Check

Once per year, check to see that the Type 90H6 contactor will pick-up at 85% of rated control voltage. Watch that the contactor picks up in a single rather than a two-step motion.

If the pick-up voltage is too high, it is possible that the vacuum bottles may be sticking slightly. In this event put a small amount of lubricating oil on the moving rod on the lower end of each bottle. Also, it may be necessary to re-adjust the resetting spring pressure as described in the instructions in the Site Altitude section of this manual.

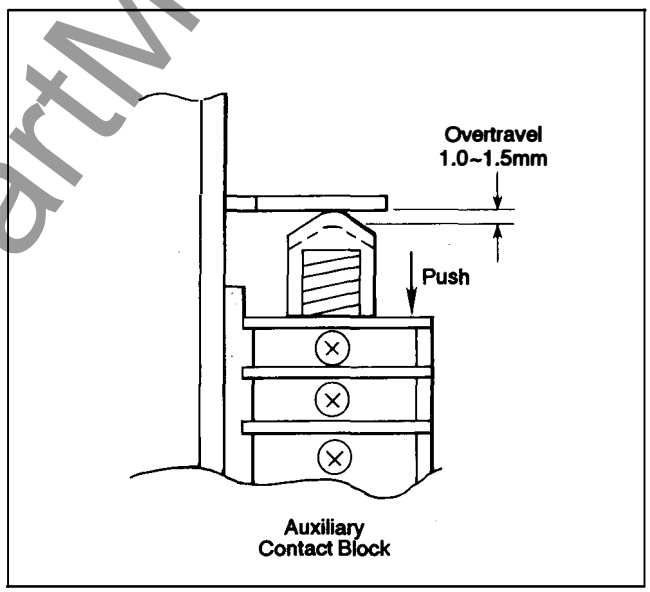


Figure 19. Measurement of Auxiliary Contact Overtravel

Auxiliary Contact Block

Once per year, measure the overtravel of the auxiliary contact block assembly on the Type 90H6 contactor with the contactor closed as shown in **Figure 19.** If the gap is not as shown, adjust by bending the operating lever slightly.

Check the gap of the normally closed auxiliary contacts which are in parallel with the economizing resistors. This gap should be 2-2.5mm.

Check for excessive accumulation of dirt or other contaminants in the auxiliary contact block and clean if necessary.

Mechanical and Electrical Operation of the Controller

Refer to the "Mechanical and Electrical Operation of the Controller" section in the Series 81000 Controller Instruction Manual, MVC-9018.

With regard to the resistance measurements described in MVC-9018, the following maximum values apply to the Type 90H6 contactor and the drawout fuse carriage:

Across a single contactor pole—1.0 milliohm
Across a single pole of the drawout fuse carriage—
38R fuse—1.5 milliohm
57X fuse—1.3 milliohm

Shutter Mechanism

It is recommended that the shutter mechanism be inspected for any loose or broken parts every time the fuse carriage is removed from the compartment. Periodic checks are strongly recommended.

Replace broken parts and check for any binding of the linkages.

⚠WARNING

Accidental contact with energized parts located behind the shutter can cause shock, burn or electrocution.

Disconnect and lock-out incoming power before performing any maintenance on the shutter mechanism.

Racking Mechanism

Information regarding the maintenance and adjustment of the racking mechanism used in Series 81000 720 amp controllers can be found in the "Racking Mechanism Adjustment" section of the Series 81000 Controller Instruction Manual, MVC-9018.

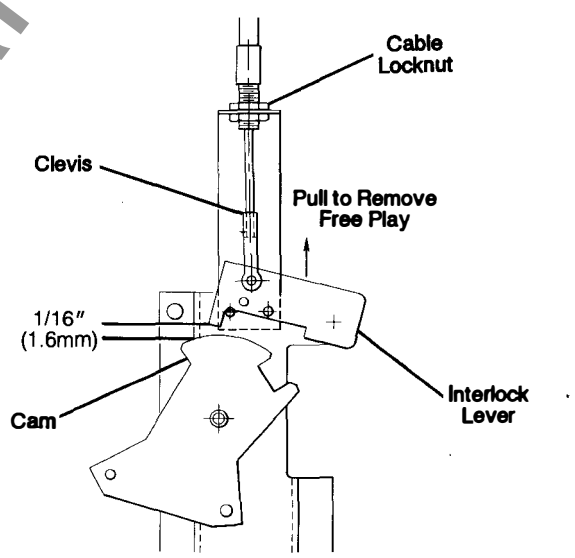
Follow the instructions in MVC-9018 which refer to "cell in bottom compartment."

Mechanical Interlocks

All mechanical interlocks are factory adjusted. With normal use, no maintenance should be required except for a light coat of grease at the moving joints.

Periodically check the condition of the cable which connects the contactor to the contactor interlock on the racking mechanism. Inspect the fittings at each end of the cable for mechanical secureness.

If it becomes necessary for any reason to adjust the length of the cable, remove the pin through the clevis at either end of the cable and turn the clevis until the gap between the lever and the cam is as shown in **Figure 20**.

