CR194 Vacuum
Limitamp™ Control

One-High Controllers with Stationary Mount
Vacuum Contactors

Caution: Product is not intended for nuclear use.

Utilization Voltage – 2.4 through 7.2 kVac
26-wide and 34-wide, One-High, 400 Amp
(For 48-wide, 800 Amp see GEH-5396)
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Warning: Before any adjustments, servicing, parts replacement or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, power must be removed from all sources and all attached rotating equipment must have come to a complete stop.

User personnel must be completely familiar with the following operating and maintenance instructions before attempting to service this equipment.

Warning: The vacuum interrupter integrity test should be performed before the high-voltage, vacuum contactor is energized for the first time and each time the contactor is returned to service after maintenance, adjustment, or repair.

Failure to perform this test may result in serious injury or death.

Introduction

Vacuum Limitamp controllers are designed to meet NEMA ICS2-324 "AC General Purpose High-voltage Class E Controllers" and UL 347 requirements, and may be described as metal-enclosed high-interrupting capacity, vacuum-contactor-type starter equipments with manual isolation. Individual starters and controllers are designed for specific applications; the components and functions being dictated by the Purchaser specifications and needs. Controllers may be fused or unfused.

The essential control functions for all types of a-c motors consist of starting, stopping, and overload protection. Vacuum Limitamp controllers also include short-circuit protection, but other functions are provided in each controller as they are applicable to the type of motor being controlled (such as synchronous and wound-rotor motors). Also, special functions are provided in great variety as may be required for particular applications.

These instructions were prepared as a guide to handling, installation, operation and maintenance of all one-high, 400 Amp types of Vacuum Limitamp controllers. This includes the 26-inch wide one-high and the 34-inch wide one-high controller. Figure 1 shows a 26-inch wide controller and Figure 2 shows a 34-inch wide synchronous controller.

The intent of these instructions is to give the Purchaser the necessary general information to identify his controller as to type and function, to describe suggested methods of installation, and to demonstrate some techniques of operation and maintenance. The Purchaser should interpret these instructions for applicability to his particular controller by referring to the nameplate data on the controller and to the electrical diagrams supplied with the controller.

If the controller is for a synchronous motor, these instructions should be used with GEH-5201. For applications questions refer to GET-6840. For details on high-voltage contactor refer to GEH-5506.
Description

Equipment Identification –
CR Number Designation

Basic type designation for all Vacuum Limitamp Control equipment is CR194 with significant alpha-numeric suffixes used to define rating, function, contactor type and enclosure type.

Starting and Speed Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Single-speed, full voltage</td>
</tr>
<tr>
<td>B</td>
<td>Single-speed, reduced voltage reactor type</td>
</tr>
<tr>
<td>C</td>
<td>Single-speed, reduced voltage autotransformer type</td>
</tr>
<tr>
<td>D</td>
<td>Single-speed, part winding start</td>
</tr>
<tr>
<td>E</td>
<td>Single-speed, reduced voltage primary resistor</td>
</tr>
<tr>
<td>G</td>
<td>2 speed, 1 winding full voltage</td>
</tr>
<tr>
<td>H</td>
<td>2 speed, 1 winding reactor reduced voltage</td>
</tr>
<tr>
<td>J</td>
<td>2 speed, 1 winding autotransformer reduced voltage</td>
</tr>
<tr>
<td>N</td>
<td>2 speed, 2 winding full voltage</td>
</tr>
<tr>
<td>P</td>
<td>2 speed, 2 winding reactor reduced voltage</td>
</tr>
<tr>
<td>Q</td>
<td>2 speed, 2 winding autotransformer reduced voltage</td>
</tr>
</tbody>
</table>

Rotation and Braking

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non reversing/non braking</td>
</tr>
<tr>
<td>2</td>
<td>Reversing/non braking</td>
</tr>
<tr>
<td>4</td>
<td>Non reversing/dynamic braking</td>
</tr>
<tr>
<td>5</td>
<td>Reversing/dynamic braking</td>
</tr>
<tr>
<td>7</td>
<td>Reversing/plugging</td>
</tr>
</tbody>
</table>

General

The basic Vacuum Limitamp controller is a front-connected assembly of components and conductors for motor starting, arranged for convenient access, in an enclosure which allows space and facilities for cable termination, plus safety interlocking of doors and isolator to prevent inadvertent entrance to high-voltage parts. No back access is required. This equipment may be rated up to 7.2 kV depending on the contactor and fuse ratings. Installation, operation, and service should be performed only by experienced personnel trained in this class of equipment.

In general, the unit enclosures are divided into high-voltage and low-voltage compartments, each with its own separate door and with interior barriers between the two. See Figures 3, 4, and 5. To open the high-voltage compartment door, the power must be disconnected by a sequence of manual operations which requires de-energizing the high-voltage contactor, operating the isolating switch handle, and unlatching the door. Low-voltage doors may be entered without disconnecting the power; however, this should be done with extreme care and caution.

The upper compartment of one-high controllers may contain a low-voltage panel, hinged on the left side, which acts as a barrier to the high-voltage control power transformer mounted on the upper rear cover.
CR194 Vacuum Limitamp 400 Ampere Control

Figure 3. 26-inch wide 400-ampere FVNR starter.

Interrupting Ratings At Utilization Voltage Shown

<table>
<thead>
<tr>
<th>Maximum Volts</th>
<th>Maximum Continuous Amperes (RMS)</th>
<th>Three-phase Symmetrical System MVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class E1 Unfused</td>
<td>Class E2 Fused</td>
</tr>
<tr>
<td>2500</td>
<td>400</td>
<td>29</td>
</tr>
<tr>
<td>5000</td>
<td>400</td>
<td>50</td>
</tr>
<tr>
<td>7200</td>
<td>400</td>
<td>50</td>
</tr>
</tbody>
</table>

Basic Impulse Level (BIL)

The standard BIL rating of Vacuum Limitamp controllers is 60kV crest (design rating). This rating excludes dry type control transformers and starting reactors or autotransformers.

Dielectric Test Voltage

2 1/4 x nameplate voltage plus 2000 volts.

High-voltage Vacuum Contactors

The vacuum contactors used in Vacuum Limitamp controllers are available in two different ratings: 400 and 800 amperes. This publication covers only the 400 ampere rating. The contactors are similar in operation but very different in size and rating. For this reason they are not directly interchangeable mechanically. See Figure 7.

