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OPERATION & MAINTENANCE MANUAL

BUILDING AS-217
MCAS, NEW RIVER, NC
LONESTAR GENERAL CONTRACTORS, INC.
CONTRACT NO. N62470-84-C-4061

MECHANICAL

SNEEDEN, INC.

Mechanical Contractor

MAINTENANCE AND OPERATION MANUAL

PROJECT:

HEADQUARTERS AND MAINTENANCE FACILITY
GROUP OPERATIONS FACILITY
M.C.A.S. (HELICOPTER) NEW RIVER
JACKSONVILLE, NORTH CAROLINA

CONTRACT NO: N62470-84-C-4061

INSTALLING CONTRACTOR:

SNEEDEN, INC.
301 EASTWOOD ROAD
WILMINGTON, N.C. 28403
(919) 791-3137

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TRANE

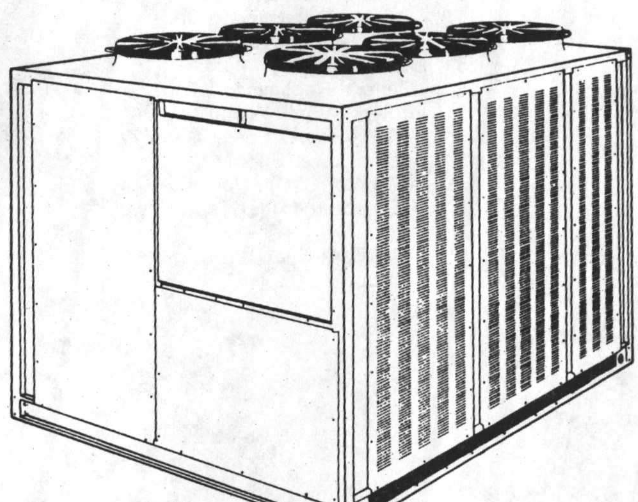
Use with Applicable
"Service Data" Sheets

Installation

CGAC-IN-4

Library	Service Literature
Product Section	Refrigeration
Product	Recip. Liquid Chillers - A/C Cold Gen.
Model	CGAC
Literature Type	Installation
Sequence	4
Date	January 1987
File No.	SV-RF-CG-CGAC-IN-4-187
Supersedes	

Model CGAC 20 thru 60 Ton Air-Cooled Cold Generators



Models

CGAC-C20K CGAC-C40K
CGAC-C25K CGAC-C50K
CGAC-C30K CGAC-C60K

Table of Contents

The Trane Company
La Crosse, Wisconsin 54601-7599
Printed in U.S.A.

Model Number Description

All standard Trane products are identified by a multiple-character model number that precisely identifies a particular type of unit. An explanation of the alphanumeric identification codes used for CGAC units is provided on this page. Its use will enable the owner/operator, installing contractors, and service engineers to define the operation, components and options for any specific unit.

CG	A	C	-	C60	1	-	K	A	N	G	G	6	0	DFGPW
1,2	3	4		5,6,7	8		9	10	11	12	13	14	15	16,etc.

Digits 1,2
Unit Model
CG = Cold Generator

Digit 3
Unit Type
A = Air-Cooled Condensing

Digit 4
Development Sequence

Digits 5, 6, 7
Nominal Capacity
C20 = 20 Tons
C25 = 25 Tons
C30 = 30 Tons
C40 = 40 Tons
C50 = 50 Tons
C60 = 60 Tons

Digit 8
Electrical and Start Characteristics
1 = 460/60/3 PW
2 = 575/60/3 PW
3 = 230/60/3 PW
4 = 460/60/3 XL
6 = 200/60/3 PW
A = 380/50/3 PW
B = 415/50/3 PW
S = Special

Digit 9
Compressor I.D.
K = Model K Hermetic
S = Special

Digit 10
Design Sequence

Digit 11
Motors (Open Compressor Only)
N = None
S = Special

Digit 12
Evaporator
B = 20 Ton
C = 25 Ton
D = 30 Ton
E = 40 Ton
F = 50 Ton
G = 60 Ton
S = Special

Digit 13
Condenser
B = 20 Ton
C = 25 Ton
D = 30 Ton
E = 40 Ton
F = 50 Ton
G = 60 Ton
S = Special

Digit 14
Unloading Steps
2 = 2-Step (20-Ton Only)
3 = 3-Step (25 and 30-Ton)
4 = 4-Step (40 Ton Only)
6 = 6-Step (50 and 60-Ton)
S = Special

Digit 15
Approval Agency
0 = None
2 = UL
3 = CSA
S = Special

Digit 16, etc.
Miscellaneous
3 = Control Power Transformer
8 = Totally-Enclosed Fan Motors
D = Unit-Mounted Disconnect Switch
E = Unit Neoprene Isolators
F = Unit Spring Isolators
G = Pressure Gauges and Piping
H = Hot Gas Bypass
P = Periodic Pumpout
V = Copper Fins
W = Low Ambient Dampers
Y = No Evaporator Heat Tape (Export Only)
S = Special
X = Export

General Information

Literature Change History

CGAC-IN-4 (January 1986)

Original issue of manual, providing installation, pre-start and start-up information for model CGAC-C20K thru C60K air-cooled Cold Generator units of "A" design sequence.

CGAC "Service Data" Sheets

Use this installation manual in conjunction with the information provided in the applicable CGAC "Service Data" publications.

To insure proper CGAC installation and start-up, the design sequence of the unit (Refer to "Model Number Description") must agree with the design sequence printed on the front cover of the "Service Data" publication.

Installation Checklist

An "Installation Checklist" is provided at the end of the "Installation" section of this manual. Use the checklist to verify that all necessary installation procedures have been completed. Do not use the checklist as a substitute for reading the detailed information contained in the manual. Read the entire manual before beginning installation procedures.

Warnings and Cautions

"Warnings" and "Cautions" appear at appropriate points in this manual. Cautions indicate areas where special attention is required to prevent equipment or property damage. Warnings focus attention on the personal safety of installing and operating personnel. The instructions given in each warning that appears in this manual must be followed carefully.

Unit Description

Trane 20 thru 60-ton Model CGAC Air-Cooled Cold Generators are equipped with either one or two Trane Model K hermetic, reciprocating compressors. All units are dehydrated, leak tested, charged and tested for proper control operation before shipment. A low ambient lockout thermostat can be customer provided.

Standard control for these units is a microprocessor-based electronic controller that governs unit operation in response to chilled water temperature leaving the evaporator. Compressor unloaders are solenoid actuated and discharge pressure operated.

The number of capacity or unloading stages provided is:

```
CGAC-C20K ........ 2-Step Control.
CGAC-C25K, C30K... 3-Step Control.
CGAC-C40K ........ 4-Step Control.
CGAC-C50K, C60K... 6-Step Control.
```

The dual-compressor units (40, 50 and 60-Tons), feature two independent refrigerant circuits--one for each compressor.

Each refrigerant circuit is provided with an operating charge of refrigerant and refrigerant oil, a liquid line solenoid valve, filter drier, sight glass, thermostatic expansion valve and service valve.

Note: The compressor suction and discharge service valves are closed for shipment to isolate the refrigerant charge in the condenser.

The shell-and-tube type evaporator is manufactured in accordance with ASME standards. Each evaporator is fully insulated and equipped with a drain connection. A bulbwell for the unit temperature controller is located on the evaporator water outlet.

A bag containing the unit wiring diagrams, installation manual, and operation/maintenance manual is provided in the control panel. Be sure to read this literature before installing and operating the unit.

If pressure gauges are ordered for field-installation on the unit, they will be shipped in a separate carton along with a cloth bag containing connectors and gaskets.

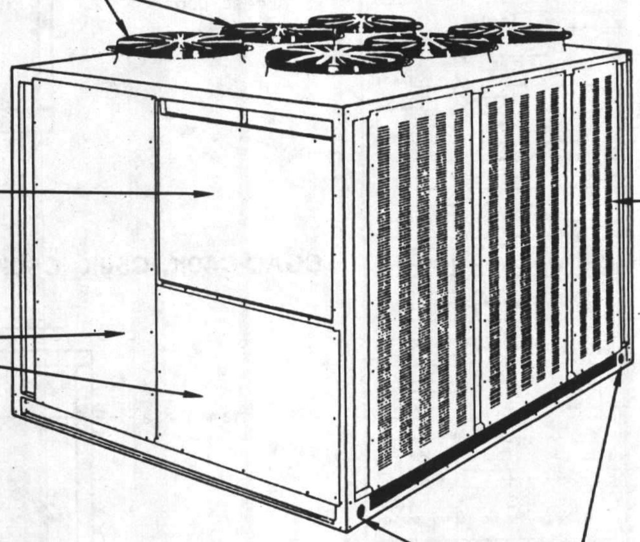
Figure 1 illustrates access panel locations and other CGAC exterior components.

Unit Inspection

When the unit is delivered, verify that the correct one has been shipped and that it is properly equipped by comparing the information that appears on the unit nameplate with ordering and submittal information. Refer to "Nameplates".

Inspect all exterior components for visible damage. Report any apparent damage or material shortage to the carrier and make a "unit damage" notation on the carrier's delivery receipt. Specify the extent and type of damage found, and notify the appropriate Trane sales office. Do not proceed with installation of a damaged unit without sales office approval.

Figure 1
Exterior Components of Typical CGAC Unit



Inspection Checklist

To protect against loss due to damage incurred in transit, complete the following checklist upon receipt of the unit:

[ ] Inspect individual pieces of the shipment before accepting the unit. Check for obvious damage to the unit or packing material.

[ ] Check the unit for concealed damage before it is stored and as soon as possible after delivery. Concealed damage must be reported within 15 days.

[ ] If concealed damage is discovered, stop unpacking the shipment. Do not remove damaged material from the receiving location. Take photos of the damage, if possible. The owner must provide reasonable evidence that the damage did not occur after delivery.

[ ] Notify the carrier's terminal of damage immediately by phone and by mail. Request an immediate joint inspection of the damage by the carrier and the consignee.

[ ] Notify a Trane sales representative and arrange for repair. Do not repair the unit until damage is inspected by the carrier's representative.

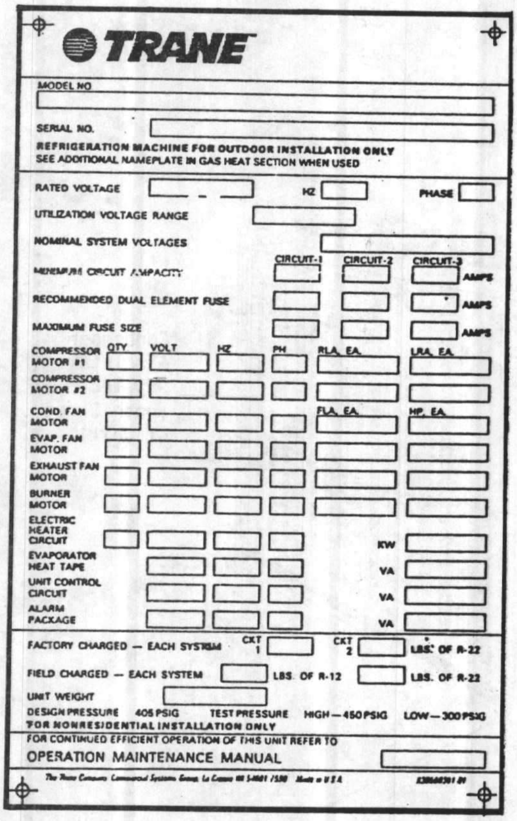
Nameplates

The nameplates on these machines provide valuable information pertaining to the identification of the unit and its components.• Provide all pertinent nameplate data when ordering parts or literature, and when making other inquiries.

Unit Nameplate

The unit nameplate for 20 thru 60-ton CGAC units is mounted in the upper left corner of the control panel access door. See Figure 2. This nameplate (Figure 2) specifies control circuit power requirements and power requirements for the chiller heat tapes and optional alarm package. It also identifies the order number of the unit Operation/Maintenance manual. The owner should refer to this manual for information regarding the proper operation and maintenance of this equipment.

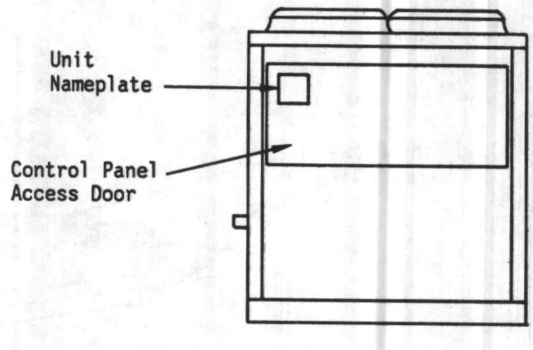
Figure 2
Typical CGAC Unit Nameplate and Nameplate Location



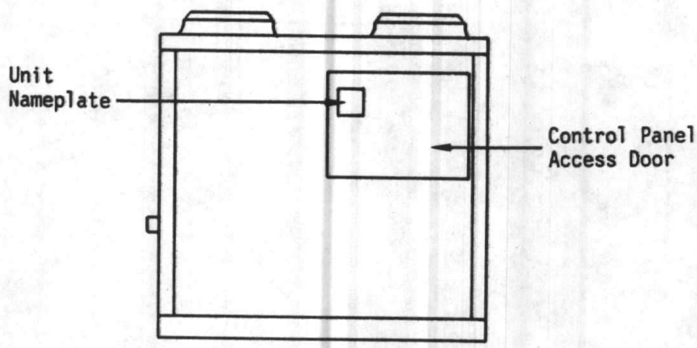
Typical Unit Nameplate

Art No.
RF/CG-2720

CGAC-C20K, C25K, C30K



CGAC-C40K, C50K, C60K



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Compressor Nameplate

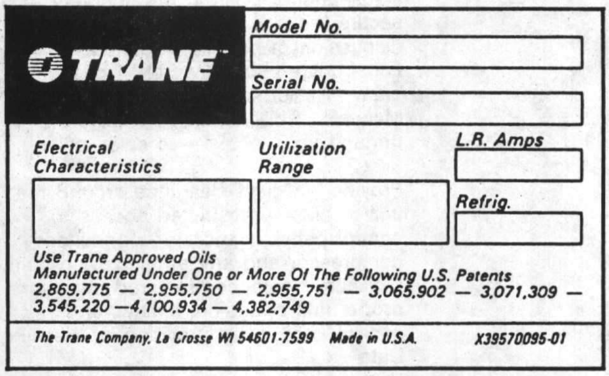
The Model K compressor nameplate shown in Figure 3, is mounted on the compressor lower housing.

Evaporator Nameplate

The evaporator nameplate is mounted on the top of the evaporator supply-end tube sheet. The word "nameplate" is applied to the insulation just above the nameplate (Figure 4); to view the nameplate, remove the tape over the area and spread the insulation.

Figure 3
Typical Model K Compressor Nameplate and Nameplate Location

Typical Compressor Nameplate



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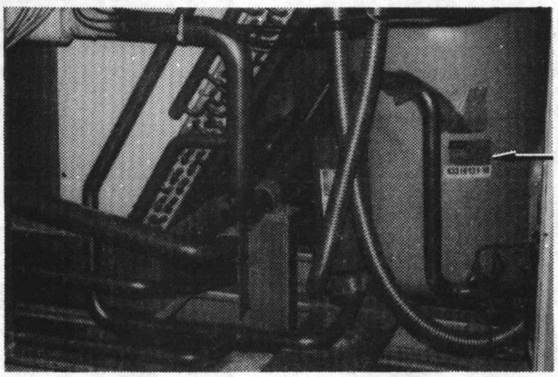
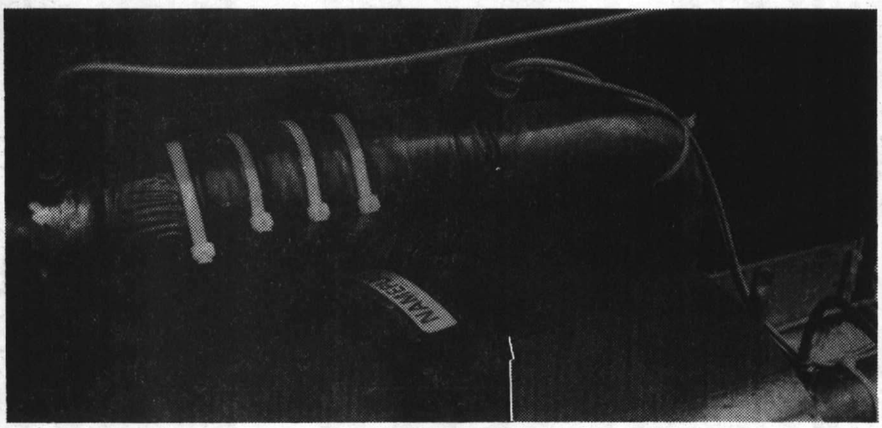


Nameplate Location

Art No. RF/CG-2736

Figure 4
Evaporator Nameplate Location



Nameplate (Under Insulation)

Art No. RF/CG-2722

Installation

Complete the "Installation Checklist" during installation to verify completion of all recommended procedures before unit start-up.

Unit Dimensions, Clearances and Location

Refer to "Service Data" for unit dimensions. Provide a level mounting surface strong enough to support the unit's weight. Unit operating weights are provided in "Service Data". An isolated concrete foundation -- or footings at each loading point -- will minimize vibration and noise problems. Install anchor bolts in the concrete to secure the unit. For a detailed discussion of base and foundation construction, see Chapter VI of the Trane "Reciprocating Refrigeration Manual". This manual is available through your local Trane sales office.

Provide sufficient clearance around the unit to allow unrestricted access to control panel, evaporator, condenser, compressor and any other service points. Minimum clearances required to ensure proper unit operation, airflow, and service access are provided in "Service Data".