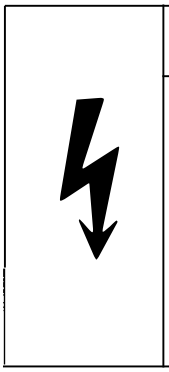


1. Move racking handle mid-way between OFF and ON positions.
2. Adjust cable length by turning clevis so that a 1/16 inch (1.6mm) gap exists between the interlock lever and the cam as shown above. When making the adjustment, pull the interlock lever up as far as it will go to remove all free play. When the lever is released, it may drag the cam slightly. This is acceptable.
3. Tighten cable locknuts.

Figure 20. Mechanical Interlock Cable Adjustment Specification

Electrical Interlocks

Refer to the "Electrical Interlocks" section in the Series 81000 Controller Instruction Manual, MVC-9018.



⚠WARNING

Interlocks are installed on this equipment to help prevent accidental or intentional misuse which can result in personal injury and equipment damage.

Never attempt to operate this equipment unless all mechanical and electrical interlocks are installed and operating properly.

Electrical Joints and Terminals

Carefully inspect all visible accessible electrical joints and terminals in the bus and wiring system.

1. Retighten bolts and nuts at bus joints if there is any sign of overheating or looseness. Refer to "Recommended Torque Values", **Table 5**.
2. If joints or terminations appear to be badly discolored, corroded or pitted, or show evidence of having been subjected to high temperatures, the parts should be disassembled and cleaned or replaced.
3. Examine all wire or cable connections for evidence of looseness or overheating. Retighten, if necessary. If major discoloration of cable insulation or if cable damage is apparent, replace the damaged portion of the cable.
4. Check torque of the fuse bolt mounting hardware.
5. Examine all joints for plating wear, replace if the plating is worn out. Special attention should be paid to the stab fingers under such adverse environmental conditions where sulfur dioxide, chlorine, some hydrocarbons and saltwater exist in the atmosphere. Replace if evidence of copper oxide or other films are formed. Use Siemens contact finger lubricant number 15-171-370-001 to protect the stab finger joint from deterioration. Worn plating on the stabs can result in overheating and may lead to flashover. Plating wear through can be expected after approximately 1500 racking operations in mild environments.
6. Examine insulation on conductors for overheating or chaffing against metal edges that could progress into an insulation failure. Replace any damaged conductors, ensure replacement conductors are braced or shielded if needed to avoid similar damage in future operation.
7. Be sure that any conditions that caused overheating have been corrected.

Recommended Torque Values

When making bolted assemblies, the following considerations should be generally followed. The recommended torque is determined by the size of hardware used. Refer to **Table 5**.

1. Metal-to-Metal—Apply standard torque.
2. Metal-to-Insert Molded in Compound Part—Apply approximately 2/3 of standard torque.
3. Compound-to-Insert Molded in Compound Part—Apply approximately 1/2 of standard torque.
4. Compound-to-Compound—Apply approximately 1/2 of standard torque.

Table 5. Recommended Torque Values

Thread Size	Standard Torque Metal-to-Metal (in.-lbs.)	2/3 Standard Torque Metal-to-Insert (in.-lbs.)	1/2 Standard Torque Compound-to-Insert (in.-lbs.)	1/2 Standard Torque Compound-to-Compound (in.-lbs.)
8-32	14-20	10-14	7-10	7-10
10-32	20-30	13-20	10-15	10-15
1/4-20	40-60	26-40	20-30	20-30
5/16-18	168-228	110-150	84-114	84-114
3/8-16	240-360	160-240	120-180	120-180
1/2-13	480-600	320-400	240-300	240-300

Periodic Cleaning

Accumulation of dust and foreign material such as coal dust, cement dust or lamp black must be removed from the controller and all surfaces must be wiped clean at regular intervals. Dust can collect moisture, causing voltage breakdown.

Do not use compressed air to clean the controller as it will only redistribute the contaminants on other surfaces.

Maintenance after a Fault has Occurred

Refer to the "Maintenance After a Fault has Occurred" section in the Series 81000 Controller Instruction Manual, MVC-9018.

Troubleshooting

If operating problems are encountered, refer to the "Troubleshooting" section in the Series 81000 Controller Instruction Manual, MVC-9018.

Spare Parts List

Description	Qty Per Controller	Part Number
Vacuum Interrupter	3	25-154-284-001
Magnet Coil Kit—115/230VAC, 125/250VDC	1	25-154-284-002
Rectifier—115/230VAC	1	25-154-284-003
Economizing Resistor Assembly—115VAC/125VDC -230VAC/250VDC	1 1	25-154-284-004 25-154-284-005
Auxiliary Contact Block—2NO-3NC-1DNC	1	25-154-284-006
Opening Spring (0-13000 ft. altitude	2	25-154-284-007
Contact Spring Kit (3 pcs. per kit)	1	25-154-284-008
Shunt Lead Kit	3	25-154-284-009
Contact Wear Gauge	1	25-154-284-010
Power Fuse 38R 5kV	3	25-154-275-001
Power Fuse 57X 5kV	3	25-154-275-002
CPT Primary Fuse 0.5E kV	2	25-131-635-005
CPT Primary Fuse 1E 5kV	2	25-131-635-004
CPT Primary Fuse 2E 5kV	2	25-131-635-001
CPT Primary Fuse 3E 5kV	2	25-131-635-002
CPT Primary Fuse 4E 5kV	2	25-131-635-003
Control Power Transformer 0.75kVA 2300-115V	1	25-213-133-001
Control Power Transformer 0.75kVA 4000-115V	1	25-213-133-013

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