The contactors are easily removable from the controller assembly by removing a few bolts that hold the contactor in position and by disconnecting the line and load power connections. The auxiliary contacts and the coil terminals are connected by means of a removable connector that is retained by two wing nuts. By removing these wing nuts, the wiring harness is easily disconnected from the contactor. Refer to the information beginning on Page 13 of this publication that details the correct method for contactor removal.

Approximate Maximum Horsepower, Current & Voltage Ratings

<table>
<thead>
<tr>
<th>Continuous Current (RMS) (Amperes)</th>
<th>Induction Motors</th>
<th>Synchronous Motors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.8PF 1.0PF</td>
<td>0.8PF 1.0PF</td>
</tr>
<tr>
<td>400 Max.</td>
<td>1600</td>
<td>1600 2000</td>
</tr>
<tr>
<td>3450</td>
<td>3450</td>
<td>3750</td>
</tr>
<tr>
<td>4800</td>
<td>4800</td>
<td>6000</td>
</tr>
</tbody>
</table>

Note: Above ratings apply to controllers in NEMA 1, vented enclosures, at 40°F ambient.
Figure 4. 34-inch wide 400-ampere FVNR synchronous starter low-voltage control section.

Figure 5. 34-inch wide 400-ampere WNR synchronous starter high-voltage section showing the 400-ampere contactor.

Figure 6. Panel data nameplate.

Figure 7. The 800 and 400 ampere vacuum contactors.
Figure 8. High-voltage compartment showing fuse assembly.

Figure 9. View of various low-voltage components on swing panel.

Figure 10. Anti single-phase contact block – wiring removed for clarity.

Figure 11. View of disconnect switch in the CLOSED position. Barriers are removed for clarity.
Vacuum Limitamp Control is supplied standard with bolt-in type fuses. The fuse holders will accommodate 2400-volt through 7200-volt fuses. The length of these types of fuses vary and the lower fuse mount can be adjusted to the proper length by unbolting the mount from the back rail and remounting it in the proper location. For 7200-volt applications, the fuses require a slightly different lower mounting strap and the top fuse mounting strap must be changed. This requires that the disconnect switch be disassembled. See Figure 8.

The vacuum contactors supplied with Vacuum Limitamp Control are magnetically operated by a dc coil fed by an integral rectifier and timed holding circuit. A base mounted contactor timing module (CTM) applies full voltage to the contactor coil for a time sufficient to fully close the contactor. A series capacitor is then switched in to hold the contactor closed without overheating the coil.

Blown Fuse Indicator

Blown fuse indication is activated by a trip bar located at the rear of the top fuse holder. The blown fuse indicator requires bolt-in type fuses. When one or more of the fuses blow, a small indicator moves upward from the top center of the fuse to indicate which fuse has blown. The right end of the trip bar has a cam that operates an anti-single phase contact which is wired to trip the controller off-line to prevent single phasing of the connected load. See Figure 10.

Manual Disconnect (Isolating Mechanism)

Vacuum Limitamp controllers, following the NEMA definition, provide a means for manually isolating the power circuit by operation of a disconnecting device. The disconnecting mechanism consists of a quick-make quick-break, non-load break disconnect switch (see Figures 11 through 13) which is controlled by the operating handle (see Figure 6). A fixed barrier (Figure 13), with a viewing window, is supplied to provide isolation from the energized bus parts. There are no moving shutters that require maintenance. The quick-make, quick-break, operating mechanism is shown in Figure 15.

Load current must not be interrupted by the disconnect switch. A mechanical interlock is provided to ensure that the contactor is in the open position before the operating handle can be actuated. Also, the contactor cannot be operated while the operating handle is being moved from one position to another.

The mechanical isolator will accept up to four padlocks to prevent operation. See Figure 16.

Mechanical Interlocking

Vacuum Limitamp equipment is designed so the high-voltage contactor performs all normal load current interrupting. The current-limiting fuses generally interrupt the fault currents.

Note: The quick-make quick-break manual isolator will not interrupt any load or fault current.

A mechanical interference system is included with all Vacuum Limitamp controllers (mechanical interlock), which prevents opening of the manually operated isolating contacts unless the high-voltage contactor itself is demonstrated by magnet position to be already open. This is to ensure that the contactor has opened the power circuit and interrupted the current before the disconnect switch may be operated. See Figure 17.

Warning: The manual isolator should never be forcibly operated. Its mechanical interference interlock should be defeated only by knowledgeable and qualified electrical maintenance personnel who have de-energised all power feeding the controller.
Figure 13. Disconnect switch shown with barrier in place. Switch shown in CLOSED position.

Figure 14. View of handle assembly area showing test power interlocks.

Figure 15. View of quick-make quick-break operator.

Figure 16. The operating handle for the disconnect may be padlocked to prevent operation.
Warning: There is no emergency condition that can justify forcible operation of the manual isolator with the main contactor closed. The isolator must be operated only with the contactor open.

All high-voltage doors are interlocked by mechanical interference mechanism that lock high voltage doors closed until the disconnect switch is in the OPEN position. This is done to prevent exposure to high-voltage. In one-high controllers the bottom door covers the high-voltage compartment. Other high-voltage doors may be full height to cover high-voltage parts located in auxiliary sections. These devices may include reactors, autotransformers or control power transformers, etc.

Key interlocking is frequently used in lieu of mechanical interference mechanisms to lock high-voltage doors closed until power inside has been removed. Nonloadbreak switches are also key interlocked to prevent operation under load. In all cases of key interlocking, it is important to follow the operating sequence as described on the drawings furnished with the equipment.

On some one-high enclosure designs, a low-voltage control panel mounted by hinges to the left side of the enclosure serves as a barrier to isolate the high-voltage control power transformer and fuses. An interference latch, shown in Figure 54, prevents swinging this panel out until the high-voltage door is opened, thus ensuring that high-voltage power to the Control Power Transformer is disconnected.

Auxiliary Enclosures

Many sizes of enclosures are furnished in Vacuum Limitamp control lineups for various purposes. Some are tabulated below:

- Wound rotor, secondary contactor and resistor compartments
- Bus transitions to switchgear
- Bus transitions to transformers
- Cable entrance compartments
- Rectifier exciter compartments
- Starting reactor or autotransformer compartments
- Relay and metering compartments
- Instrument transformer compartments
- Manual switch compartments

Refer to Figure 60 for details.