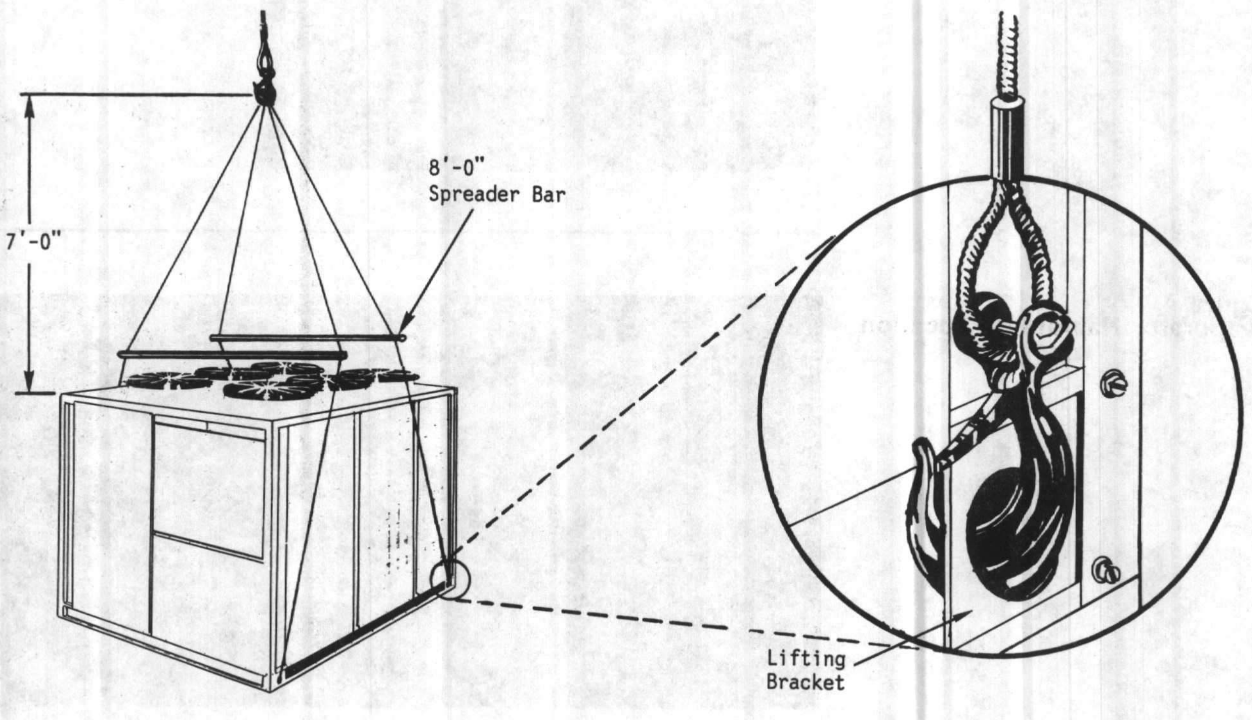
Note: If the unit is installed in a well, the depth of the well must not exceed the height of the unit.

Rigging

Lifting brackets are provided along the base rail on either side of the unit. Pass lifting cables through the brackets and install spreader bars between the cables above unit. A label on the unit base rail illustrates proper lifting procedure. See Figure 5. When rigged properly, the unit will balance at its center of gravity.

WARNING: To prevent injury, death or equipment damage, use cables strong enough to support unit weight. Test-lift unit to ensure proper balance and rigging.

Figure 5
CGAC Rigged for Lifting



Drainage

Locate a large-capacity drain near the unit for system drainage during shutdown or repair. A 3/4-inch NPT drain connection is provided at the leaving chilled water end of the chiller.

Unit Isolation

Mounting methods that will minimize sound and vibration problems are:

1. Mount the unit directly on an isolated concrete pad or on isolated concrete footings at each unit mounting point.

2. Install the optional neoprene or spring mounting isolators at each mounting location. Refer to "Neoprene Isolators" or "Spring Isolators".

Neoprene Isolators

Unit mounting locations and isolator selection information are provided in "Service Data". Proper isolator placement instructions are also placed the the control panel with other unit documentation. Isolators are identified by color and by the isolator part number.

Install neoprene isolators at each unit mounting point using the following procedure:

1. Secure the isolator to the mounting surface using the mounting holes in the base of the isolator (Figure 6). Do not fully tighten the isolator mounting bolts at this time.

2. Align the mounting holes in the base-rail of the unit with the holes in the top of the isolators and lower the unit.

3. Install mounting bolts through the unit base-rail into the threaded tap in the isolator and tighten securely. Maximum isolator deflection should be approximatley 1/4-inch.

4. Level the unit carefully. Refer to "Leveling the Unit".

Spring Isolators

Unit mounting locations and isolator selection information are provided in "Service Data". Proper isolator placement instructions are also placed the the control panel with other unit documentation. Isolators are identified by color and by the isolator part number.

Install neoprene isolators at each unit mounting point using the following procedure:

1. Bolt the isolators to the mounting surface using the mounting slots in the isolator base plate. Do not fully tighten the isolator mounting bolts at this time.

2. Set the unit on the isolators; the isolator positioning pins (Figure 6) must register in the unit mounting holes.

3. Clearance between upper and lower isolator housings should be 1/4 to 1/2 inch (Figure 6). A clearance of over 1/2 inch dictates that shims are required to level the unit (See "Leveling the Unit").

4. Make minor clearance adjustments by turning the isolator levelling bolt (Figure 6) clockwise to increase clearance and counterclockwise to decrease clearance.

5. If proper isolator clearance cannot be obtained by turning the levelling bolt, level the isolators themselves. A 1/4-inch variance in elevation is acceptable.

Leveling the Unit

Before snugging down the mounting bolts, level the unit carefully. Use the unit base rail as a reference. Level the unit to within 1/4 inch over its entire length. Use shims if adjustable isolators are not used.

Compressor Isolators

The Trane Model K hermetic compressor is fully operational as shipped. The compressor is mounted on neoprene grommet isolators that require no special pre-operational adjustments. The compressor receives a correct operational oil charge before shipment.

Caution: To prevent compressor damage, be certain that suction and discharge valves are open (backseated) before starting the unit.

Low Ambient Dampers

Operation

A set of dampers is used to extend operation of these units from the standard low limit operational temperature to a minimum of 0 F. The dampers modulate airflow across the condenser coils to maintain condensing pressure during low ambient operation.

Refrigerant-operated actuators control damper modulation for each refrigerant circuit in response to condensing pressure, closing the dampers when condensing pressure decreases due to a fall in ambient temperature. Damper operating setpoints are given in "Service Data".

Installation

Dampers are available factory or field-installed. If field installing the dampers, mount them over the condenser fans as shown in "Service Data" and connect the actuator capillary tube to the backseat port of the liquid line service valve for each circuit.

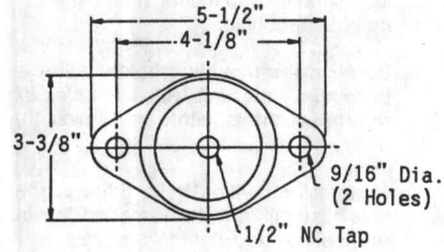
Adjustment

Inspect the blades for proper alignment and operation. If adjustment is required, hold damper blades firmly in closed position, and slide the operator to remove any slack in the actuating linkage.

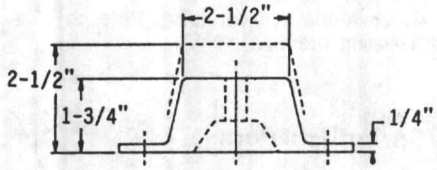
Figure 6
Typical CGAC Unit Mounting Isolators

Neoprene Isolator

Top View

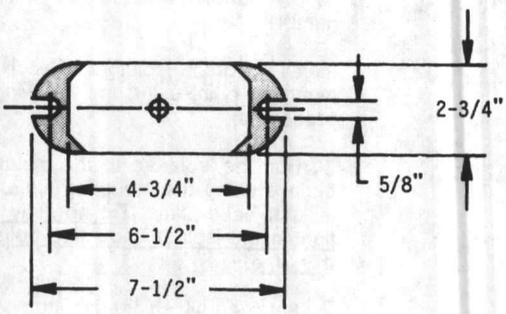


Side View

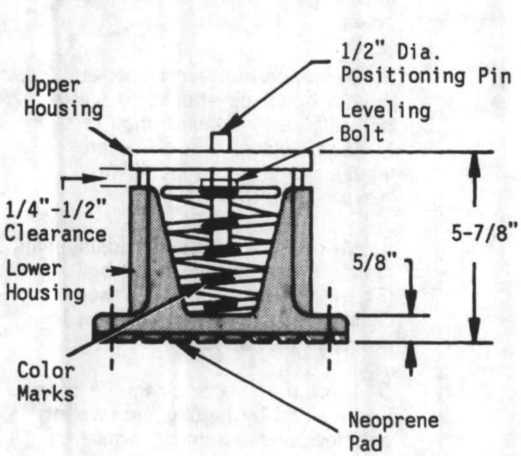


CP1 Spring Isolator

Top View



Side View



Unit Water Piping

General Water Piping Recommendations

Thoroughly flush all system water piping before making final piping connections to the unit.

Caution: If using an acidic commercial flushing solution, construct a temporary bypass around the unit to prevent damage to internal components of the evaporator.

Caution: To avoid possible equipment damage, do not use untreated--or improperly treated--system water.

Use thread sealant or Teflon tape at all water connections to prevent leakage. To minimize heat gain and prevent condensation, insulate all piping.

Caution: Avoid overtightening to prevent damage to water connections; the use of Teflon tape makes overtightening more likely to occur.

The "Trane Reciprocating Refrigeration Manual" disusses proper piping practices and sizing methods. This manual is available through Trane sales offices.

Evaporator Water Piping

Connections. Types, sizes and locations of water inlet and outlet connections are provided in "Service Data".

Piping Components. Figure 7 shows typical evaporator water piping components. Components and layout will vary, depending upon the locations of the connections and water source. A vent is located on top of the evaporator at the return end. Provide additional vents at high points in the piping to bleed air from the chilled water system. Install pressure gauge(s) to monitor entering and leaving chilled water pressure.

Caution: To prevent evaporator damage, do not exceed 150 psig evaporator water pressure.

Provide shutoff valves in the pressure gauge line(s) to isolate them from the rest of the system when they are not in use. Use pipe unions to simplify disassembly for system service, and vibration eliminators to prevent vibration transmission through the water lines.

Install thermometers in the lines to monitor evaporator entering and leaving water temperatures, and a balancing cock in the leaving water line to establish a balanced water flow. Install shutoff valves in entering and leaving water lines to isolate the evaporator for service. Install a pipe strainer in the evaporator supply line.

Evaporator Drain. There is a 3/4-inch drain connection under the leaving chilled water end of the evaporator (Figure 8) that can be piped to a drain for emptying the evaporator during shutdown or service. Install a shutoff valve in the drain line. If drain is not piped, remove the drain plug from the plastic bag in the control panel and install it in the drain connection.

Evaporator Flow Switch. Use a flow sensing device (i.e., flow switch) to prevent or stop compressor operation if evaporator water flow drops drastically. Install it in the evaporator chilled water outlet piping as shown in Figure 7. See "Electrical Wiring" for the flow switch electrical interlock diagram; a procedure for measuring water pressure drop (along with a pressure drop chart) is provided in the "Prestart Procedures" section of this manual.

Freeze Protection

General Recommendations

Use the procedure described below to ensure that the chilled water system is adequately protected from freeze-up in those applications where the unit remains operational at subfreezing ambient temperatures.

1. Install chilled water piping heat tape along with a fused disconnect switch; refer to the instructions outlined under "Heat Tape". Ensure that all exposed piping is adequately protected.

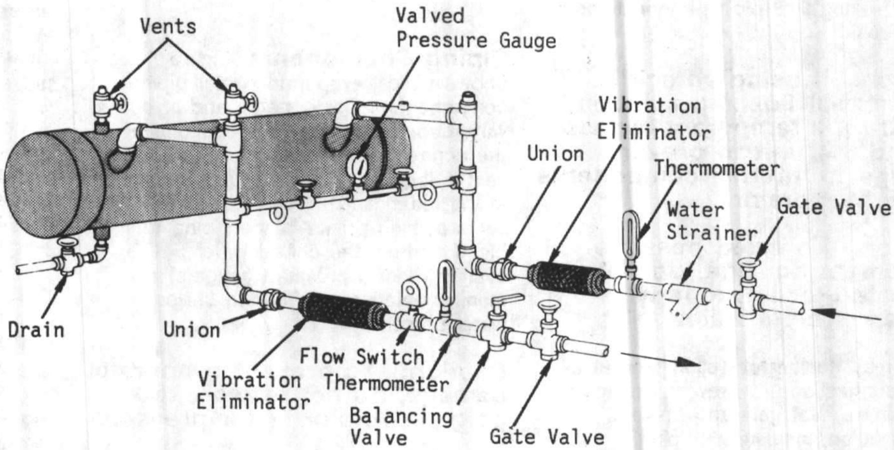
Note: Heat tape is factory-installed on the unit evaporator and all internal water piping; this heat tape will protect these components from freeze-up at ambient temperatures down to -20 F.

2. Freeze-proof the chilled water system by adding a non-freezing, low-temperature, heat-transfer fluid to the chilled water system. This solution must provide protection against ice formation at the lowest expected ambient temperature.

Evaporator water capacities are provided in "Service Data". Follow the manufacturer's recommendations for the use and testing of the anti-freeze solution.

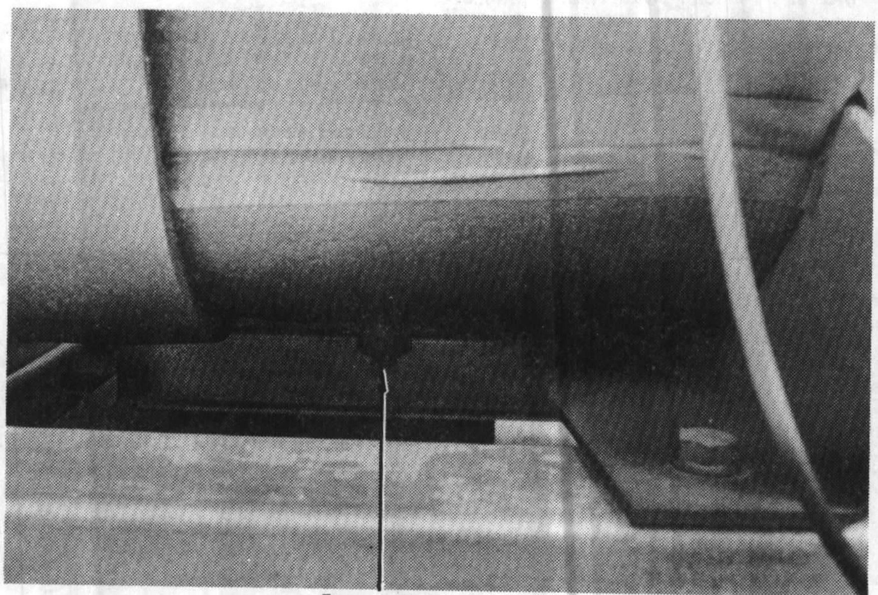
Note: Use of an ethylene glycol-type antifreeze reduces unit cooling capacity; this condition must be accounted for during total system design.

Figure 7
Recommended Piping Components for Typical Evaporator Installation



Art No. RF/CG-5000

Figure 8
Evaporator Drain for Typical CGAC Units



Art No. RF/CG-2724

Heat Tape Installaton

Install heat tape on all external water piping that may be exposed to freezing temperatures. Be sure to use heat tape that is recommended for low-temperature applications; it should be rated at 110/120 volts, thermostatically controlled, and dissipate 7 watts per linear foot.

Heat tape selection should be based on the lowest expected ambient temperature --including any wind chill factor. For heat tapes not automatically (i.e., thermostatically) controlled, install an accessory thermostat.

Refer to Tables 1 and 2 for typical heat tape characteristics.

To install the heat tape properly, follow the instructions provided by the heat tape manufacturer. If none are provided, use the recommendations outlined below:

1. Wrap the heat tape around the pipe or apply it straight along the pipe (Tables 1 and 2) as necessary to provide the required protection.

2. Use friction tape to secure the heat tape to the water pipe.

3. Place the thermostat tightly against -- and parallel to -- the water pipe; then tape it into place at both ends. Be sure to install the thermostat on the most exposed (i.e., coldest) portion of the pipe.

4. Wrap the pipe with weatherproof tape. On vertical pipe runs, start the wrap at the bottom and work up as shown in Figure 9. Be sure to overlap the tape so that it will shed moisture.

Note: If additional protection is required, insulate the pipe with fiberglass wrap before installing the outer wrap.

Caution: To prevent heat tape failure, frozen pipes, and other unit damage, do not install fiberglass insulation under outer pipe wrap if non-thermostatic heat tape is used.

If freezing is a potential problem, all exposed piping, pumps and other components must be protected with heat tape and insulation.

Figure 9
Typical Insulated Heat Tape Installation (Spiralled Application)

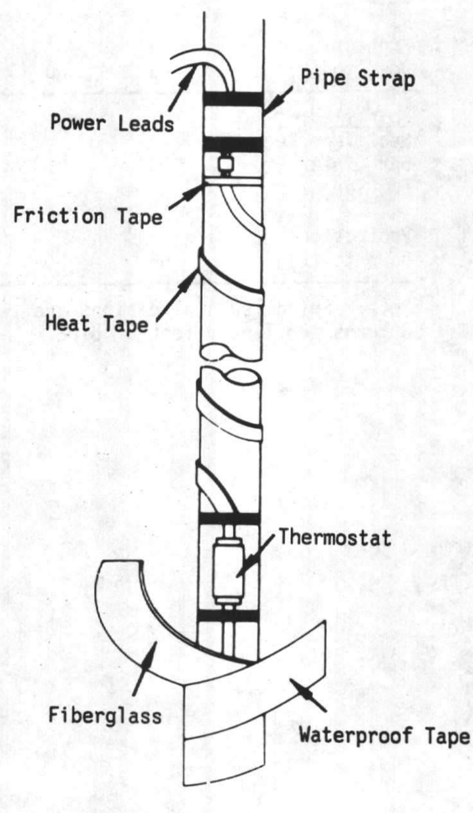


Table 1
Application of Non-Thermostatic Heat Tape w/Outer Wrap and No Insulation

Application Technique	Pipe Size				
	2"	2-1/2"	3"	4"	5"
Straight: Heat Tape Req. per Linear Ft. of Pipe	12"	12"	12"	12"	12"
Protection Down to (F)	6	11	15	20	22
Spiralled: Heat Tape Req. per Linear Ft. of Pipe	28"	31"	35"	47"	54"
Protection Down to (F)	-27	-23	-20	-17	-15

Note: Spiralled applications are twisted around pipe 3 turns per linear foot of pipe.

Table 2
Application of Non-Thermostatic Heat Tape w/Outer Wrap and Insulation

Application Technique	Pipe Size				
	2"	2-1/2"	3"	4"	5"
Straight: Heat Tape Req. per Linear Ft. of Pipe	12"	12"	12"	12"	12"
Protection Down to (F)	-6	0	3	12	16
Spiralled: Heat Tape Req. per Linear Ft. of Pipe	26"	31"	35"	47"	54"
Protection Down to (F)	-55	-50	-45	-40	-1

Note: Spiralled applications are twisted around pipe 3 turns per linear foot of pipe.

Electrical Wiring

General Recommendations

WARNING: To prevent injury or death, disconnect electrical power source before completing wiring connections to unit.

All wiring must comply with local and national electrical codes. The installer must provide properly sized system interconnecting and power supply wiring with with appropriate fused disconnect switches. Type and locations of disconnects must comply with all applicable codes.

Caution: Use only copper conductors for terminal connections to avoid corrosion or overheating.

Electrical connection locations, minimum circuit ampacities, recommended fuse sizes, and other unit electrical data is provided in "Service Data" and on the unit nameplate. Typical field wiring diagrams are shown in Figures 10 and 11.

Power Supply Wiring

Water Pump Power Supply. Provide supply power wiring with fused disconnect for the chilled water pump (Figures 10 and 11).

Unit Power Supply. Run appropriately sized power wiring through the line voltage access openings provided on the side of the unit and up through the openings in the bottom of the control panel. Connect it to the proper terminal block or unit-mounted disconnect. Refer to Figures 10 and 11. Install fused disconnects as required by local codes. Sizes and locations of electrical access openings are shown in "Service Data". Provide proper equipment ground to the ground connections in the control panel.

Note: For unit applications requiring supply power wiring conductors exceeding 500 MCM, run parallel conductors through the two line voltage electrical openings provided.

A non-fused, unit-mounted disconnect switch and the control power transformer are optional.

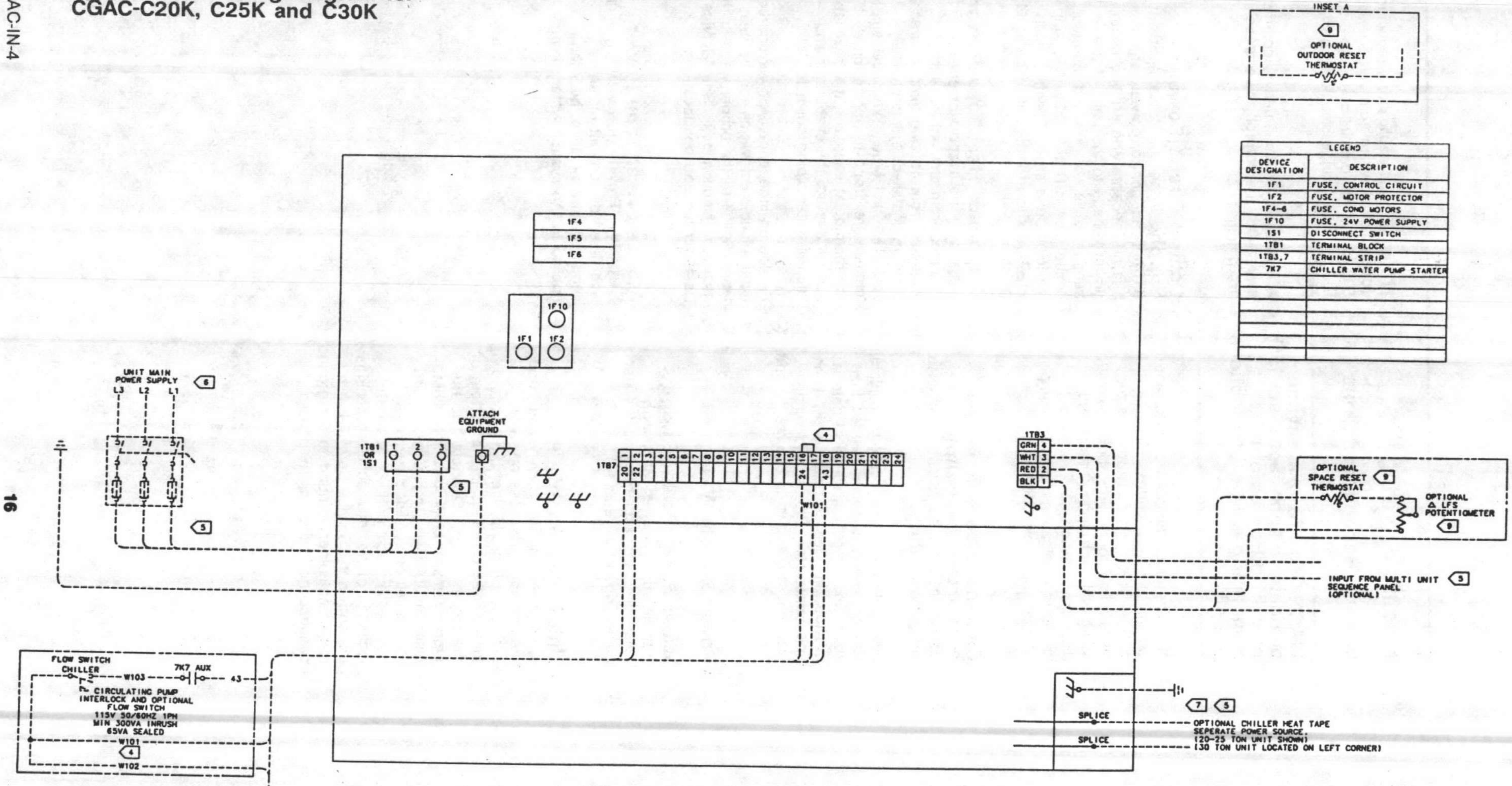
Control Circuit Power Supply. If the unit is equipped with the optional control power transformer it is not necessary to provide control power voltage to the unit. If the transformer is not provided, connect control power (115V, 750VA, 15 amp maximum fuse size) to terminal strip 1TB7 as shown in Figures 10 and 11.

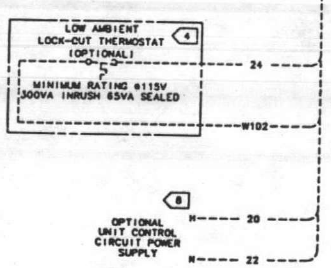
Evaporator Heat Tape Power Supply. The evaporator shell is insulated from ambient air, and protected from freezing temperatures by a factory installed, thermostatically controlled heat tape. Whenever ambient temperature drops to approximately 37 F, the thermostat energizes the heat tape; this will protect the evaporator and internal water piping down to -20 F.

Provide an independent power source with fused disconnect switch for the heat tape. Splice to the proper wires in the heat tape junction box. See "Service Data" for junction box locations.

Auxiliary Heat Tape Power Supply. Provide power supply wiring with fused disconnect for any supplementary electrical heat tape applied to the system water piping.

Figure 10
Typical Field Wiring Diagram for CGAC-C20K, C25K and C30K





LEGEND	
DEVICE DESIGNATION	DESCRIPTION
1F1	FUSE, CONTROL CIRCUIT
1F2	FUSE, MOTOR PROTECTOR
1F4-6	FUSE, COND MOTORS
1F10	FUSE, 24V POWER SUPPLY
1S1	DISCONNECT SWITCH
1TB1	TERMINAL BLOCK
1TB3,7	TERMINAL STRIP
7K7	CHILLER WATER PUMP STARTER

NOTES:

1. WIRE NUMBERS ARE THE SAME AS THE NODE NUMBER THAT THE WIRE IS CONNECTED TO, BUT LESS ANY SUFFIX LETTER. WHERE NODE NUMBERS ARE NOT AVAILABLE W_ NUMBERS ARE USED.
2. ALL 3-PHASE MOTORS ARE PROTECTED UNDER PRIMARY SINGLE PHASE FAILURE CONDITIONS.
3. CAUTION-DO NOT ENERGIZE UNIT UNTIL CHECK-OUT AND START-UP PROCEDURES HAVE BEEN COMPLETED.

4 WARNING-REMOVE JUMPER WHEN LOW AMBIENT LOCK-OUT THERMOSTAT IS USED. LEAD W101 IS NOT REQUIRED WHEN LOW AMBIENT LOCKOUT THERMOSTAT IS USED.

5 ALL CUSTOMER WIRING TO CONTROL PANEL TO BE COPPER CONDUCTORS ONLY.

6 SEE NAMEPLATE MARKING FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE.

7 CHILLER HEAT TAPE IS STANDARD ON ALL 60 HZ UNITS. POWER SUPPLY REQUIRED IS 115 VOLTS AND MAX FUSE SIZE IS 15 AMPS. ON 50 HZ UNITS THE HEAT TAPE IS OPTIONAL. WHEN PROVIDED FOR 380 & 415 VOLTS 50 HZ UNITS THE HEAT TAPE POWER REQUIRED IS 240 VOLTS AND MAX FUSE SIZE IS 15 AMPS.

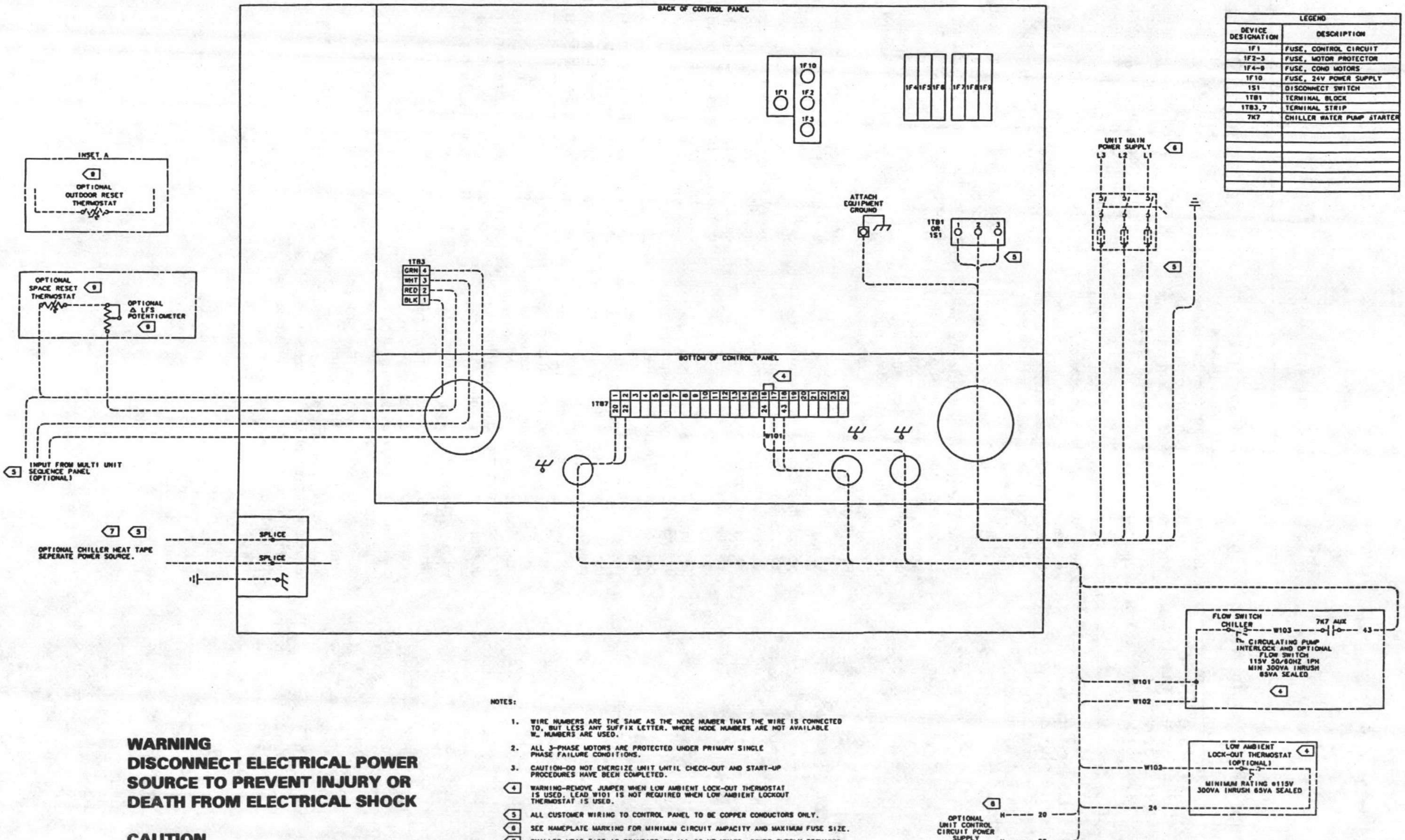
8 THIS POWER SUPPLY MAY BE CUSTOMER PROVIDED AS SHOWN OR CAN BE SUPPLIED BY AN OPTIONAL FACTORY MOUNTED CONTROL CIRCUIT TRANSFORMER. IF CUSTOMER PROVIDED THE POWER REQUIREMENTS ARE 115 VOLTS, 750 VA AND THE MAX FUSE SIZE IS 15 AMPS. IF THE OPTIONAL TRANSFORMER IS ORDERED THIS POWER SUPPLY AND LEADS 20 AND 22 ARE NOT REQUIRED.

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

2306-1929

Figure 11
Typical Field Wiring Diagram for CGAC-C40K, C50K and C60K



LEGEND	
DEVICE DESIGNATION	DESCRIPTION
1F1	FUSE, CONTROL CIRCUIT
1F2-3	FUSE, MOTOR PROTECTOR
1F4-9	FUSE, COND MOTORS
1F10	FUSE, 24V POWER SUPPLY
1S1	DISCONNECT SWITCH
1TB1	TERMINAL BLOCK
1TB3,7	TERMINAL STRIP
7K7	CHILLER WATER PUMP STARTER

NOTES:

1. WIRE NUMBERS ARE THE SAME AS THE NODE NUMBER THAT THE WIRE IS CONNECTED TO, BUT LESS ANY SUFFIX LETTER. WHERE NODE NUMBERS ARE NOT AVAILABLE W_ NUMBERS ARE USED.
2. ALL 3-PHASE MOTORS ARE PROTECTED UNDER PRIMARY SINGLE PHASE FAILURE CONDITIONS.
3. CAUTION—DO NOT ENERGIZE UNIT UNTIL CHECK-OUT AND START-UP PROCEDURES HAVE BEEN COMPLETED.

4 WARNING—REMOVE JUMPER WHEN LOW AMBIENT LOCK-OUT THERMOSTAT IS USED. LEAD W101 IS NOT REQUIRED WHEN LOW AMBIENT LOCKOUT THERMOSTAT IS USED.

5 ALL CUSTOMER WIRING TO CONTROL PANEL TO BE COPPER CONDUCTORS ONLY.

6 SEE NAMEPLATE MARKING FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE.

7 CHILLER HEAT TAPE IS STANDARD ON ALL 60 HZ UNITS, POWER SUPPLY REQUIRED IS 115 VOLTS AND MAX FUSE SIZE IS 15 AMPS. ON 50 HZ UNITS THE HEAT TAPE IS OPTIONAL. WHEN PROVIDED FOR 380 & 415 VOLTS 50 HZ UNITS THE HEAT TAPE POWER REQUIRED IS 240 VOLTS AND MAX FUSE SIZE IS 15 AMPS.

8 THIS POWER SUPPLY MAY BE CUSTOMER PROVIDED AS SHOWN OR CAN BE SUPPLIED BY AN OPTIONAL FACTORY MOUNTED CONTROL CIRCUIT TRANSFORMER. IF CUSTOMER PROVIDED THE POWER REQUIREMENTS ARE 115 VOLTS, 750 VA AND THE MAX FUSE SIZE IS 15 AMPS. IF THE OPTIONAL TRANSFORMER IS ORDERED THIS POWER SUPPLY AND LEADS 20 AND 22 ARE NOT REQUIRED.

9 △LFS RESET POTENTIOMETER USED WITH REMOTE SPACE SENSOR. FOR OUTDOOR RESET, REMOTE SPACE SENSOR AND △LFS RESET POTENTIOMETER IS NOT USED (SEE INSET A). THE NOTED OPTIONAL SPACE OR OUTDOOR RESET THERMOSTAT ARE NOT AVAILABLE IF THE MULTI UNIT SEQUENCE PANEL IS PROVIDED.

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

2306-1929

Interconnecting System Wiring

WARNING: To prevent injury or death, disconnect electrical power source before completing wiring connections to unit.

Caution: Use copper conductors only to prevent galvanic corrosion and overheating at terminal connections.

Chilled Water Pump (7B1). The installing contractor must provide interconnecting wiring from the chilled water pump (7B1) pushbutton station to the proper terminals on terminal block 1TB7 in the control panel (Figures 10 and 11).

The water pump motor starter (7K7) must have two normally-open auxiliary contacts: one contact in series with the pump START pushbutton, the other wired in the flow switch circuit. See Figures 10 and 11.

Flow Switch Interlock. To avoid possible evaporator freeze-up resulting from restricted water flow, install a flow switch (or other flow sensing device) in the evaporator water outlet piping; see "Unit Piping: Evaporator Flow Switch".

Whether field-supplied or a factory option, this sensing device must be adjusted to stop compressor operation if water flow to the evaporator drops below 50 percent of the system design full-flow rate.

The installer must provide interconnecting wiring between the unit control panel, the auxiliary contacts of the chilled water pump motor starter (7K7), and the flow sensing device in the evaporator water supply line. Connect the switch to the proper terminals of terminal strip 1TB7 in the control panel; see Figures 10 and 11. This interlock must allow compressor operation only if the chilled water pump is running and providing the minimum acceptable water flow rate.

Low Ambient Lockout Thermostat. The installer must provide interconnecting wiring between the customer-provided low ambient lockout thermostat (Figures 10 and 11), the chilled water flow switch and the proper terminals of 1TB7 in the control circuit panel. The thermostat should be adjusted to prevent unit operation at ambient temperatures below the minimum unit start-up temperatures given in "Service Data".

Installation of Optional Setpoint Reset

A factory control option is available that enables the leaving chilled water setpoint (i.e., from the unit) to be reset in response to either indoor zone or outdoor air temperature.

Indoor Zone Temperature

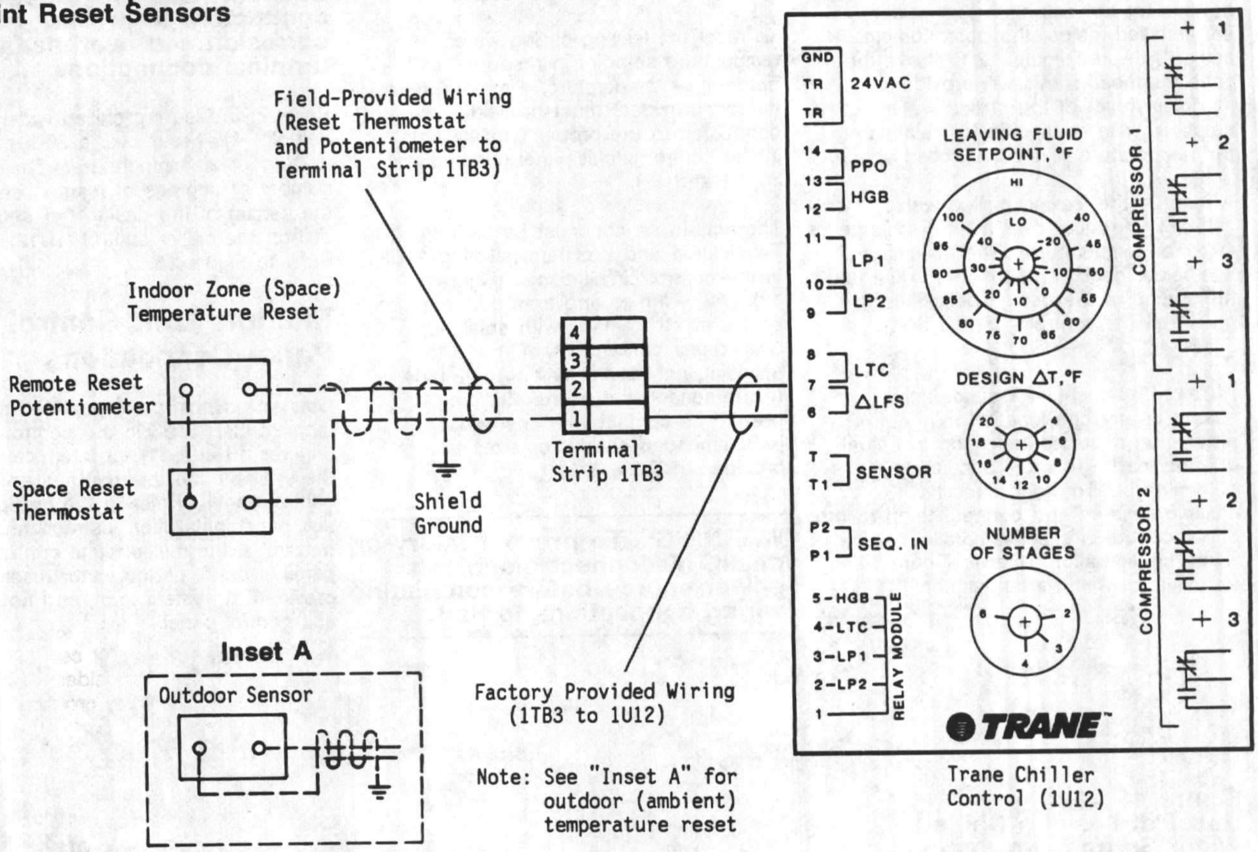
To reset unit leaving chilled water setpoint based on indoor zone temperature, a remote setpoint potentiometer and a space sensor (both factory-provided) must be field-connected to the proper terminal strip in the control circuit panel (Figures 10, 11 and 12).