Dimensions

Vacuum Limitamp controllers are normally 30-inches deep and 90-inches high. Width varies for one-high controllers, induction motors, synchronous motors, other special applications, or cable space requirements. Refer to Figure 60 for typical outline dimensions.
Power Fuses

Bolted EJ-2 type current-limiting power fuses are supplied as standard with Vacuum Limitamp controllers. These standard fuses are bolt-in type because the blown fuse indicator and the trip bar that operates the anti-single phase contact block require precise alignment of the striker pin at the top of the fuse with the operators. Clip-in fuses are available as an option in 400 ampere to cover requirements for EJ-1 type fuses, but the "anti-single phase" indication/trip functions are not available with clip fuses. Coordination information for EJ-2 type fuses is available in GES-5000, and for EJ-1 type fuses, GES-5002. Interrupting ratings are shown on page 5 of these instructions. Figure 18 shows the top of the bolted power fuse assembly with the blown fuse indicators in the normal position.

Power Fuse Conversion Instructions

Bolt-in fuses used on Vacuum Limitamp and Air-break Limitamp may be field converted from one to the other by carefully following the instructions below.

Starting Autotransformers & Reactors

Reduced voltage controllers include a reactor or autotransformer designed for starting duty in accordance with NEMA ICS2-214. The duty cycle generally furnished is for medium-duty applications which consist of three 30-second starts spaced 30-seconds apart followed by a one-hour rest. To prevent overheating and possible damage when applied on more severe duty (heavy duty) applications, special reactors or autotransformers must be specified. Thermostats are mounted on the reactor and transformer cores to offer protection against overheating. These thermostats must be manually reset if tripped by high temperature.
Figure 19. Vacuum Limitamp controller wrapped in plastic film wrap ready for shipment.

Figure 20. Vacuum Limitamp controller with outside packaging material removed and ready for handling.

Figure 21. Recommended method of lifting single panel.

Figure 22. Recommended method of lifting a Vacuum Limitamp lineup. Note that the lineup is suspended from an equalizing bar.
Installation

General

This section contains information on receiving and handling, disassembly, power-cable termination, grounding, and reassembly to make the equipment ready for operation.

Receiving

Vacuum Limitamp controllers are fabricated as rigid, floor-mounted, self-supporting steel sections requiring no floor sills. They are crated and shipped in an upright position and, when received, should be kept upright.

Some components may be shipped separately, such as top-mounted resistors or potential transformers. These components are identified by catalog number coinciding with that of the section on which they are to be mounted.

Plastic film wrap or corrugated cardboard is normally used for domestic crating with the steel enclosure sections bolted to a wooden skid. See Figure 19. After receiving, the packing may be removed and the equipment handled on the wooden skid. See Figure 20.

Handling

It is always preferable to handle Limitamp controllers by the lifting means provided. Figure 21 shows the recommended method of lifting a single section, while Figure 22 shows the recommended method of lifting a lineup.

Note that the lineup in figure 22 is suspended from an equalizing bar. A lineup should be supported at as many points as possible. If there is not enough headroom to lift the panel by its lifting beam, then a track jack can be used. The controller can be raised by placing a track jack under the shipping skid. Rollers can then be placed under the skid for rolling the equipment to its final location. The panel should then be raised by its lifting beam, the shipping skid removed, and the panel set into place.

The use of fork-lift trucks is not recommended, since the forks may damage the enclosure or interior parts of the equipment, and the equipment becomes very unstable when lifted from the bottom. If no other method of handling is available, the forks must go under the skid bottom to avoid damaging the equipment, and the assembly lifted only slightly to allow the skid to be slid along a flat, level surface. However, the recommended method is by crane as pictured.

Placement of Enclosure

It is essential that the controller be securely fastened in an upright position on a level surface to allow proper functioning of the internal devices. While there are no roll out components, access will be improved if the controller is located at floor level with plenty of room allowed for doors to swing fully open as shown on the drawings supplied with the equipment.

After the controller has been placed in position, the floor mounting bolts may be installed and tightened. The location of these bolts is shown on the outline drawing furnished with each controller. These bolts are ½-inch bolts and are usually located in each corner of the controller base.

Disassembly

After the equipment has been set in place where it is to be permanently connected, some internal disassembly is required to make the necessary external power-cable and control-wire connections. Disassembly should be done in a definite sequence by following Figure 23 through Figure 34, and as described below:

Disassembly Sequence of Operation

Warning: Remove all power from the equipment before proceeding with disassembly.

1. Move the manual isolator handle to the OFF position. Refer to the nameplate attached to the high-voltage door near the handle. Figure 23-2 shows the method of first depressing the pusher with one hand and moving the handle with the other. Refer to page 27 and 29 for normal and emergency door opening procedures.

2. Open both the top (low-voltage) and bottom (high-voltage) doors.

Contactor Removal

Normally it is not necessary to remove the contactor from its mount in order to make external power-cable and control-wire connections. If the contactor is not to be removed proceed to Step 4. Otherwise, follow the steps outlined below to remove the contactor from the controller.

3. Contactor removal.

   a. Remove the wing nuts holding the contactor umbilical cord and connectors in place and save the hardware. This hardware will be reused to remount the connector when the contactor is reinstalled. Unplug the connector and place the bracket in the lower front channel to the left of the contactor for safe keeping. See Figure 24.
b. Loosen the line side cable bolts at the bottom of
the fuse assembly and save the hardware. Be sure
the cables are free of their mounts and that they
can be freely removed. See Figure 27.

c. Remove the three load side connection bolts in the
bottom of the contactor. These bolts are accessed
through the openings at the bottom of the
contactor from the front. A socket wrench with an
extension may be used to remove these bolts. Save
this hardware for reuse. See Figure 29.

Note: Do not loosen R. T. V. covered bolts.

(d) There are two retaining nuts at both sides on the
lower front of the contactor. These nuts must be
removed. See arrows in Figure 29.

e. Slide the contactor out of the mounting base and
lift it and the line side cables out of the enclosure.

f. Replace the three bolts removed from the load side
connections in their holes and thread them in a
few turns. These bolts will prevent reinstalling the
contactor until removed again. This serves as a
reminder that the bolts are there and need to be
reinstalled when the contactor is being replaced.