The potentiometer and indoor zone sensor are connected in series to Terminals 1 and 2 of terminal strip 1TB3 in the control circuit panel. Refer to Figure 12. All wiring to and from these remote input devices to the unit control panel must be made with shielded, twisted-pair conductors; be sure to ground the shielding at the unit. See Table 3 for recommended conductor sizes.

WARNING: To prevent injury or death, disconnect electrical power source before completing wiring connections to unit.

Caution: Use only copper conductors to prevent galvanic corrosion and overheating at terminal connections.

Figure 12
Installation of Optional Setpoint Reset Sensors



Trane Chiller Control (1U12)

Table 3
Recommended Wire Sizes for Installation of Optional Setpoint Reset

Wire Gauge	Maximum Distance from Sensor to Unit	Maximum Total Wire Length
22 Awg	30 Feet	60 Feet
20 Awg	50 Feet	100 Feet
18 Awg	75 Feet	150 Feet
16 Awg	125 Feet	250 Feet
14 Awg	200 Feet	400 Feet

Once the indoor zone temperature input devices for the setpoint reset option are installed, adjust the potentiometer setting to approximately 2 F above the zone thermostat; this will provide maximum reset of the chilled water setpoint while continuing to maintain the temperature of the controlled space.

A reset in the leaving chilled water setpoint will occur over a 4.5 F change in space temperature. The maximum number of degrees of reset is equal to the setting of the design delta-T knob on the chiller control (1U12). See Figure 13.

Note: Placement of a single zone sensor in any one location may not provide an accurate indication of actual building load. To more accurately determine building load, install multiple sensors and connect them to the chiller control in a series-parallel wiring configuration; refer to Figure 14 for a typical wiring arrangement.

Outdoor Air Temperature

To reset the leaving chilled water temperature setpoint in response to the outdoor air temperature, a remote sensor (factory-provided) must be field connected to the proper terminal strip in the control circuit panel (Figures 10, 11 and 12).

The remote sensor must be connected to Terminals 1 and 2 of terminal strip 1TB3 in the control circuit panel. (Figure 12). All wiring to and from this input device must be made with shielded, twisted-pair conductors. Ground the shielding only at the unit. Apply tape to the sensor end of the shielding to prevent its contact with any surface. Recommended conductor sizes are provided in Table 3.

WARNING: To prevent injury or death, disconnect electrical power source before completing wiring connections to unit.

Caution: Use only copper conductors to prevent galvanic corrosion and overheating at terminal connections.

Reset in the leaving chilled water setpoint will occur over a 30 F change in outdoor air temperature. The maximum number of degrees of reset is equal to the setting of the design Δ T setpoint dial on the chiller control (1U12). Refer to Figure 13.

Multiple Unit Control Panel Connections

Connection points are provided at terminal strip 1TB3 in the control panel (Figures 10 and 11) for interface with the available multiple unit system control panel. Refer to the multiple unit panel installation instructions for details. If the multiple unit control panel is used, chilled water reset is provided at system level, and not at the unit control panel.

Figure 13
Reset of Leaving Chilled Water Setpoint vs. Input Resistance

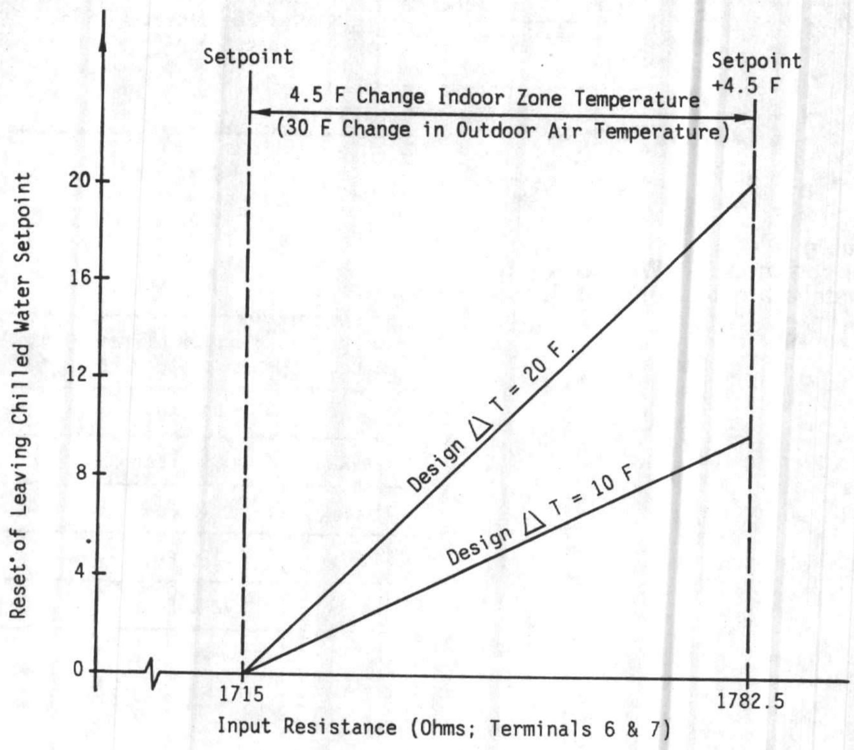
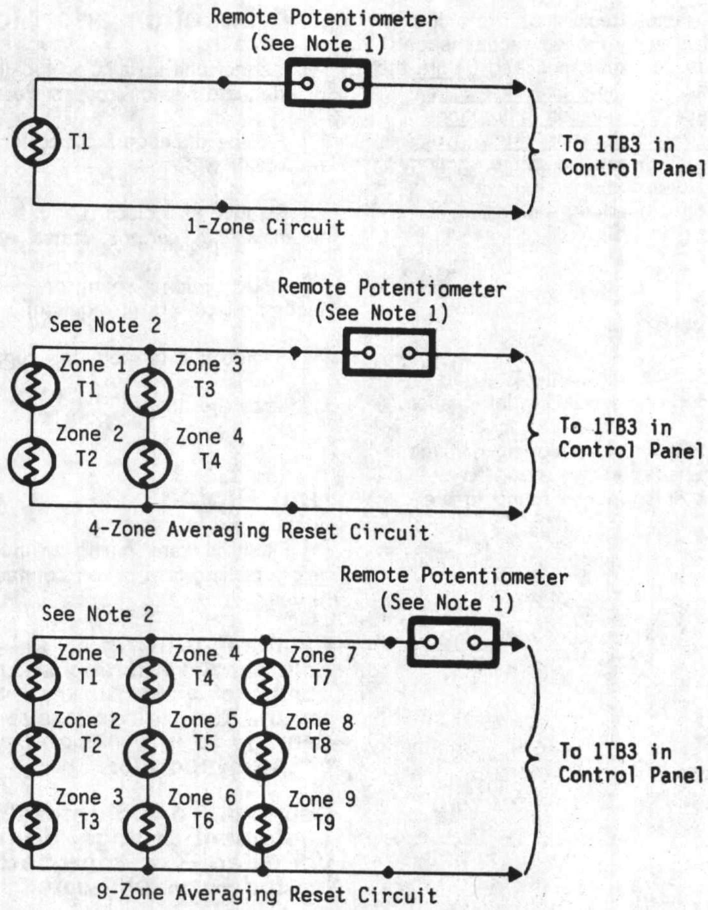


Figure 14
Setpoint Reset from Single or Multiple Indoor Zone Sensors



Notes:

1. Remote setpoint potentiometer required to permit adjustment of reset control point. (Use only with indoor zone sensors; do not use with outdoor air sensors.)
2. All thermostats wired in series-parallel configuration.

Installation Checklist

Complete this checklist as the unit is installed to verify that all recommended procedures are accomplished before the unit is started. This checklist does not replace the detailed instructions given in the "Installation" section of this manual! Read the entire section carefully to become familiar with installation procedures before installing the unit.

Receiving

[ ] Verify that unit nameplate data corresponds with ordering information.

[ ] Inspect unit for shipping damage and material shortage; report any damages or shortages found to the carrier.

Unit Location and Mounting

[ ] Inspect unit installation location for adequate service access clearances.

[ ] Provide drainage facilities for evaporator water.

[ ] Remove and discard any shipping materials (e.g., cartons, crates, etc.).

[ ] Install optional spring or neoprene isolators (if required).

[ ] Secure unit to mounting surface.

[ ] Level the unit.

Unit Piping

[ ] Flush all water piping to unit before making final piping connections to unit.

Caution: If using an acidic commercial flushing solution, construct a temporary bypass around the unit to prevent damage to internal components of the evaporator.

Caution: To avoid possible equipment damage, do not use untreated -- or improperly treated -- system water.

[ ] Make evaporator water connections.

[ ] Vent chilled water system at high points in system piping.

[ ] Install pressure gauges with shutoff valves, thermometers and shutoff valves on water inlet and outlet piping.

[ ] Install water strainer in evaporator supply line.

[ ] Install balancing valve and flow switch on water outlet piping.

[ ] Install evaporator drain plug, or install drain piping with shutoff valves.

[ ] Apply heat tape and insulation as necessary to protect all exposed piping from freeze-up.

Electrical Wiring

WARNING: To prevent injury or death, disconnect electrical power source before making final connections to unit.

Caution: Use only copper conductors for terminal connections to avoid corrosion or overheating.

Power Supply Wiring

[ ] Connect unit (compressor) power supply wiring with fused disconnect to terminal block (or unit-mounted disconnect) in control panel.

[ ] On units without optional control power transfomer, connect control power supply wiring with fused disconnect to terminal strip in control panel.

[ ] Connect power supply wiring for chilled water (evaporator) pump.

[ ] Connect power supply wiring with fused disconnect for factory evaporator heat tape.

[ ] Connect power supply wiring with fused disconnect, to any auxiliary heat tape installed on system water piping.

Interconnection Wiring

[ ] Install wiring to connect remote pushbutton station to chilled water (evaporator) pump motor starter.

[ ] Connect auxiliary contacts of chilled water pump starter to flow switch and unit control panel.

[ ] Install wiring to connect flow switch to unit control panel.

[ ] If unit is equipped with optional setpoint reset, install wiring between remote sensor (and potentiometer, if applicable) and the unit.

Pre-Start Procedures

Pre-Start Checklist

After the unit is installed, complete each step in the checklist that follows and check off each step as completed. When all are accomplished, the unit is ready to run.

[ ] Inspect all wiring connections. Connections should be clean and tight.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

Caution: To prevent over-heating at connections and undervoltage conditions at the compressor motor, check tightness of all connections in the compressor power circuit.

[ ] Check compressor crankcase oil levels. Oil level with the compressor not running should be at the one-half to three-quarters point on the oil level sight glass. Refer to "Checking Operating Conditions" in the "Start-Up Procedure" section.

[ ] Open (backseat) the liquid line service valves and the compressor suction and discharge service valves (Figures 15 and 16).

Caution: To prevent compressor damage, be certain that all refrigerant valves are open before starting the unit.

[ ] Check voltage to the unit at the line power fused disconnect. Voltage must be within the voltage utilization range given in "Service Data" (also stamped on the unit nameplate). Voltage imbalance must not exceed 2 percent. Refer to "Unit Voltage".

WARNING: To prevent injury or death due to contact with rotating parts, open and lock all electrical disconnects.

[ ] Check condenser fans. Fan blades should rotate freely in fan orifices and should be mounted securely on the motor shafts.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

[ ] Check the sensing bulb in the bulbwell on the evaporator leaving water outlet (Figure 17). It must be installed securely in the bulbwell with heat transfer compound.

[ ] Energize the compressor crankcase heaters by closing the line power fused disconnect. The unit-mounted disconnect if used, must also be closed. The compressor service switches, on the operating panel should be in the Stand By position. The unit service switch should be in the Pump Down Or Reset position.

Caution: To prevent compressor damage, energize compressor crankcase heaters a minimum of eight hours before operating the unit.

[ ] Fill the chilled water system. Refer to "Service Data" for evaporator liquid capacities. Vent the system while filling it and remove the pipe plug from the vent located on the top of the evaporator (Figure 18). Replace the vent plug when the evaporator is filled.

Caution: To avoid possible equipment damage, do not use untreated -- or improperly treated -- system water.

[ ] Close the fused disconnect for the chilled water pump starter.

[ ] Start the chilled water pump by turning the chilled water pump On/Off switch at the pump remote pushbutton station to On. With water circulating through the chilled water system, inspect all piping connections for leakage. Make any necessary repairs.

[ ] With water circulating through the system, adjust water flow and check evaporator water pressure drop. Refer to "Water System".

[ ] Adjust the flow switch on the evaporator outlet piping for proper operation.

[ ] Stop the chilled water pump.

[ ] Open all fused disconnects.

Unit Voltage

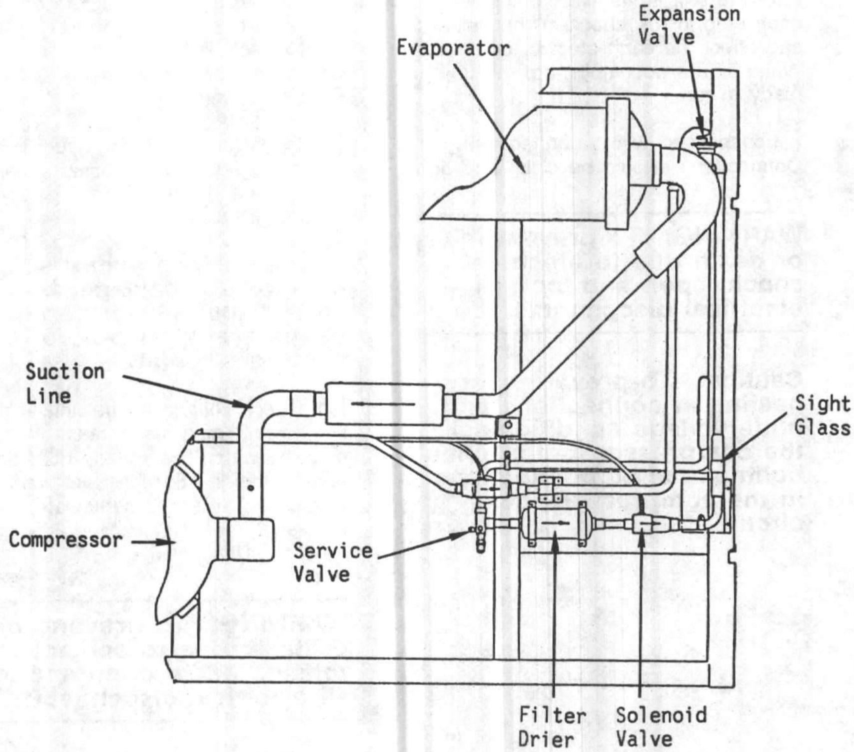
Electrical power to the unit must meet stringent requirements for the unit to operate properly. Total voltage supply and voltage imbalance between phases must be within the following tolerances.

Voltage Supply

Measure each leg of supply voltage at the line voltage disconnect switch. Readings must fall within voltage utilization range shown on the unit nameplate. If voltage of any leg does not fall within tolerance, notify the power company to correct this situation before operating the unit. Inadequate voltage to the unit will cause control components to malfunction and shorten the life of relay contacts and compressor motors.

Figure 15
Typical Liquid Line Component Locations

CGAC-C30K



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CGAC-C60K

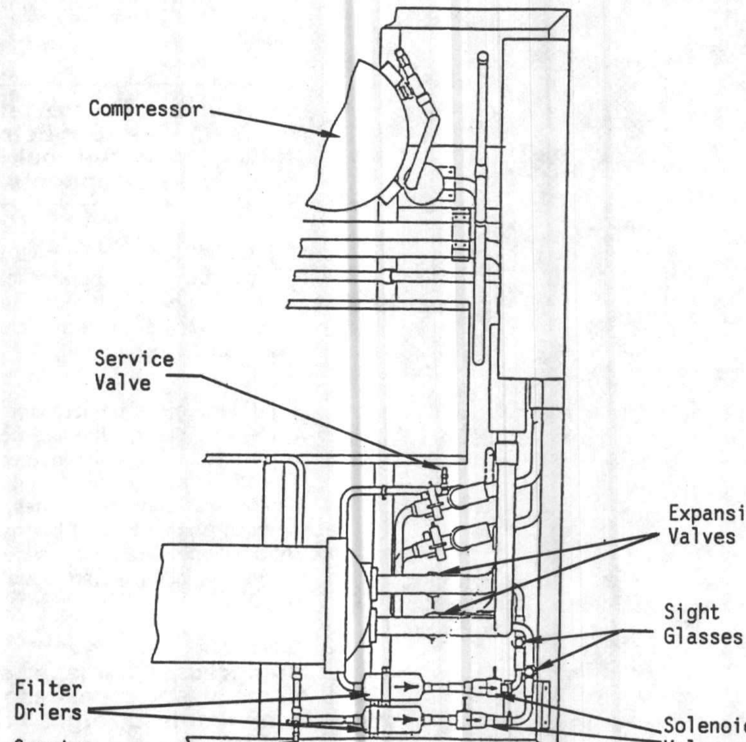

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Figure 16
Typical Compressor Service Valve and Locations (CGAC-C60K Shown)

Compressor Side View

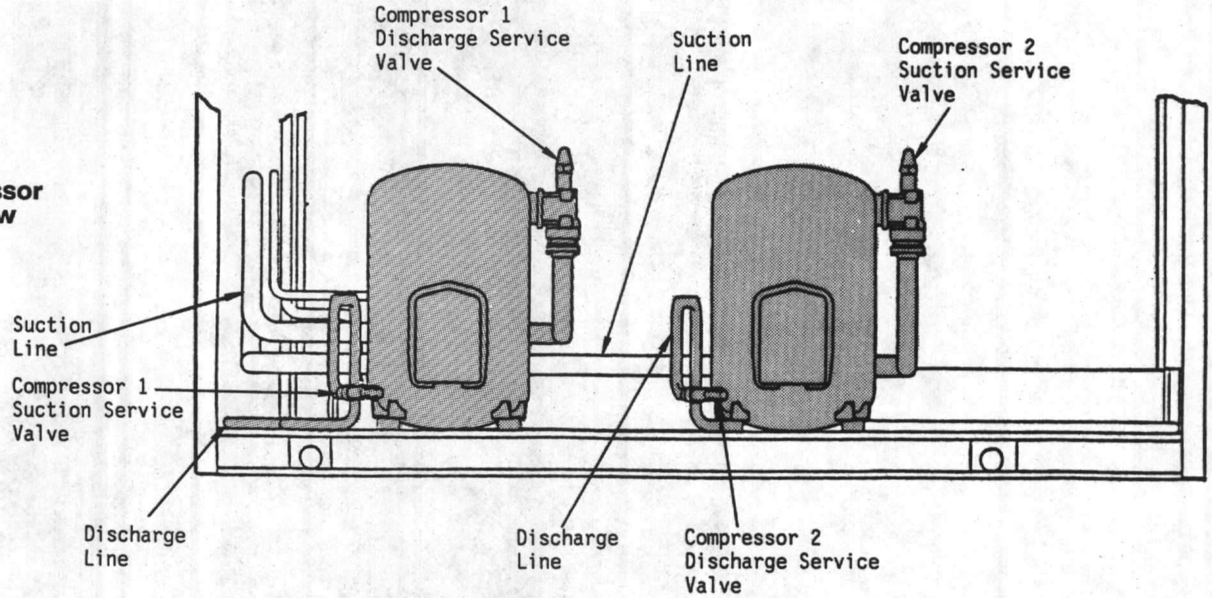

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Figure 17
Chiller Control (1U12) Sensing Bulb Location on Evaporator Water Outlet

Evaporator Side View of Unit

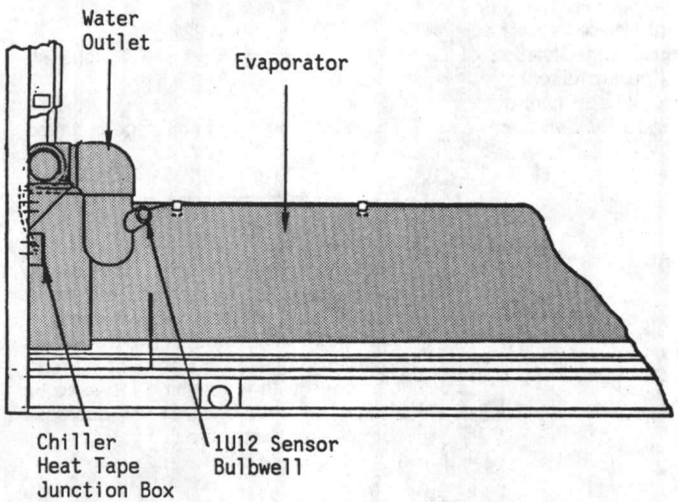

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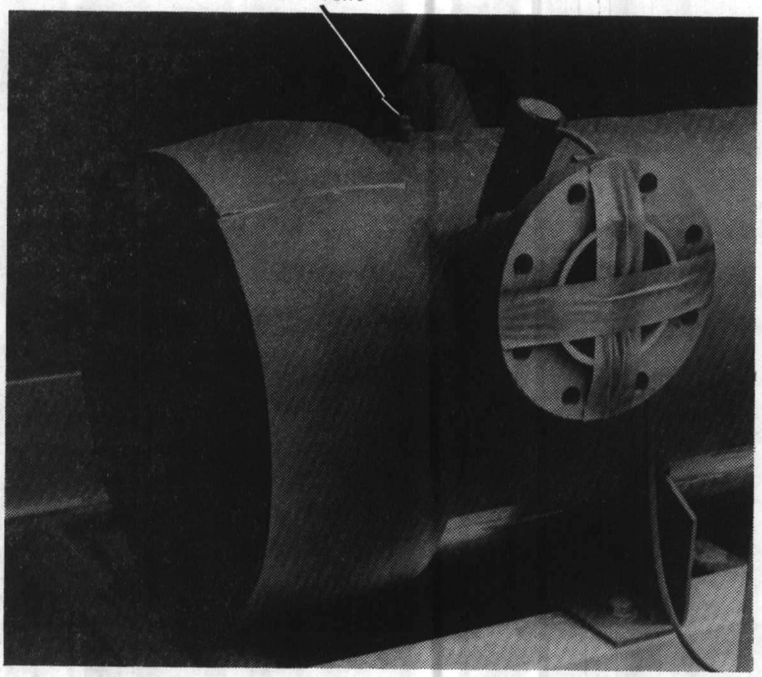
Figure 18
Air Vent Location on Typical Evaporator Shell



Voltage Imbalance

Excessive voltage imbalance between phases in a three-phase system will cause motors to overheat and eventually fail. Maximum allowable imbalance is 2 percent. Voltage imbalance is defined as 100 times the maximum deviation of the three voltages (three phases) subtracted from the average (without regard to sign), divided by the average voltage.

Example:

If the three voltages measured at the line voltage fused disconnect are 221 volts, 230 volts and 227 volts, the average would be:

$$\frac{221 + 230 + 227}{3} = 226 \text{ volts.}$$

The percentage of imbalance is then:

$$\frac{100(226 - 221)}{226} = 2.2\%.$$

The 2.2 percent imbalance that exists in the example above exceeds maximum allowable imbalance by 0.2 percent. This much imbalance between phases can equal as much as 20 percent current imbalance with a resulting increase in winding temperature that will decrease compressor motor life.

Water System

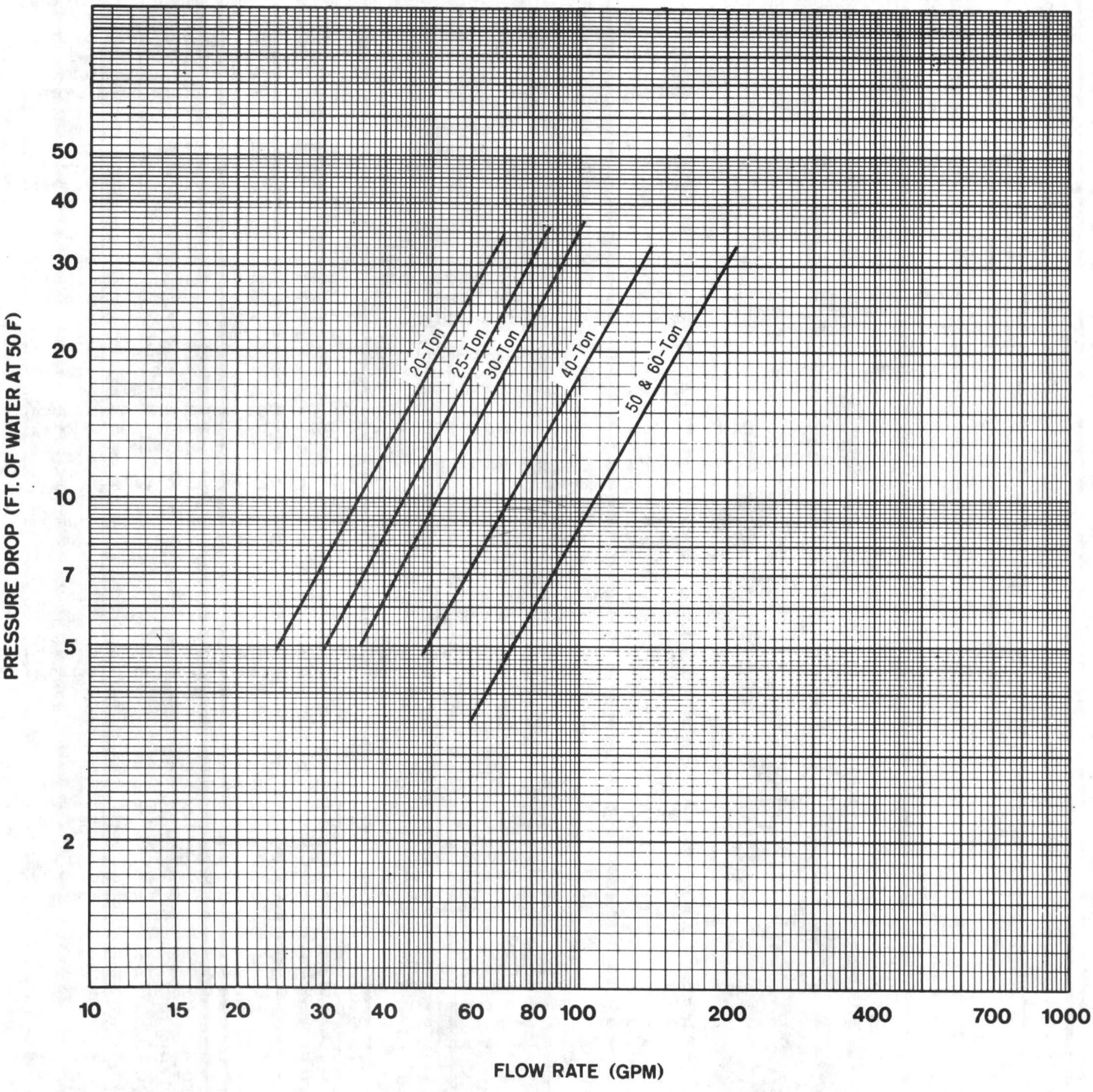
Water Flow Rates

Establish balanced water flow through the evaporator. Flow rates should fall between the minimum and maximum values given in "Service Data". Flow rates below minimum values will result in laminar flow, reducing heat transfer and causing either loss of TEV control or repeated nuisance low pressure cutouts. Excessively high water flow can cause damage to the tube supports and baffles in the evaporator.

Pressure Drop Measurement

Measure evaporator water pressure drop at the pressure gauge(s) on the system water piping. Pressure drop readings should approximate those shown by the pressure drop chart in Figure 19.

Figure 19
Evaporator Water Pressure Drop Chart for CGAC-C20K thru C60K Units



Refer to "Model Number Description" to determine evaporator designation for any unit.

Start-Up Procedure

Start-Up Checklist

To start the unit, complete each step of this checklist, in sequence. Check off each step as completed. Do not start the unit until all "Pre-Start Procedures" are complete. Typical unit operating controls are illustrated in Figures 24 and 25 on pages _ and _.

[ ] Turn the unit service switch on the operating panel to Pump Down Or Reset.

[ ] Turn the compressor service switches to the Operate position.

[ ] Adjust chiller control setpoints (1U12) for normal system operation. Refer to "Chiller Control Setup".

[ ] Close the evaporator water pump fused disconnect. Energize the pump by turning the pump On/Off switch at the remote pushbutton station to On. The chilled water (evaporator) circulating pump will run.

[ ] Check liquid line service valves and compressor suction and discharge service valves (Figures 15 and 16). These valves must be open (backseated) before starting the compressors.

Caution: To prevent compressor damage, be certain that all refrigerant valves are open before starting the unit.

[ ] Energize the compressor crankcase heaters if they aren't already energized by closing the line voltage disconnect. Also close the unit-mounted disconnect, if used.

Caution: To prevent compressor damage, energize compressor crankcase heaters a minimum of eight hours before operating the unit.

[ ] Energize evaporator heat tape by closing the fused disconnect switch provided by the installer.

[ ] Turn the unit service switch to On. If the chiller control calls for cooling and all safety interlocks are closed, the unit will start. The compressors load and unload in response to chilled water temperature leaving the evaporator as sensed by the sensing bulb on the evaporator water outlet.

Ambient temperature should be above the recommended minimum start-up temperatures given in "Service Data". Use the minimum start-up temperatures to establish proper setpoints for the customer-provided low ambient lockout thermostat, if used. Refer to the field wiring diagrams in Figures 10 and 11.

Checking Operating Conditions

Once the unit has been operating for about 30 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

[ ] Recheck evaporator water flow and pressure drop. These readings should be stable at proper levels. If pressure differential drops off, clean all evaporator water supply strainers.

[ ] Check suction pressure, discharge pressure and oil pressure at the gauges on the unit (Figure 20). If the unit is not equipped with gauges, install them on the gauge valves provided on the unit if so equipped. Use a refrigerant-tight thread seal such as teflon tape.

To read pressures, remove the cap from the shut-off valve and open (backseat) the valve (Figure 21). Read the operating pressure. Close (frontseat) the valve to isolate it from the system. Replace and retighten the cap.

Caution: To minimize gauge wear, close shut-off valves to isolate the gauges when pressure readings have been taken.

Note: If the unit is not equipped with pressure gauges, take operating pressures using a manifold gauge set at these points:

Discharge pressures - take at compressor discharge service valve backseat port (Figure 20). Normal discharge pressure is 250 to 360 psig. Refer to "Service Data" for more specific information.

Suction pressures - take at compressor suction service valve backseat port (Figure 20). Normal suction pressure is 55 to 70 psig. Refer to "Service Data" for more specific information.

[ ] Check compressor oil levels. At full load, oil level should be visible about one-half of the way up on the oil level sight glass on the compressor (Figure 22). If it is not, add or remove oil as required. Refer to "Service Data" for correct oil charges and recommended oils for these units.

[ ] Check and record compressor amperage draw. Compare the readings with the compressor electrical data provided in "Service Data" and on the unit nameplate.

[ ] Check the liquid line sight glasses (Figure 15). Refrigerant flow past the sight glasses should be clear. Bubbles in the liquid line indicate either low refrigerant charge or excessive pressure drop in the liquid line. Such a restriction can often be identified by a noticeable temperature differential on either side of the restricted area. Frost often forms on the outside of the liquid line at this point also. Refrigerant charges for CGAC units are provided in "Service Data".

Caution: The system may not be properly charged although the sight glass is clear. Also consider superheat, subcooling and operating pressures.

Figure 20
Location of Optional Operating Pressure Gauges (Typical Dual Compressor Unit)

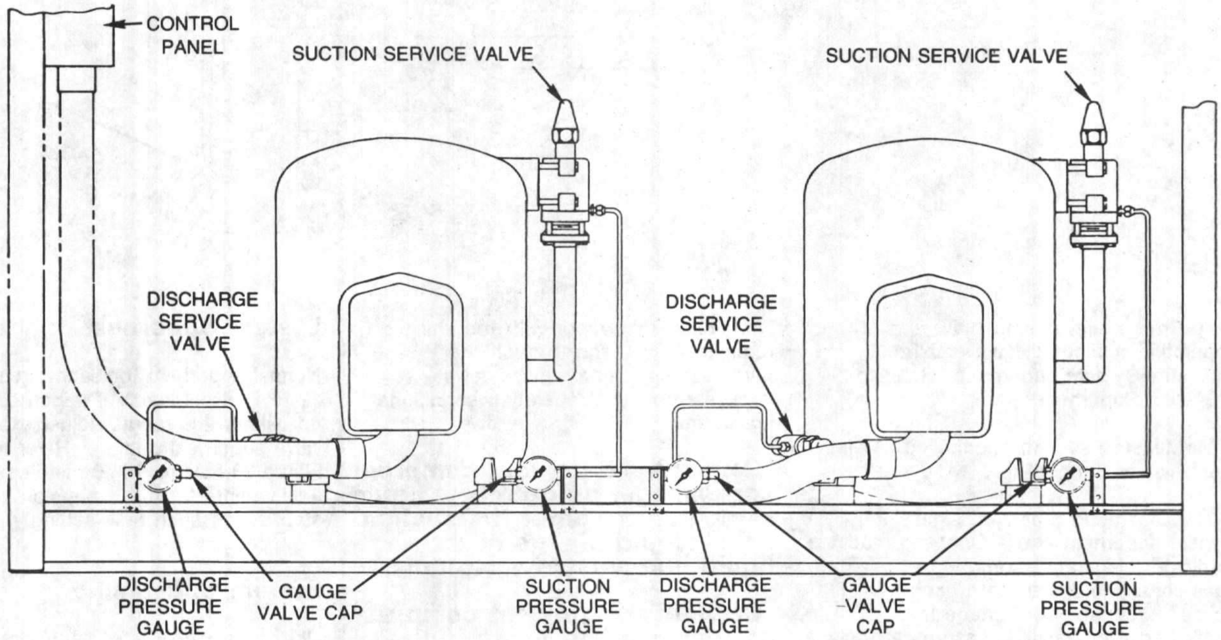


Figure 21
Typical Operating Pressure Gauge

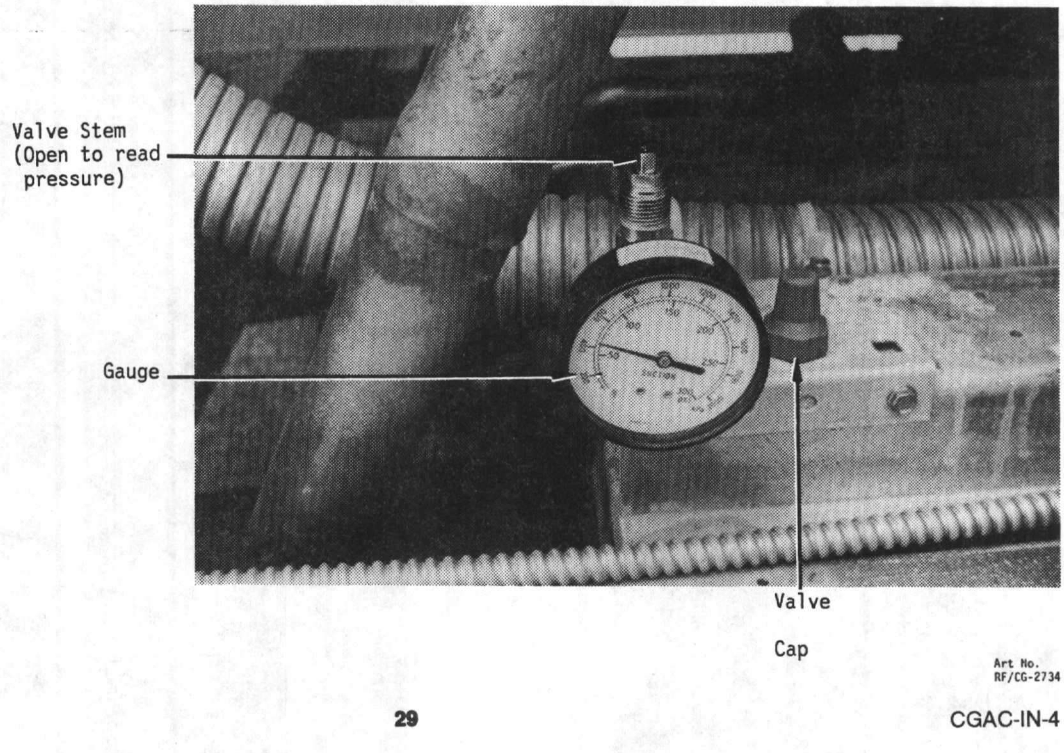
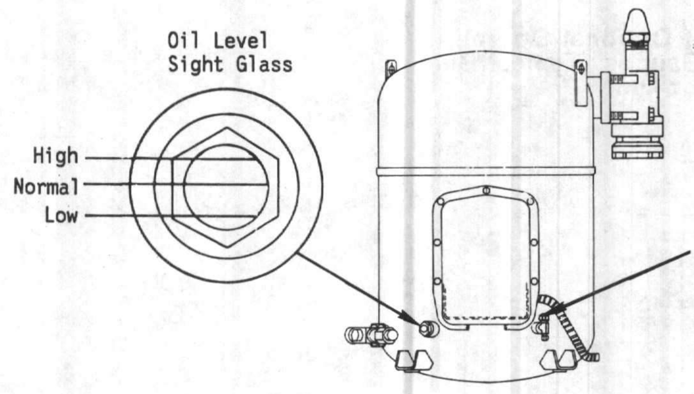


Figure 22
Model K Compressor Oil Level Sight Glass and Oil Charging Valve Locations



[ ] Once oil level, amp draw and operating pressures have stabilized, measure system superheat. Refer to "System Superheat".