4. Prepare to remove the horizontal compartment
barrier by removing the two bolts shown in Figure 30.

5. Remove the horizontal barrier, Figure 30. (If a
hinged low-voltage panel is used, swing it to the left and
out of the enclosure.)

6. Remove the horizontal bus barrier bolts as shown in
Figure 31, and then lift the barrier out of the enclosure.
The horizontal bus is then exposed as shown in Figure 32.

7. Detach the switch barrier with the viewing window by
removing the ten bolts, Figure 33. Pull the barrier out of
the enclosure.

8. Remove the front cover of the lower incoming line
barrier, Figure 34, (if incoming cables are to be routed
from the floor) or remove the top incoming line barrier
(if cables are to be routed into the enclosure from the top).

After the preceding steps have been completed, all
power termination points and bus connections are
accessible. See Figure 35.

Grounding
All controller enclosures must be grounded. A stud is
welded to the lower back of the enclosure in the incom-
ing-line compartment area for connection to the
grounding system. This connection must be made
before making any power connection.

If ground bus is ordered, the ground stud is connected
to the ground bus at the factory and the system ground
can be connected to the ground bus instead.

The control and instrumentation circuits are grounded
to the enclosure at the terminal board. This is normally
the only grounding point. It can be temporarily re-
moved for test purposes; but it must be regrounded
before the control is returned to operation.

Incoming Power Connections
Incoming power connections to the bus may be made in
any one of the enclosures in a lineup. Space for one
500- MCM cable with stress cones per phase is available
in the standard 26-inch wide enclosure. A 34-inch wide
enclosure is also optionally available when larger cable
capacities are required. The 34-inch enclosure is
standard with synchronous controllers and 7200 volt
collectors. If shielded cable is used, refer to the
information on Page 23 of this manual.

In the one-high enclosure with horizontal power bus,
goinge
Figure 23-1. Depress STOP push button.

Figure 23-2. Place isolator handle in the OFF position by depressing pusher bar and rotating handle rapidly down.

Figure 23-3. Handle OFF – Pusher bar OUT.

Figure 23-4. Turn door latches and open door.
Figure 24. Remove wing nuts as shown.

Figure 25. View showing armature interlock.

Figure 26. Unplug the umbilical cord assembly.

Figure 27. Unbolt the cables from the bottom of the fuse assembly.
Figure 28. Unbolt the cables from the bottom of the fuse assembly.

Figure 29. Remove the three load-side connecting bolts. (do not adjust the R.T.V. covered bolts)
Remove the two retaining nuts.

Figure 30. Remove the bolts shown and slide the horizontal barrier out of the enclosure.

Figure 31. Remove the horizontal main bus barrier bolts shown and remove the barrier.
Figure 32. Exposed main bus after removal of main bus barrier.

Figure 33. Isolator switch barrier showing bolts to be removed.

Figure 34. Lower incoming line barrier.

Figure 35. Main bus compartment with all barriers removed and incoming line cables terminated.
Motor Connections

Motor cables may enter from the top or bottom of the enclosure. In the one high enclosure, the motor terminals are located on the inside lower left wall as shown in Figure 36. The incoming leads should be trained for maximum space between phases and ground. The connections may be made before or after energizing the main bus and without shutting down adjacent equipment. Also see Figure 60.

Warning: If the main bus is energized while load cables are being installed, all barriers must be in place and the disconnect switch must be in the off position and the blades must be visually checked to ensure that they are completely disconnected from the vertical bus.

The motor terminals can accommodate up to one 500-MCM per phase with stress cones in the standard 26-inch wide enclosure. If larger cable entries are required, an optional 34-inch wide cabinet is available.
Extra-width Enclosure

A special 34-inch-wide enclosure is available for terminating shielded cable with stress cones, or for terminating more than one large cable per phase. The enclosure design permits space for termination of two 500-MCM cables per phase with stress cones* for motor and power leads. Figures 35 and 38 show the space available in this extra-width enclosure. Design is basically the same as the 26-inch-wide one-high, and all data and information in these instructions applicable to the 26-inch one-high design apply to the 34-inch-wide enclosure.

Power Cable Termination

In any installation, the cable should be prepared for termination in accordance with the instructions of the cable manufacturer. However, the following general recommendations are given for proper cable termination in Vacuum Limitamp equipment.

1. Pull in the cables in accordance with the panel outline diagram and position them for maximum clearance between phase, ground and other cable or wire runs. Refer to Figure 60 of these instructions for recommended location of incoming cables in a standard Limitamp controller.

*General Electric Termi-Kit® stress cones.
2. Prepare the cable for termination in accordance with the manufacturer's instructions. For suggested terminating methods, see pages 20 through 23 and Figures 39 through 45.

3. Bolt the cable terminals to the bus or other point of termination.

![Diagram of cable termination](image1)

**Figure 40.** Termination of rubber-insulated, non-shielded, non-lead-covered, 5000-volt cable.

**Figure 42.** Termination of interlocked-armor, non-shielded, 5000-volt cable.

1. Cut cable to proper length leaving conductor sufficiently long to extend into the terminal lug.

2. Remove braid, tape, and inner insulation and expose the conductor end for a distance of one inch plus the length of conductor to go into the terminal lug.

3. Attach terminal to conductor.

4. Taper the insulation as shown.

5. Remove the braid and tape, if any, six inches from the lug, exposing the insulation. Leave one-half inch of original cable tape extending beyond the cutback braid.

6. Apply the end seal using GE IRRASIL electrical tape. Obtain a smooth wrapping but do not stretch tape more than necessary.

7. Bind down end of braid and tape, if any, with IRRASIL tape as shown on drawing.

8. Apply two layers half-lap of GE IRRASIL tape over-all from lug to exposed braid.

![Diagram of cable termination](image2)

**Figure 41.** Termination of varnished-cambric-insulated, non-shielded, non-lead-covered, 5000-volt cable.

**Figure 43.** Termination of interlocked-armor, shielded, 5000-volt cable.
4. If contact between the cable and an adjacent bus cannot be avoided, as may be the case with the two 500-MCM cables per phase, tape the bus in the immediate vicinity of the cable contact point so that the surface creepage distance from the cable to the bare bus bar is at least three inches. Thus, the surface creepage from the bare bus where the cable terminates, to the bare part of the bus where the cable touches, will be at least seven inches. The thickness of tape on the bus should be approximately ½ inch. General Electric No. 8380 tape is recommended for most of the buildup and General Electric No. 42005 Irrasil® tape is recommended overall.

5. Where more than two 500-MCM cables per phase are required, they should be brought into different sections, or an incoming line compartment must be provided. If the two 500-MCM cables must be terminated with stress cones, a cable entrance compartment must be ordered.

6. Run all the low-voltage wires so as to avoid any possible contact with high-voltage lines.

**Termination of Lead-covered Cable**

Termination of lead-covered cable requires the use of potheads (see Figure 39.) The pothead manufacturer’s instructions should be followed in terminating the cable at the pothead. Standard Limitamp starters have space for locating one pothead of the pull-through type which accommodates up to and including 2/0, three-conductor, 5000-volt cable. In this type of pothead, the three conductors of the cable are fanned out within the pothead and pass completely through it, with the pothead sealing and terminating the lead covering. For larger cables, potheads with terminating bushings are required. In this case, or when more than one pull-through type is required, special cable entrance compartments are available.

Through-type potheads are satisfactory for varnished-cambric cable indoors. Paper-insulated cables are more hygroscopic and, since the only thing protecting the individual conductors from moisture is tape on the surface, high humidity might cause difficulty. Terminal-type potheads are required for paper-insulated cable.

**Termination of Pothead Cable**

The instructions for terminating lead-covered cable by using potheads apply as well to those terminations of other types of cable where potheads may be desired.

**Termination on Non-shielded, Non-lead-covered Cable**

This cable is generally run through rigid conduit or cable raceways and brought into the enclosure by the use of conventional cable clamps and conduit fittings. Refer to Figures 40 and 41 for termination details.

**Termination of Interlocked-armor Cable**

Interlocked-armor cable is terminated by means of specially designed cable fittings. These terminators consist generally of mounting bracket, armor clamp, and supporting base and bushing, with various modifications available for special types of sealing.
Interlocked-armor, Non-shielded Cable

RUBBER-COVERED – Refer to Figure 42 for general information concerning termination. For details, refer to Figure 40. Note that rubber-covered cable requires only taping near the terminal and not back to the terminator fitting. However, if there is a possibility of oil coming in contact with the rubber insulation, it would be well to use a layer of Irrasil® No. 42005 tape all the way back to the terminator fitting.

VARNISHED-CAMBRIC – Refer to Figure 42 for general information concerning termination. Note that varnished-cambric cable requires taping back to the terminator fitting, since the individual conductors or "singles" have no braid.

Interlocked-armor, Shielded Cable

Interlocked-armor, rubber-covered, and varnished-cambric insulated cables are sometimes shielded at ratings of 5 kV and below. If they should be, proceed to terminate as detailed for other types of shielded cables. Refer to Figure 43.

Termination of Shielded Cable

It is recommended that when shielded cable is used, "stress-relief cones" be built up at the cable terminations, or else General Electric Termi-Matic® stress cones be used as shown in Figure 44 and Figure 45. This will relieve the electrical stress which occurs in the area around the termination of the ground shield. Whenever possible, the conduit should be brought in through the bottom. A maximum of one 500-MCM cable per phase may be terminated in one full-voltage starter section. When making shielded cable terminations to Limitamp, the following procedure is recommended:

Use GE Termi-Matic system per Figure 45, or else build stress cones with tape as follows:

1. Mark the cable at least 10 inches from the terminal point.

2. Remove all shielding from the terminal end to this point, leaving sufficient ground strip to reach the nearest ground connection.

3. Proceed to build stress cones as prescribed by the cable manufacturer. Refer to Figure 43 and 44 for details.

4. Tie all of the ground strips together and fasten them to ground bus (if ordered) or to a large stud on the enclosing case. (See note on grounding under item on "Wire and Cable Entrance").

If the foregoing recommendations, along with the cable manufacturer's recommendations, are followed, the cable terminations should be satisfactory and reliable. These instructions apply to both rubber-covered and varnished-cambric insulated shielded cables.

Control Connections

Conduit for control wires should be brought in the areas as shown in the outlines. There is room in both the bottom and top for the control conduits to be brought into the enclosure. In all Vacuum Limitamp controllers, the control connections are made through a terminal board on the left side of the low-voltage control compartment. Refer to Figures 46 and 47 for details.

*Figure 46. Low-voltage compartment showing low-voltage terminal strip on left side of panel.*

*Figure 47. High-voltage compartment showing low-voltage wiring trough. Low-voltage cables entering from the floor should be routed through this channel.*
Control wires coming up through the floor should be run just behind the door hinges inside the channel (see Figure 47) provided for this purpose and the wires should be terminated on the terminal board in the low-voltage compartment. Control wires entering from the top of the enclosure should also be run in the channel provided just behind the low-voltage door hinges and terminated on the terminal block.

Reassembly

After all power and control-wire connections are made, the Vacuum Limitamp controller must be reassembled by following the sequence on pages 13 and 14 in reverse order. If the controller is enclosed in a NEMA type 3 enclosure, refer to Figure 51 for assembly instructions.

Note: Do not attempt to operate without all barriers reassembled.

Replacing Contactor In Enclosure

When replacing the contactor in the enclosure, the following procedures should be followed:

**400-Ampere Contactor**

1. Before installing the contactor, ensure that the cables attached to the line side of the contactor are properly tightened to 35 lb-ft.

2. Remove the three bus bar bolts that were placed in position during contactor removal and slide the contactor onto its mounting base and ensure that the retaining studs protrude through the front of the contactor side bars. Also ensure that the armature interlock is properly engaged in the interlock pawl on the lower-right side wall. (See Figures 17 and 25)

Note: This mechanism transmits the contactor armature motion to the mechanical interlock and it is vital that this mechanism function properly.

3. Install and tighten the three load-side connection bolts. See Figure 29.

Caution: Be absolutely certain that these bolts are properly installed and tightened. These are current carrying connections and must be tight or damage will result. These connections must be tightened to 16 lb-ft. See Figure 29.

4. Install the mounting nuts on the retaining studs on each side of the contactor and tighten.

5. Attach the line cables to the bottom of the fuse assembly. Be absolutely certain that these connections are properly tightened to 9 lb-ft. See Figure 48.