[ ] Measure system subcooling. Refer to "System Subcooling".

[ ] If operating pressure, sight glass, superheat and subcooling readings indicate refrigerant shortage, gas-charge refrigerant into each circuit. Refrigerant shortage is indicated if operating pressures are low and subcooling is also low.

Caution: If suction and discharge pressures are low but subcooling is normal, no refrigerant shortage exists. Adding refrigerant, will result in overcharging.

Add refrigerant vapor with the unit running by charging through the compressor suction service valve backseat port until operating conditions are normal.

Caution: To prevent compressor damage, do not allow liquid refrigerant to enter the suction line. Liquid charge at the liquid line service valve only.

Caution: To prevent compressor damage and insure full cooling capacity, use refrigerants specified on the unit nameplate only.

[ ] If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove refrigerant at the liquid line service valve. Do not discharge refrigerant into the atmosphere.

WARNING: To prevent injury due to frostbite, avoid skin contact with refrigerant.

[ ] If the unit is equipped with hot gas bypass, check regulating and solenoid valve for proper operation, Valve operating setpoints are provided in "Service Data".

[ ] If the unit is equipped with low ambient dampers, check for proper actuator and blade travel in relation to condensing pressure. Refer to "Service Data" for damper operating setpoints.

[ ] Once proper unit operation is confirmed, inspect for debris, misplaced tools, etc. Secure all exterior panels in place.

System Superheat

Normal superheat for each circuit is 12-15 F at full load. If superheat is not within this range, adjust expansion valve superheat setting. Refer to Figure 23. Allow 15-30 minutes between adjustments for the expansion valve to stabilize on each new setting.

System Subcooling

Normal subcooling for each circuit is 17 to 20 F at full load. If subcooling for either circuit is not in this range check superheat for the circuit and adjust, if required. If superheat is normal but subcooling is not, contact a qualified service technician.

Control Operation and Setup

Unit Operating Panel

CGAC unit operating switches and fuses are located on the switch panel inside the control panel (Figures 23 and 24).

Operating Switches

Unit Service Switch (1S41). Two-position toggle switch used for unit pumpdown or reset and to stop unit operation. Switch to On position to energize chiller control 1U12. If 1U12 calls for cooling and safety interlocks are complete, the compressor(s) will run. Switch to Pump Down Or Reset position to deenergize 1U12. If unit is operating, compressor(s) will go through pumpdown cycle, then stop.

Note: After turning 1S41 to On, allow a minimum of 4 minutes to elapse before turning the switch back to Pump Down or Reset, to allow the low ambient time delay function of the chiller control to elapse.

If the unit must be shutdown within 3 minutes of either compressor start, stop the compressor by turning the compressor service switch (1S5, 1S6) to Standby. This is necessary because, during this three-minute period, the low ambient delay function of the chiller control is energized (low pressure switches bypassed). Turning the unit off by switching the unit service switch (1S41) to Pump Down or Reset may allow a compressor to operate at excessively low pressure conditions.

Caution: To prevent possible damage to the evaporator or compressor, stop compressor using switch 1S5 or 1S6 if within 3 minutes of compressor start.

Compressor Service Switches (1S5, 1S6). Two-position toggle switches used to deactivate compressor control circuit for compressor service. On dual compressor units, this allows continued operation of the remaining compressor during service procedures. Turn to Operate for normal compressor operation. Turn to Stand-By to deactivate the compressor for service procedures. If the compressor is operating when switched to Stand By, it will not go through a pumpdown cycle.

Fuses

Control Circuit Fuse (1F1). 125V/10A fuse used to protect unit control circuit. Check if unit cuts out for unknown reasons.

Motor Protector Fuses (1F2, 1F3). 125V/6A fuses used to protect compressor control circuits.

Power Supply Fuse (1F10). 24V/3A fuse to protect low voltage control components (microprocessor 1U12, auxiliary relay module 1U13, etc.).

Evaporator Heater (4HR1)

The evaporator shell on all standard 60-cycle CGAC units is insulated from ambient air and protected by factory-installed, thermostatically controlled heat tapes for operation during low ambient conditions. The thermostats close to energize the heat tapes when evaporator shell temperature drops to approximately 37 F.

The installer must provide an independent 115V/60HZ/1PH power source with a fused disconnect switch to the proper terminal strip in the control panel.

Chilled Water (7B1) Pump and Interlocks

The chilled water pump is typically operated by a start/stop pushbutton (7S). If the chilled water pump overload (7K7-OL) is closed, the magnetic starter (7K7) is energized to run the chilled water pump when the pushbutton (7S) is pressed. Once the chilled water pump is running, the auxiliary contacts of the pump starter (7K7-Aux.) provide a holding circuit for the pump magnetic starter. A set of auxiliary contacts installed in series with the flow switch contacts establishes an interlock that keeps the unit from starting when the chilled water pump is not operating.

Figure 23
Unit Operating Panel for Typical CGAC Unit with Single Model K Compressor

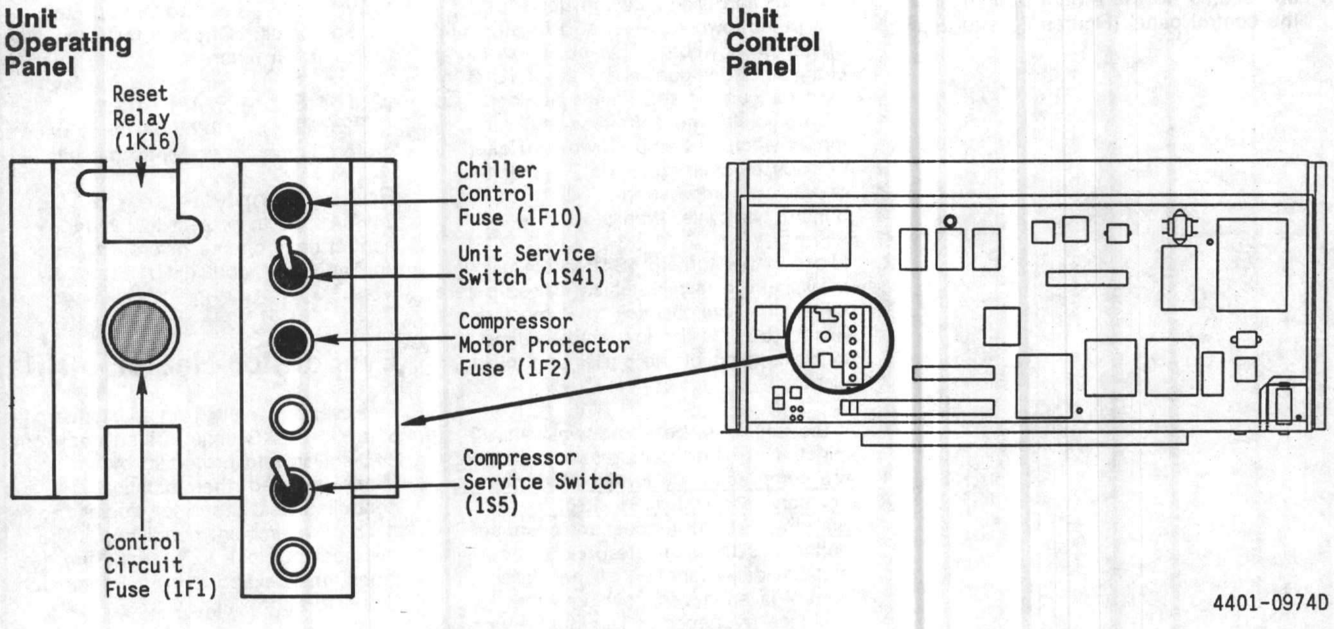
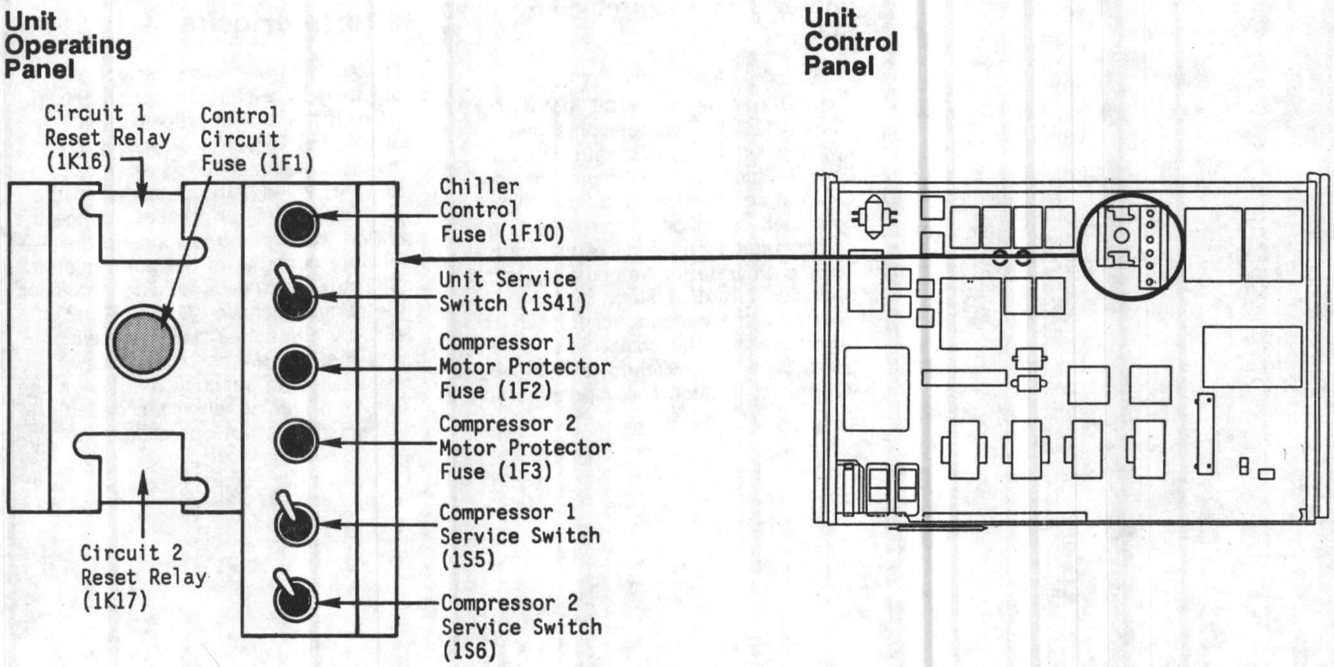


Figure 24
Unit Operating Panel for Typical CGAC Unit with Dual Model K Compressors



Electrical Control System

Controls for CGAC units are classified either as "operational controls" or "unit safety" controls. Figures 25 and 26 identify the locations of all unit control devices.

Refer to "Service Data" for control operating setpoints.

Safety Controls

Safety controls for CGAC units include the high pressure switches, compressor motor overloads and customer-provided flow switch. All, except the flow switch stop unit operation at the setpoints given in "Service Data" and require manual control circuit reset to continue unit operation.

To restart the compressor, correct the malfunction that caused the safety control to cut out and turn the unit service switch (1S41) to Pump Down Or Reset and back again to On. There will be a 4-5 minute time delay before compressor restart.

Caution: To prevent unit damage, do not reset the control circuit until the cause of the safety lockout is identified and corrected.

Operational Controls

Chiller Control and Auxiliary Relay Module (1U12, 1U13)

The solid-state, microprocessor-based chiller control (1U12) and auxiliary relay module (1U13) are used to maintain leaving chilled water temperature within a desired range. Multiple-stage capacity control of each unit is accomplished by loading and unloading each compressor.

The chiller control and auxiliary relay module, located in the control section of the unit control panel (Figures 25, 26 and 27), also provide the special operating and safety features described below:

- Evaporator Freeze Protection
- Compressor Anti-Recycle Protection
- Load Limiting
- Automatic Compressor Lead/Lag Sequencing
- Low Ambient Time Delay and Loss-of-Charge Protection
- Timed Periodic Pumpout (Optional)
- Timed Hot Gas Bypass (Optional)
- Setpoint Reset (Optional)

Refer to the unit operation and maintenance literature for a more detailed description of these features.

Chiller Control Setup

There are three setpoint adjustment dials on the face of the chiller control (Figure 27). They are: Leaving Fluid Setpoint, F; Design Δ T, F; and Number of Stages.

The number of stages setpoint is factory-set at the number of capacity control steps provided on the unit. It is not necessary to change this setting for normal unit operation.

The design Δ T setpoint and the leaving fluid setpoint are factory-set at ARI rating conditions. It may be necessary to reset either or both of these setpoints to satisfy job requirements.

Set the design Δ T setpoint (Figure 28) at the desired chilled water temperature drop through the evaporator. This setpoint is adjustable from 4 F to 20 F in two-degree F increments.

The leaving fluid setpoint dial (Figure 27) has two calibration scales. The inside scale is used for low temperature applications. The range of this scale is minus 20 F to plus 40 F in five-degree F increments. The outer scale is used in all normal comfort cooling applications where there is no requirement for glycol or an unusually low leaving chilled water temperature. The range of this scale is plus 40 F to plus 100 F in five-degree F increments. Set this dial for the desired leaving chilled water temperature at the evaporator water outlet.

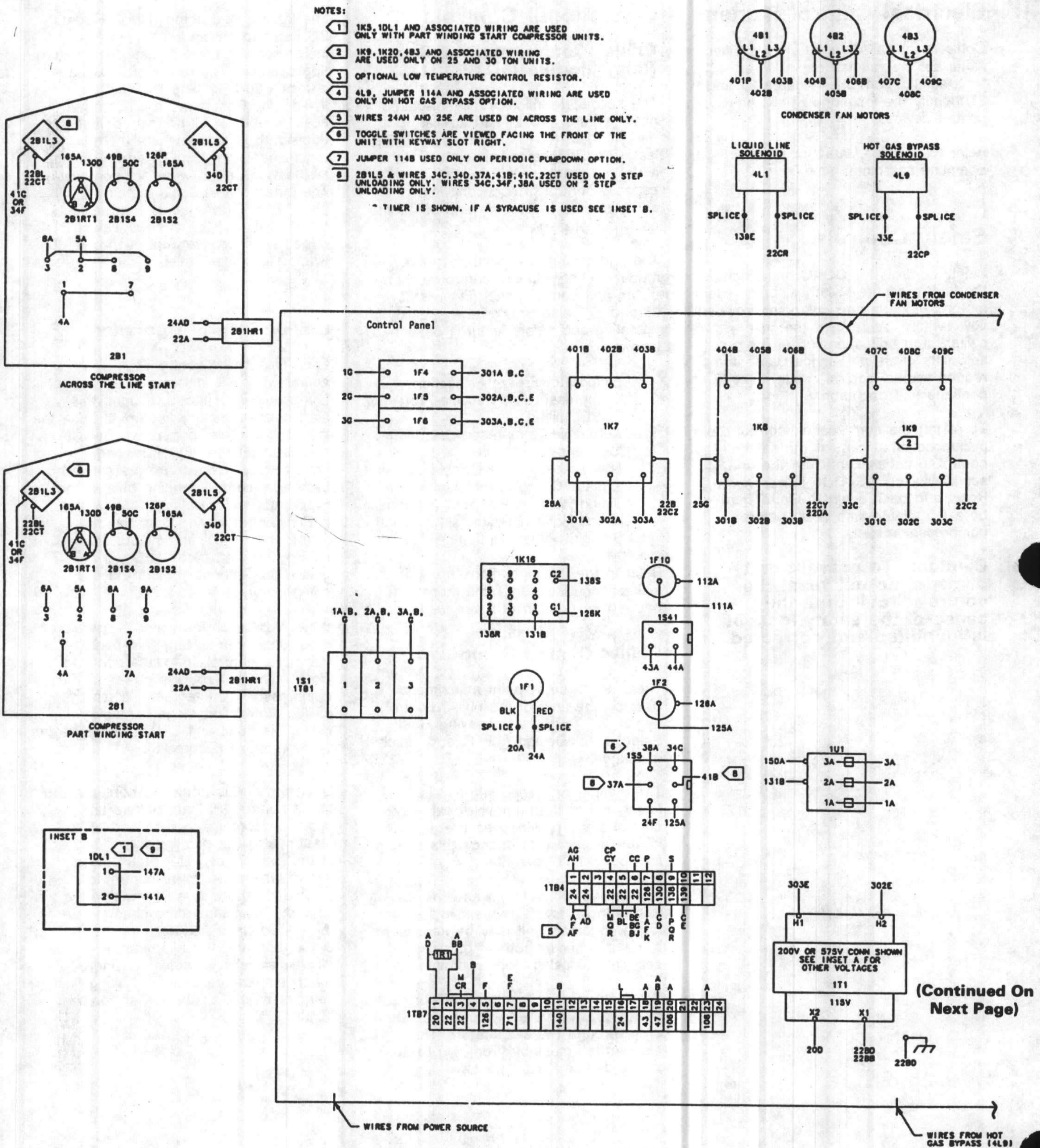
Chiller Control Operation

Each time chiller control (1U12) is energized, it will initiate a four-minute start mode. During this start delay, the "start mode" LED on the face of the chiller control will be energized (Figure 28). If leaving chilled water temperature (as sensed by the chiller control sensing bulb in the evaporator water outlet) is below the chiller control leaving fluid setpoint at the end of this four-minute timing period, the start mode LED will deenergize without starting the compressor.