6. Manually operate the contactor armature and observe that the mechanical interlock functions properly. If so, the contactor is properly installed.

7. Reconnect the control umbilical cord to the contactor and be sure the retaining wing nuts are tight. Installation of the contactor is now complete.

**Figure 48. Line connection bolts for 400-ampere contactor.**

Warning: Make certain that all barriers are replaced and bolted tightly into position. Make sure the line and load side terminations of the contactor are tightened properly. Failure to perform these operations could result in failure of the unit to operate safely and reliably.

Mechanical Operation Check

**All Power Off**

With the main incoming power removed, operation of the isolating switch should be checked. This may be accomplished as follows:

1. With the high-voltage door open (and power disconnected) push in the door-operated release (A), Figure 49, with your left hand. This is not a normal function and should only be used for initial equipment check out.

2. Push in the handle latch release (B), Figure 49, with the thumb of your right hand and lift the handle (C) in a rapid, positive motion from the OFF to the ON position. The door operated release (A) can now be released. Near the top of the handle movement a sharp snap should be heard and the isolator switch contacts should be in the closed position. The contacts may be viewed by looking through the window supplied in the main fixed barrier. The contacts should be fully seated on all three phases. The handle latch release (B), Figure 49, should pop fully out at the top of the handle travel (See Figure 57).
3. Push in the latch release (B) and move the handle (C) mechanism from the ON to OFF position, again in a rapid, positive motion.

Near the bottom of the handle travel a sharp snap should again be heard and the disconnect contacts should be fully open. Inspection may be made by viewing through the window provided in the fixed barrier. The handle latch release (B), Figure 49, should pop fully out at the bottom of the handle travel (See Figure 57).

4. Repeat steps 1 and 2 until the disconnect switch is again in the closed position. Simulate the contactor being energized by depressing the contactor armature downward until the contactor is in the fully closed position. While holding the contactor in the closed position, attempt to push in the latch release (B). The release should move forward only slightly and the handle should not rotate. Now, release the contactor armature and depress the latch release. Attempt to close the contactor armature. The armature should move slightly and stop, preventing the contactor from moving to the closed position.

5. Repeat steps 1 and 2 above. When the handle (C) is rotated to the ON position, the door latch (G) should drop to within 1/4 to 2 inches from the bottom of the handle assembly (H).

6. If the mechanism fails to meet any of the above checks, an adjustment must be made to the interlock assembly as shown in Figure 50. This adjustment is made to ensure that the interlock slider is moving properly. If the contactor can be made to turn ON manually when the disconnect switch operating handle is in an intermediate position, the interlock needs to be adjusted.

**Caution:** Before making any adjustments, be sure that the contactor is in the fully off position and the disconnect switch handle is in an intermediate position with the handle latch release (B), Figure 49, fully depressed.

A. Loosen the bottom locking nut (X), Figure 50, while holding the top adjusting nut (W) firmly in position. Also loosen the two retaining nuts at the top of the rod.

B. Turn the adjusting nut until the interlock slider is just slightly below the handle latch release rod (0.06 inches).

C. When the proper position has been reached hold the top adjusting nut (W) and tighten the lower locking nut (X) to hold the adjustment. Finally tighten the two locking nuts at the top of the rod.

D. Test the interlock mechanism again by following Steps 1 through 6 above.

If the controller fails to meet any of the above checks DO NOT ENERGIZE THE CONTROLLER. Contact your nearest General Electric sales office.

7. Return the disconnect handle to the OFF position.
Add gussets to joints of roof channel supports on walk-in type. Add coupling to roof joints. Use 3M sealer in all cracks.

On sides of single cases and sides of cases on ends of lineups, use sealer around cutouts under all cover plates. Also use sealer in all bolt holes.

Purpose of sealer is to have weathertight seal between exposed joints of enclosures.

Where to apply:
- Apply to one side of one case at each junction of lineup of cases.

Method of Application:
Place the extruded sealer strip with slight pressure 1/2-inch in from front and rear edge of side of case except 1/4-inch in at cutouts. Use two (2) strips side by side the full height of case. Also apply across the top of the side of the case 1/2-inch down. See Fig. "A".

Material:
Extruded 3M sealer formula EC1126, 1/4-inch diameter extruded bead x 30-inch long strips. Product of Minnesota Mining and Manufacturing Co., 700 Grand Avenue, Ridgefield, New Jersey.

The approximate total length of sealer required at each junction will be 42 feet, for non walk-in and 70 feet for walk-in.
Operation

General

A test-power interlock (TPI) (See Figure 14) circuit and Test-Normal Selector Switch (TSW) (See Figure 9) is provided to check out the control circuit of the complete unit without applying power to the motor. After all control-circuit connections are made, the controller should be put through its complete operating sequence, in the test position, as a final check.

A wiring diagram which shows the circuit and connections that apply to the controller is included with the controller when it is shipped from the factory. All external wiring from the controller must be made in accordance with the connection diagram supplied with the controller.

Test Power Circuit

A complete operational check of the controller can be made without applying voltage to the motor or to the bus as follows:

1. The isolating-device handle must be in the open position. In the open position, contacts of the mechanically operated test-power interlock (TPI) will open the secondary circuit of the control-power transformer, thereby isolating it. The Test-Normal Selector Switch (TSW) must be in the "Test" position to close the circuit to the test-power terminals on the control terminal board.

2. Refer to the elementary and connection diagrams for the required control voltage, frequency, and test-power terminal designations. Connect the required test-power to terminals provided on the terminal board in the low-voltage control compartment. Power may then be applied to the low-voltage control circuit and the circuit tested for proper operation.

Preparation of Controller for Operation

Once the panel is in place and the cable terminated, clean the inside with a brush, soft cloth, or dry compressed air. Make certain that any dirt, dust or bits of packing material, which may interfere with successful operation of the panel devices, are removed from the panel.

Caution: Care should be taken during the cleaning operation to prevent any dirt from being blown into the inaccessible spaces of the devices.

Before the controller can be operated, even for a tryout without power, all devices must be placed in full operating condition. Also, check to ascertain that no tools or loose wires have been left within the panel during installation.

Operate each device by hand to see that the moving parts operate freely and without binding. Make sure that all electrical contact tips are clean, free of grease and dirt, and make a good contact when closed. The relay and contactors are carefully adjusted at the factory; however, should an adjustment of these devices be necessary, these adjustments are explained in the individual instructions for each device.

After all connections have been properly made, all parts properly assembled, and all components thoroughly inspected and adjusted, the controller is ready for operation.

Normal Operation

1. After all power and control connections are made, AND WITH THE ISOLATING DEVICE OPEN, megger between phases at the motor terminals, and between each phase and ground stud or bus, to ascertain that no short circuits are present.

2. Close the compartment doors and apply power to the controller.

If the operating handle of the isolating mechanism cannot be moved to the closed position, it may be that the mechanical interlock device is preventing this movement. To move the handle to the closed position, the high-voltage door must be fully closed and the contactor must be open.

3. Close the isolating-device handle by moving the handle with a rapid, positive motion to the extreme upper position until it latches into position. Unless the latch (pusher) snaps out when the handle is moved to the extreme positions, either in the open or closed position, the contact marked CPI (control-power interlock) will not close and the operation is not complete.

4. Operate the controller in the normal manner with the pilot devices (usually, push buttons) provided.

5. After the preliminary operation check is made, check the motor for proper rotation.

Door Opening Procedure

General

To open the high-voltage doors to gain access to the contactor or motor terminals, the contactor must be in the de-energized position. If the contactor is energized, the latch on the disconnect handle cannot be pushed in, the handle cannot be operated, nor can the door be opened.

Depressing the stop button de-energizes the contactor. The latch release on the disconnect handle can then be depressed, which opens an electrical interlock in the secondary of the control-power transformer. When the latch release has been depressed, the isolating switch handle may be moved to the lower or open position. With the disconnect handle in the lower position, the high-voltage door may be opened by turning the 9/16 turn latches.
Figure 52. Door interlock defeater bolts.

Figure 53. Interlock defeater bolt – rear view from inside of door.

Figure 54. Interference latch may be operated by opening the high-voltage door and pulling latch down.

Figure 55. Isolating mechanism and electrical interlocks mounted in enclosure.
Door-Defeater Latch

**Warning:** The following steps should only be taken as a last resort to enter a malfunctioning controller. It is imperative that all power to the main bus be removed before proceeding.

IN CASE OF EMERGENCY, remove all power to the controller; then the high-voltage door may be opened with the contactor in the closed position and with the isolating switch closed by using the hex-head bolts, located to the lower left of the isolating-switch handle, as follows:

**Warning:** Do not proceed unless all power to the controller is removed. Doors must not be opened with the power connected to the bus.

1. Turn the door latches ¼ turn counterclockwise.
2. Remove the right-hand hex-head bolt, as shown in Figure 52.
3. Turn the left-hand bolt ¼ turn counterclockwise. Figure 53 shows the bolts from the inside. The door may then be opened.

**Warning:** Defeating the door interlock leaves the controller connected to the bus. The bus power must be removed.

On some one-high enclosures, the low-voltage control panel serves as a barrier to isolate the high-voltage control-power transformer and fuses. An interference pin, shown in Figure 54, prevents swinging this low-voltage panel out until the high-voltage door is opened.

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Inspection, Maintenance, and Servicing

**Vacuum Contactor**

Complete maintenance and adjustment instructions for the high-voltage contactors are presented in GEH-5306. Refer to that instruction for all problems of servicing and adjusting; and to the proper renewal parts bulletin for renewal parts.

Contactor tip life depends on the severity of the service, but in any case, it is recommended that the contactor tip wear be checked at least once a year or in very high duty cycle operations, after every 250,000 operations.

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**Isolating Mechanism and Mechanical Interlock**

**Warning:** Under no circumstances should the isolation switch be inspected or adjusted with power applied to the main bus.

The quick-make quick-break isolation switch assembly is adjusted and tested at the factory. Under normal circumstances the switch does not need adjustment, however, if conditions require it the switch may be adjusted in the field. To adjust the isolating switch the following steps should be followed:

**Warning:** All power must be removed from the main bus before attempting to adjust the isolating switch mechanism.

1. After removing all power to the controller, and as described in steps 1 & 2 of the Mechanical Operation Check, rotate the isolating switch handle to the ON position. Then remove the fixed barrier (Figure 33) by removing the retaining screws that hold it in place. Retain the hardware for reassembly.

Some of the barrier mounting hardware is nylon type hardware. Note the location of these parts so they may be reassembled properly.

2. Near the end of each switch blade assembly, an adjusting nut is located along with a Belleville washer type spring. To adjust the blade pressure the nut must be adjusted. Loosen the small set screw located on each of the retaining nuts to enable adjustment.

3. Loosen the adjusting nut at the top of the blades. With your fingers retighten the nut until all the slack is out between the blades, stationary contact, spring washer & nut, then tighten an additional ¼ (one-eighth) turn. This procedure provides the necessary 0.005 inch spring compression of the blades.

4. Tighten the set screw on the nut to lock the adjustment in position. Use caution to prevent turning the nut on the main screw while tightening the set screw.

5. When the adjustment is complete for all three phases, rotate the isolating switch handle to the OFF position. Then, apply a thin coating of Mobil Temp SHC-32 grease to the contact surfaces of the male stab portion of the disconnect.

To properly adjust the pivot point Belleville washer type spring, return the isolating switch handle to the ON position per step 1 above. Then, follow the steps below:

1. On each phase, loosen the set screw on the pivot point adjusting nut.
2. Loosen the adjusting nut and then retighten using your fingers until the nut is just snug and no side play of the parts is evident.
3. Using wrenches tighten the adjusting nut an additional one-half (½) turn and tighten the set screw to hold the adjustment in place.
4. Rotate the isolating switch handle to the OFF position, then reinstall the isolator switch barrier. If necessary the viewing window may be cleaned before reinstallation of the barrier. Use a soft cloth and a mild soap and water solution or a commercial cleaner such as Windex or other similar cleaner.

**Warning:** Severe injury or death may result if the equipment is energized with the mechanical interlocks defeated. Remove all power from the equipment before defeating any of the mechanical interlocking mechanisms.
WARNING: Defeating the door interlock leaves the controller connected to the bus. The bus power must be removed.