When leaving chilled water temperature rises above the leaving fluid setpoint, the chiller control first-stage contacts close. This will provide power to the compressor 1 contactors. When the chiller control first stage contacts close, the number 1 LED for Compressor 1 will energize (Figure 28).

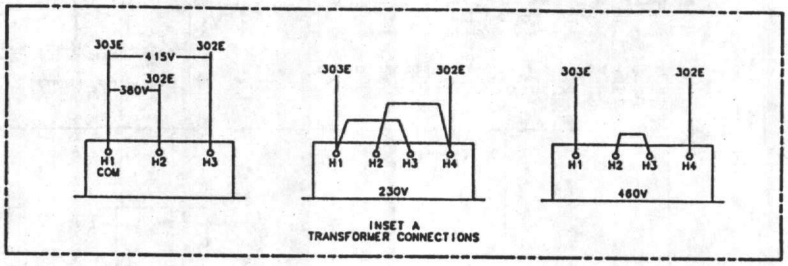
Once the unit is operating normally, the chiller control will load, unload and cycle the compressors on and off in response to the perceived cooling load at the evaporator water outlet. The rate at which the chiller control loads or unloads the unit is determined by two factors: the temperature change rate of the chilled water leaving the evaporator, and the temperature differential between actual leaving water temperature and the leaving fluid setpoint as set on the chiller control (Figure 27).

Figure 25
Typical Component Locations for CGAC-C20K, C25K and C30K Units



(Continued On Next Page)

Component Legend (Outside Control Panel)	
2B1	Compressor 1
2B1HR1	Compressor 1 Crankcase Heater
2B1L3/2B1L5	Compressor 1 Unloader Solenoids
2B1RT1	Compressor 1 Winding Sensor
2B1S2	Ckt 1 High Pressure Switch
2B1S4	Ckt 1 Low Pressure Switch
4B1	Fan Motor 1 - Circuit 1
4B2	Fan Motor 2 - Circuit 1
4B3	Fan Motor 3 - Circuit 1
4L1	Ckt 1 Liquid Line Solenoid Valve
4L9	Ckt 1 Hot Gas Bypass Solenoid Valve
4RT1	Leaving Chilled Water Sensing Bulb



WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

Control Panel Legend	
1DL1	Compressor 1 PWS Time Delay
1DL7	Thermal Time Delay
1F1	Control Circuit Fuse
1F2	Compressor 1 Mtr Protector Fuse
1F4,5,6	Fuse, Condenser Fan Motor 4B1,2,3
1F10	24V Power Supply Fuse
1K3	Compressor 1 Contactor
1K5	Compressor 1 PWS Contactor
1K7	Fan Motor 4B1 Contactor
1K8	Fan Motor 4B2 Contactor
1K9	Fan Motor 4B3 Contactor
1K16	Ckt 1 Reset Relay
1K18	Ckt 1 Cooling Relay
1K20	Circuit 1 Fan Relay
1K45	Pump Down Relay
1R1	Transient Suppressor
1R2	Low Temperature Resistor
1S1	Unit-Mounted Disconnect Switch
1S5	Compressor 1 Service Switch
1S41	Unit Service Switch
1S42	Ckt 1 Fan Temperature Control
1T1	Control Power (115V) Transformer
1T15	24V Transformer
1TB1	Line Power Terminal Block
1TB3	Term. Strip: MUAA & Setpt. Reset
1TB4	Terminal Strip
1TB5	Terminal Strip
1TB7	Term. Strip: System Interconn.
1U1	Compressor 1 Current Overload
1U12	Microprocessor Chiller Control
1U13	Auxiliary Relay Module
GND	Equipment Ground Connections

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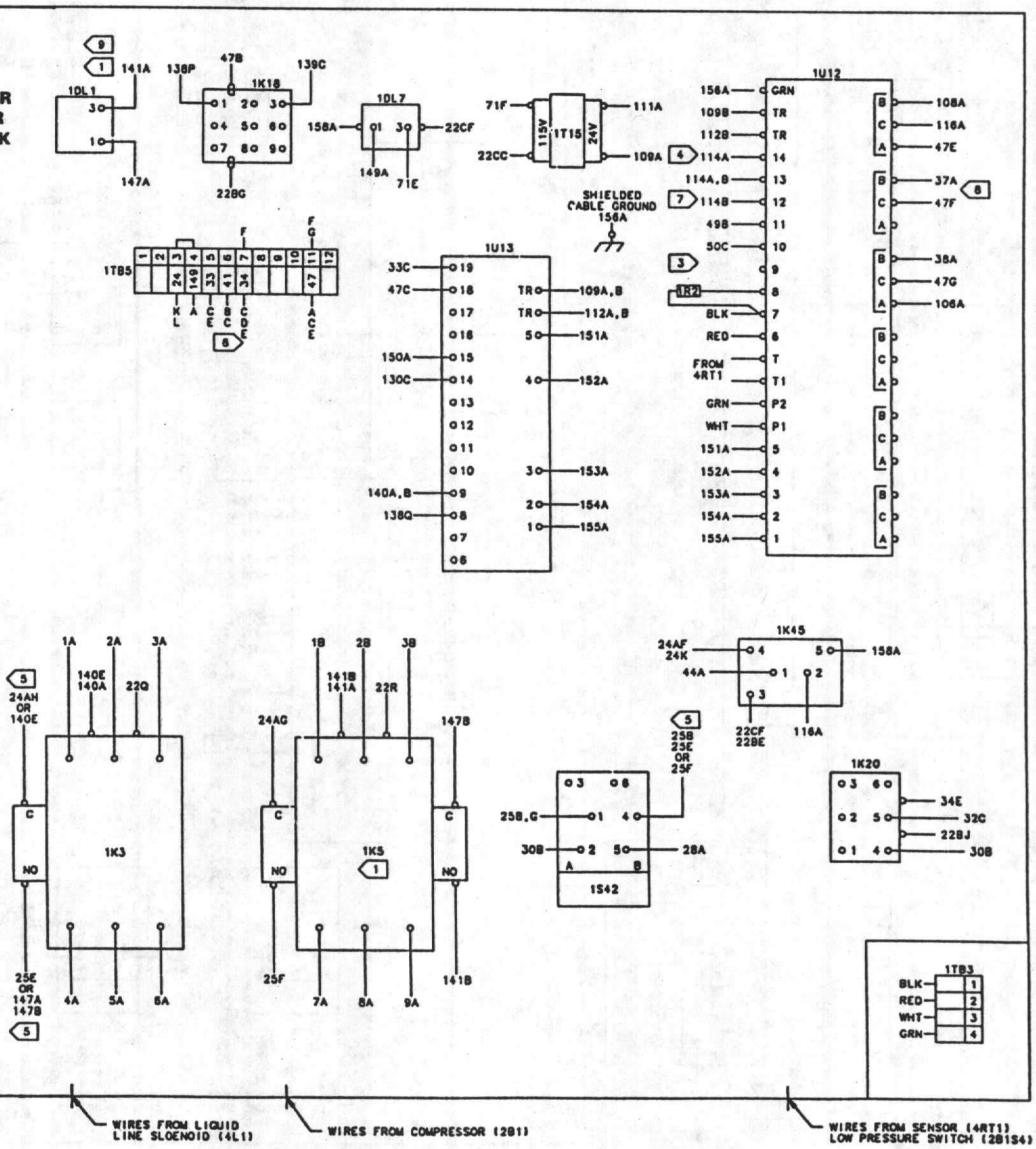
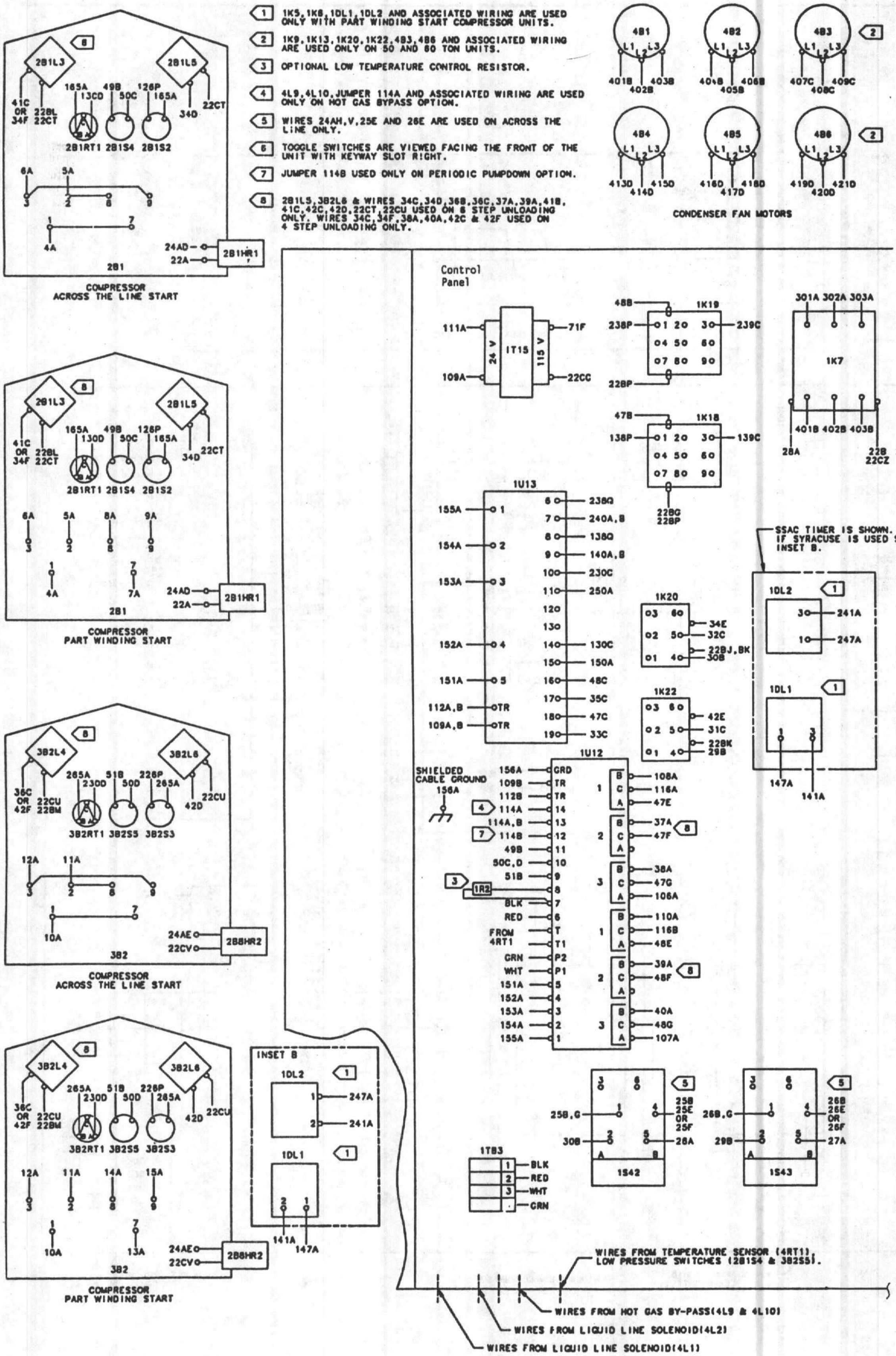


Figure 26
Typical Component Locations for CGAC-C40K, C50K and C60K Units

NOTES:

1. 1K5, 1K6, 1DL1, 1DL2 AND ASSOCIATED WIRING ARE USED ONLY WITH PART WINDING START COMPRESSOR UNITS.
2. 1K9, 1K13, 1K20, 1K22, 4B3, 4B6 AND ASSOCIATED WIRING ARE USED ONLY ON 50 AND 60 TON UNITS.
3. OPTIONAL LOW TEMPERATURE CONTROL RESISTOR.
4. 4L9, 4L10, JUMPER 114A AND ASSOCIATED WIRING ARE USED ONLY ON HOT GAS BYPASS OPTION.
5. WIRES 24AH, V, 25E AND 26E ARE USED ON ACROSS THE LINE ONLY.
6. TOGGLE SWITCHES ARE VIEWED FACING THE FRONT OF THE UNIT WITH KEYWAY SLOT RIGHT.
7. JUMPER 114B USED ONLY ON PERIODIC PUMPDOWN OPTION.
8. 2B1L5, 3B2L6 & WIRES 34C, 34D, 36B, 36C, 37A, 39A, 41B, 41C, 42C, 42D, 22CT, 22CU USED ON 6 STEP UNLOADING ONLY. WIRES 34C, 34F, 38A, 40A, 42C & 42F USED ON 4 STEP UNLOADING ONLY.



Component Legend (Outside Control Panel)	
2B1	Compressor 1
2B1HR1	Compressor 1 Crankcase Heater
2B1L3/2B1L5	Compressor 1 Unloader Solenoids
2B1RT1	Compressor 1 Winding Sensor
2B1S2	Compressor 1 High Pressure Switch
2B1S4	Compressor 1 Low Pressure Switch
3B2	Compressor 2
3B2HR2	Compressor 2 Crankcase Heater
3B2L4/3B2L6	Compressor 2 Unloader Solenoids
3B2RT1	Compressor 2 Winding Sensor
3B2S3	Compressor 2 High Pressure Switch
3B2S5	Compressor 2 Low Pressure Switch
4B1	Fan Motor 1 - Circuit 1
4B2	Fan Motor 2 - Circuit 1
4B3	Fan Motor 3 - Circuit 1
4B4	Fan Motor 4 - Circuit 2
4B5	Fan Motor 5 - Circuit 2
4B6	Fan Motor 6 - Circuit 2
4L1	Ckt 1 Liquid Line Solenoid Valve
4L2	Ckt 2 Liquid Line Solenoid Valve
4L9	Ckt 1 Hot Gas Bypass Solenoid Valve
4L10	Ckt 2 Hot Gas Bypass Solenoid Valve
4RT1	Leaving Chilled Water Sensing Bulb

(Continued on next page)

Control Panel Legend	
1DL1	Compressor 1 PWS Time Delay
1DL2	Compressor 2 PWS Time Delay
1DL7	Thermal Time Delay
1F1	Control Circuit Fuse
1F2	Compressor 1 Mtr Protector Fuse
1F3	Compressor 2 Mtr Protector Fuse
1F4,5,6	Fuse, Condenser Fan Motor 4B1,2,3
1F4	Fuse, Condenser Fan Motor 4B1
1F5	Fuse, Condenser Fan Motor 4B2
1F6	Fuse, Condenser Fan Motor 4B3
1F7	Fuse, Condenser Fan Motor 4B1
1F8	Fuse, Condenser Fan Motor 4B2
1F9	Fuse, Condenser Fan Motor 4B3
1F10	24V Power Supply Fuse
1K3	Compressor 1 Contactor
1K4	Compressor 2 Contactor
1K5	Compressor 1 PWS Contactor
1K6	Compressor 2 PWS Contactor
1K7	Fan Motor 4B1 Contactor
1K8	Fan Motor 4B2 Contactor
1K9	Fan Motor 4B3 Contactor
1K11	Fan Motor 4B4 Contactor
1K12	Fan Motor 4B5 Contactor
1K13	Fan Motor 4B6Contactor
1K16	Ckt 1 Reset Relay
1K17	Ckt 2 Reset Relay
1K18	Ckt 1 Cooling Relay
1K19	Ckt 2 Cooling Relay
1K20	Circuit 1 Fan Relay
1K22	Circuit 2 Fan Relay
1K45	Pump Down Relay
1R1	Transient Suppressor
1R2	Low Temperature Resistor
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1S5	Compressor 1 Service Switch
1S6	Compressor 2 Service Switch
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1S42	Ckt 1 Fan Temperature Control
1S43	Ckt 2 Fan Temperature Control
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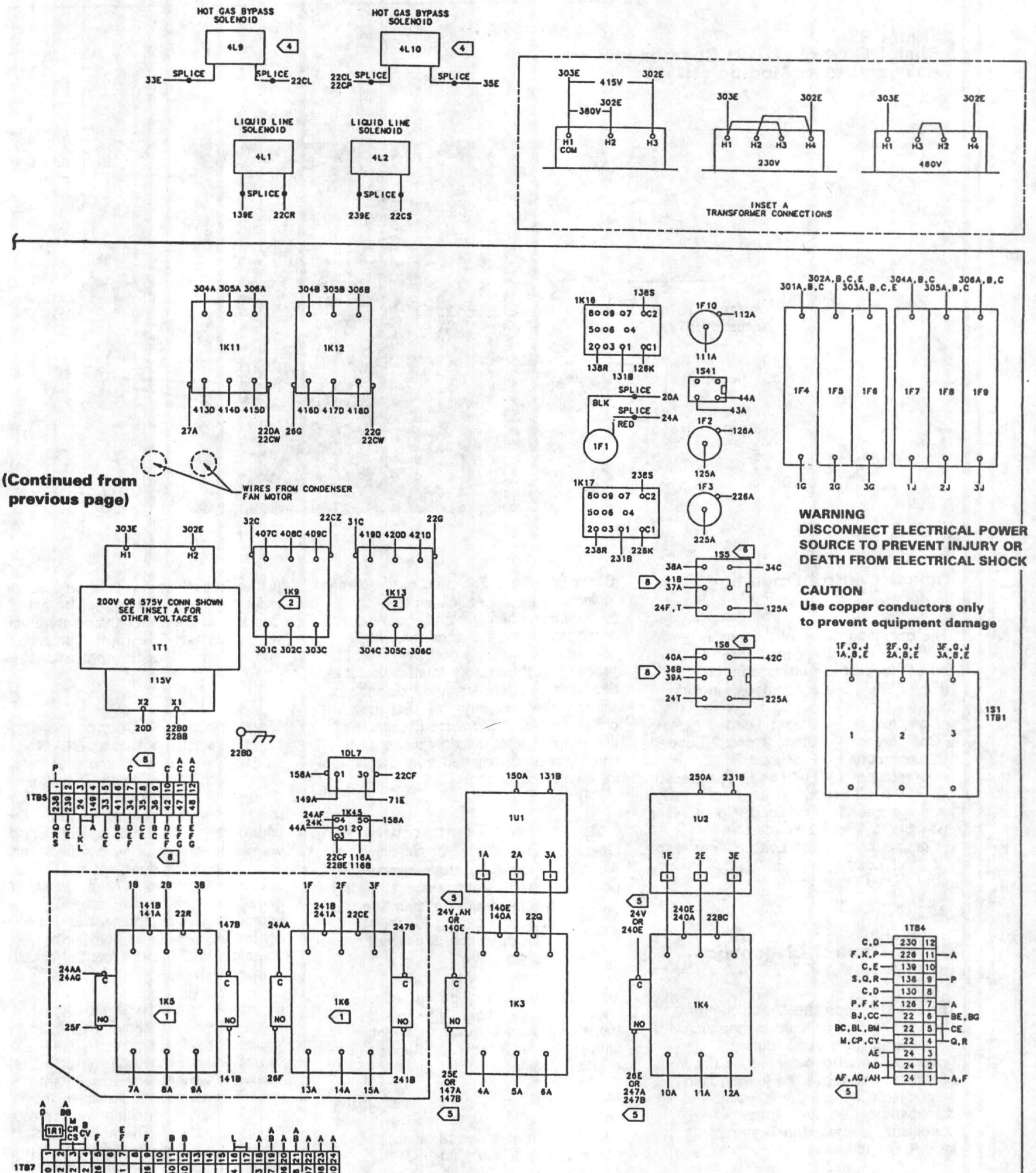
1T15	24V Transformer
1TB1	Line Power Terminal Block
1TB3	Term. Strip: MUAA & Setpt. Reset
1TB4	Terminal Strip
1TB5	Terminal Strip
1TB7	Term. Strip: System Interconn.
1U1	Compressor 1 Current Overload
1U2	Compressor 2 Current Overload
1U12	Microprocessor Chiller Control
1U13	Auxiliary Relay Module
GND	Equipment Ground Connections