NOTE
To check if sufficient (or safe) interlocking between door and door interlock bar exists, the following should be done:

A. Open high-voltage door.
B. With the door open, close the isolator switch by manually depressing the door operated release. See Figure 49.
C. Close door against interlock bar.
D. Look through door cutout below handle and visually determine if there is a minimum of 0.50-inch overlap (see sketch).
E. For a final check, close the door, close the disconnect switch, and try to pull the door open. The door should not open.

Figure 56. Checking procedures for mechanical door interlock.

WARNING: Defeating the door interlock leaves the controller connected to the bus. The bus power must be removed.

NOTE
1. Set 0.12-inch gap (as shown) with pusher extended (out position). See 0.60-inch reference.
2. Then, check the interlock operation with the pusher depressed.
3. Both contacts must be open and have a contact gap of at least 3/8 inch.
4. Insure the pusher pops out fully (see 0.60-inch reference) in both the down (off) and up (on) positions.

Figure 57. Checking for proper operation of pusher and control power interlock (CPI).
CR194 Vacuum Limitamp 400 Ampere Control

Checking Procedures – Mechanical Interlock & Manual Isolator (See Figures 56-58)

1. Check the door mechanical interlock for proper interference. See Figure 56.
2. Check for proper operation of pusher rod and Control Power Interlock (CPI) operation. See Figure 57.
3. Check the Test Power Interlock (TPI) adjustment. See Figure 58.

Vacuum Interrupter Integrity Test

Warning: The controller isolation switch (QMQB) must be placed in the off position and the motor load must have come to a complete stop before attempting to perform the vacuum interrupter integrity test.

Caution: X-ray emission may be produced if an abnormally high voltage is applied across the open contacts of a vacuum interrupter. Do not apply a voltage across the 400A CR193B contactor that is higher than 20.0 kV RMS.

General

This test determines the internal dielectric condition and vacuum integrity of the vacuum interrupters. Prior to performing this test the outside surfaces of the vacuum interrupters should be wiped clean of any contaminants with a non-linting cloth or industrial type wiper. During this test each interrupter should be checked separately.

Warning: The vacuum interrupter integrity test should be performed before the high-voltage contactor is energized for the first time and each time it is returned to service after maintenance, adjustment, or repair (See GEH-5306). Otherwise the vacuum interrupter integrity test should be performed annually.

Caution should be exercised during this test since high voltage testing is potentially hazardous. First open the controller isolating switch then completely isolate the contactor by disconnecting the bolted connections at the contactor load terminals prior to performing the high potential test. Also remove CPT primary fuses.

Failure to perform these tests may cause serious injury or death.

High potential test instruments can be purchased to perform the vacuum interrupter integrity test. The following is a recommended test instrument:

Hipotronics Model 7BT 60A

Use of a DC Hipot is not recommended because results may indicate a problem with a good interrupter. If you wish to use DC Hipot, set for 28kV, but if interrupter fails, confirm failed interrupter using above AC Hipot.

Test Procedure

Note: Before performing vacuum integrity test, confirm that both the armature gap setting and contact wear adjustment (GEH-5306, Sections 5 & 6) are proper.

1. Disconnect load side power leads from contactor and CPT primary fuses.
2. With the contactor in the open position connect the test leads to the contactor power terminals as shown in Figure 59. Apply the recommended test voltage (per above) and hold for a minimum of five (5) seconds.
In these routine inspections, four basic categories of deteriorating influences should be kept in mind:

1a. The effect of foreign material: Dirt and dust from the environment such as wood fibers, coal dust, cement, lamp black, lint.

1b. The effect of chemicals in the atmosphere: such as sulfur dioxide, chlorine, some hydrocarbons and salt water.

2. Mechanical wear and fatigue on all moving parts.

3. Heat.

4. Loose joints and connections.

5. Perform vacuum interrupter integrity test as described in these instructions.

Follow directions in these instructions for obtaining access to all sections of the controller including high-voltage door interlocking. Also, refer to GEH-5306 for directions relative to inspection of the high-voltage contactor.

The following are some specific recommendations:

1. Check for cleanliness generally, but particularly for accumulation of any foreign material on insulators. Voltage failures can result from tracking across insulation surfaces when they are dirty. The primary circuit insulation on the controller may be checked phase to phase and phase to ground using a 2500 volt megger.

2. Check for abrasive material accumulated in the isolating mechanism and mechanical interlock bearing and cam surfaces.

3. Check for buildup of dust or dirt which would reduce any air or surface voltage clearances.

4. Excessive heat can cause wire and cable insulation breakdown. Therefore, check for any evidence of melting, discoloring, deterioration of wire and cable.

5. The isolating mechanism has a life expectancy of approximately 6000 operations. If the application is such that the mechanism is operated more than twice each day, then the mechanism should be checked at the end of each 1000 operations, otherwise a yearly inspection is recommended.

6. Periodic checks of dimensions of the isolating mechanism and mechanical interlocks is strongly recommended. Follow the section in these instructions entitled "ISOLATING MECHANISM AND MECHANICAL INTERLOCK".

7. When any part of the isolating mechanism and mechanical interlock is replaced, all dimensions and checking procedures referred to under No. 6 above should be followed to be sure the system is in normal working order.

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Figure 59. Method of connecting test leads to interrupter for vacuum integrity test.
Figure 66. Conduit space and mounting holes.

**NOTE:**

B - INCOMING POWER TERMINAL CONNECTION

B1 - AC POWER BUS

C - CONTROL LEAD TERMINAL BOARD

D - MOTOR LEAD TERMINAL CONNECTION

E - GROUND BUS TERMINAL CONNECTION

F - GROUND TERMINAL CONNECTION

G - SPACE REQUIRED TO OPEN DOORS 90 DEGREES

J - MOUNTING HOLES FOR 1/2 IN. DIA. ANCHOR BOLTS

K - SPACE AVAILABLE FOR INCOMING CONDUIT

L - RECOMMENDED POSITION FOR INCOMING MOTOR CONDUIT

M - RECOMMENDED POSITION FOR INCOMING CONTROL CONDUIT

N - RECOMMENDED POSITION FOR INCOMING POWER CONDUIT

* - INDICATES TERMINAL LOCATION - APPROX. FOR CABLE LENGTH

Δ - APPROXIMATE UNCRATED WEIGHT

- ADD 5 PERCENT FOR DOMESTIC SHIPPING WEIGHT

- ADD 20 PERCENT FOR EXPORT SHIPPING WEIGHT
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 GE Company.