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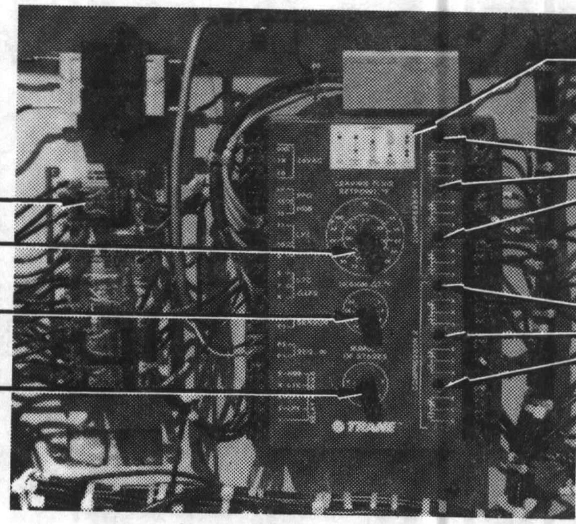
WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

2306-2439B

Figure 27
Chiller Control (1U12) Components and Auxiliary Relay Module (1U13)



Art No. RF/CG-2727

Chiller Control Operating Indicators

The operating mode of the unit is indicated at all times by the red LED's on the face of the chiller control (Figure 28). Operating modes include:

Compressor 1 - Step 1 Loaded
Compressor 1 - Steps 1 and 2 Loaded
Compressor 1 - Full Load
Compressor 1 - Full Load, Compressor 2 - Step 1 Loaded
Compressor 1 - Full Load, Compressor 2 - Steps 1 and 2 Loaded
Compressor 1 - Full Load, Compressor 2 - Full Load
Load Limit Operation.

Chiller Control Diagnostic Indicators

The red LED's on the chiller control also display five different diagnostic states which can occur during operation. A label mounted on the front of the control above the leaving fluid setpoint dial (Figure 27) identifies the diagnostic conditions. These conditions, illustrated in Figure 28, include the following:

Start Mode
Setpoint/Low Temperature Control Overlap
Compressor 1 - Low Pressure Lockout
Compressor 2 - Low Pressure Lockout
Low Temperature Control Lockout.

Start Mode. The start mode diagnostic indicator (Figure 28) will light immediately when the chiller control is energized. This indicates that the control is functioning normally, proceeding through its four-minute start time delay. The start mode diagnostic will also energize any time that the chiller control is repowered when the unit is reset after a safety lockout, or when power is removed from the control for any other reason.

Setpoint/Low Temperature Control Overlap. If this diagnostic energizes (Figure 28), the minimum permitted leaving water temperature is too close to the low water temperature (freezestat) cutout setting for the unit. No unit operation is allowed under these conditions.

To correct this condition and allow normal unit operation, slowly adjust the leaving fluid setpoint to a higher temperature until the control setpoint overlap diagnostic lights go off.

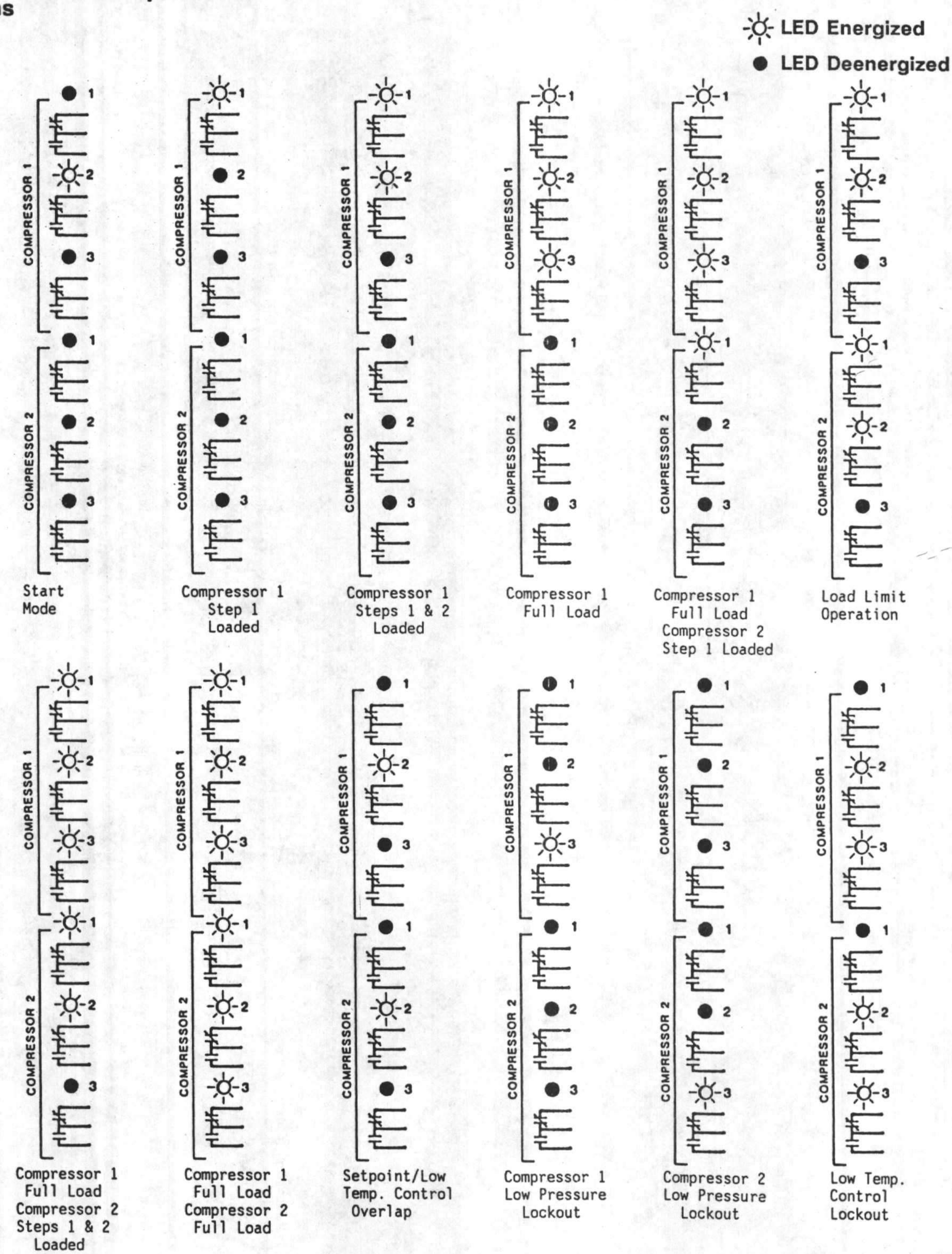
Note: Turn the setpoint dials on the chiller control slowly. Once the setpoints are established, allow the chiller control a minimum of 10-15 seconds to compute the value of the new setpoints and compare this to the low temperature cutout limit.

If the desired leaving fluid setpoint or design ∆ T setpoint cannot be selected due to the low water temperature limit (35 F), contact The Trane Company for information on special applications.

Compressor 1/Compressor 2 Low Pressure Lockout. The diagnostic lights for Compressor 1 or Compressor 2 low pressure lockout (Figure 28) will energize and lock out the compressor if either low pressure control (2B1S4, 3B2S5) opens during normal operation. This condition for one compressor does not affect the operation or loading of the remaining compressor which may continue to operate normally. The compressor and chiller control are prevented from further operation until the unit control circuit is manually reset.

Low Temperature Lockout. The low temperature lockout diagnostic (Figure 28) will energize any time leaving water temperature falls to the low water temperature limit for the unit. This diagnostic indicates that a potential freeze condition was detected during operation. The chiller control is locked out from further operation and the diagnostic will remain energized until the condition is corrected and the unit manually reset.

Figure 28
Chiller Control LED Operational Functions



For further information on this product or other Trane products, refer to the "Trane Service Literature Catalog", ordering number IDX-IOM-1. This catalog contains listings and prices for all service literature sold by Trane. The catalog may be ordered by sending a $20.00 check to: The Trane Company, Service Literature Sales, 3600 Pammel Creek Road, La Crosse, WI 54601.

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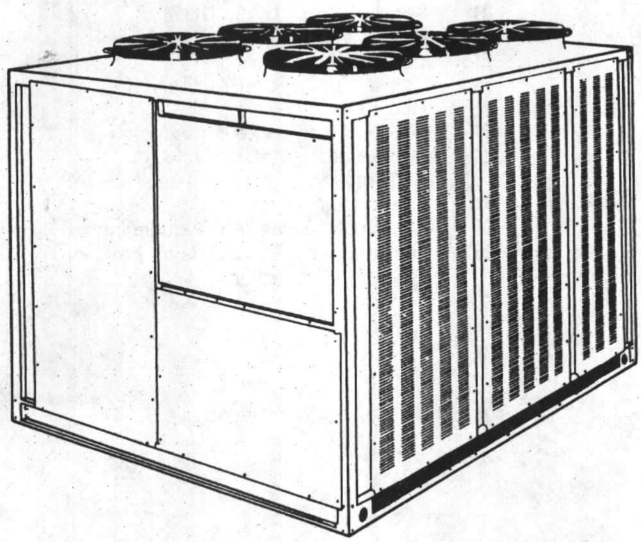
Use with Applicable
"Service Data" Sheets

Operation Maintenance

CGAC-M-4A

Library	Service Literature
Product Section	Refrigeration
Product	Recip. Liquid Chillers - A/C Cold Gen.
Model	CGAC
Literature Type	Operation and Maintenance
Sequence	4A
Date	September 1987
File No.	SV-RF-CG-CGAC-M-4A-987
Supersedes	CGAC-M-4 Dated 187

Model CGAC 20 thru 60 Ton Air-Cooled Cold Generators



Models

CGAC-C20K CGAC-C40K
CGAC-C25K CGAC-C50K
CGAC-C30K CGAC-C60K

Table of Contents

The Trane Company
La Crosse, Wisconsin 54601-7599
Printed in U.S.A.

Model Number Description

All standard Trane products are identified by a multiple-character model number that precisely identifies a particular type of unit. An explanation of the alphanumeric identification codes used for CGAC units is provided on this page. Its use will enable the owner/operator, installing contractors, and service engineers to define the operation, components and options for any specific unit.

CG	A	C	-	C60	1	-	K	A	N	G	G	6	0	DFGPW
1,2	3	4		5,6,7	8		9	10	11	12	13	14	15	16,etc.

Digits 1,2
Unit Model
CG = Cold Generator

Digit 3
Unit Type
A = Air-Cooled Condensing

Digit 4
Development Sequence

Digits 5, 6, 7
Nominal Capacity
C20 = 20 Tons
C25 = 25 Tons
C30 = 30 Tons
C40 = 40 Tons
C50 = 50 Tons
C60 = 60 Tons

Digit 8
Electrical and Start Characteristics
1 = 460/60/3 PW
2 = 575/60/3 PW
3 = 230/60/3 PW
4 = 460/60/3 XL
6 = 200/60/3 PW
A = 380/50/3 PW
B = 415/50/3 PW
S = Special

Digit 9
Compressor I.D.
K = Model K Hermetic
S = Special

Digit 10
Design Sequence

Digit 11
Motors (Open Compressor Only)
N = None
S = Special

Digit 12
Evaporator
B = 20 Ton
C = 25 Ton
D = 30 Ton
E = 40 Ton
F = 50 Ton
G = 60 Ton
S = Special

Digit 13
Condenser
B = 20 Ton
C = 25 Ton
D = 30 Ton
E = 40 Ton
F = 50 Ton
G = 60 Ton
S = Special

Digit 14
Unloading Steps
2 = 2-Step (20-Ton Only)
3 = 3-Step (25 and 30-Ton)
4 = 4-Step (40 Ton Only)
6 = 6-Step (50 and 60-Ton)
S = Special

Digit 15
Approval Agency
0 = None
2 = UL
3 = CSA
S = Special

Digit 16, etc.
Miscellaneous
3 = Control Power Transformer
8 = Totally-Enclosed Fan Motors
D = Unit-Mounted Disconnect Switch
E = Unit Neoprene Isolators
F = Unit Spring Isolators
G = Pressure Gauges and Piping
H = Hot Gas Bypass
P = Periodic Pumpout
V = Copper Fins
W = Low Ambient Damper(s)
Y = No Evaporator Heat Tape (Export Only)
S = Special
X = Export

General Information

Literature Change History

CGAC-M-4 (January 1987)

Original issue of manual, providing operating, maintenance and trouble analysis information for model CGAC-C20K thru C60K air-cooled Cold Generator units of "A" design sequence.

CGAC-M-4A (September 1987)

Manual reissued to update electrical diagrams and revise "Chiller Control (1U12) Checkout Procedure". All units remain at "A" design sequence.

CGAC "Service Data" Sheets

Use this operation manual in conjunction with the information provided in the applicable CGAC "Service Data" publications.

To insure trouble-free operation and use of proper component information, the design sequence of the unit (Refer to "Model Number Description") must agree with the design sequence printed on the front cover of the "Service Data" publication.

Warnings and Cautions

"Warnings" and "Cautions" appear at appropriate points in this manual. Cautions indicate areas where special attention is required to prevent equipment or property damage. Warnings focus attention on the personal safety of service and operating personnel. The instructions given in each warning that appears in this manual must be followed carefully.

Unit Description

Trane 20 thru 60-ton Model CGAC Air-Cooled Cold Generators are equipped with either one or two Trane Model K hermetic, reciprocating compressors. All units are dehydrated, leak tested, charged and tested for proper control operation before shipment. A low ambient lockout thermostat can be customer provided.

Standard control for these units is a microprocessor-based electronic controller that governs unit operation in response to chilled water temperature leaving the evaporator. Compressor unloaders are solenoid actuated and discharge pressure operated.

The number of capacity or unloading stages provided is:

```
CGAC-C20K ........ 2-Step Control.
CGAC-C25K, C30K... 3-Step Control.
CGAC-C40K ........ 4-Step Control.
CGAC-C50K, C60K... 6-Step Control.
```

The dual-compressor units (40, 50 and 60-Tons), feature two independent refrigerant circuits–one for each compressor.

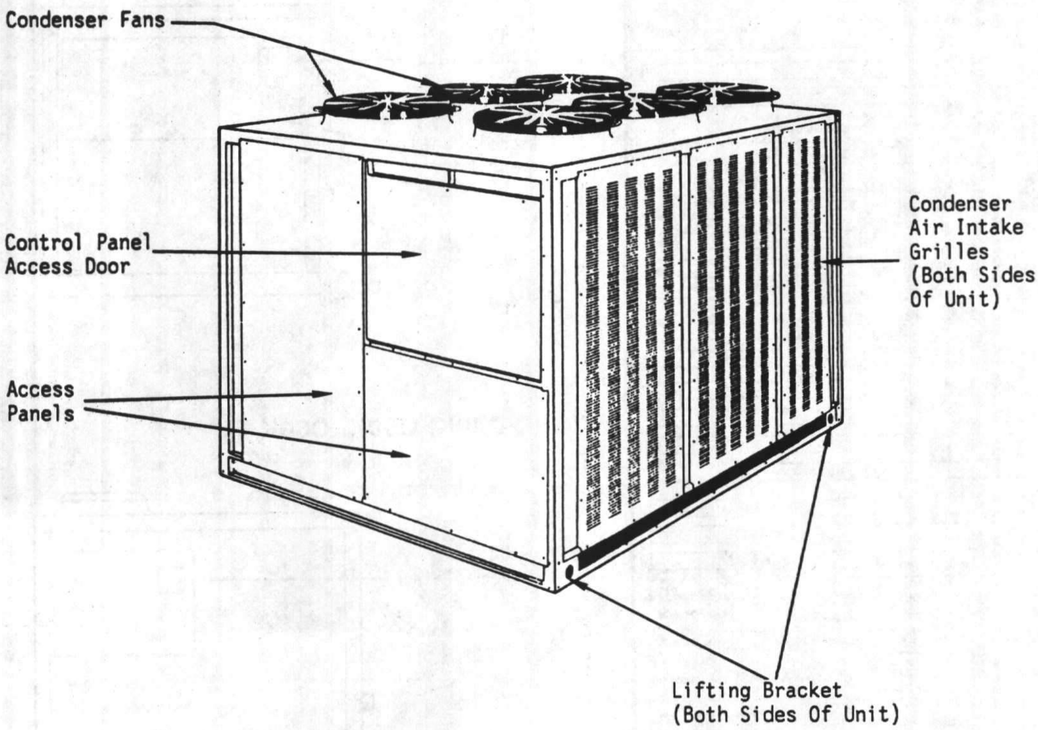
Each refrigerant circuit is provided with an operating charge of refrigerant and refrigerant oil, a liquid line solenoid valve, filter drier, sight glass, thermostatic expansion valve and service valve.

The shell-and-tube type evaporator is manufactured in accordance with ASME standards. Each evaporator is fully insulated and equipped with a drain connection. A bulbwell for the unit temperature controller is located on the evaporator water outlet.

A bag containing the unit wiring diagrams, installation manual, and operation/maintenance manual is provided in the control panel. Be sure to read this literature before operating the unit.

Figure 1 illustrates access panel locations and other CGAC exterior components.

Figure 1
Exterior Components of Typical CGAC Unit



Nameplates

The nameplates on these machines provide valuable information pertaining to the identification of the unit and its components. Provide all nameplate data when ordering parts or literature, and when making other inquiries.

Unit Nameplate

The CGAC unit nameplate is mounted in the upper left corner of the control circuit panel access door. See Figure 2. This nameplate (Figure 2) specifies control circuit power requirements and power requirements for the chiller heat tapes. It also identifies the order number of the unit Operation/Maintenance manual. Refer to this information if it becomes necessary to replace the operation and maintenance literature for this equipment.

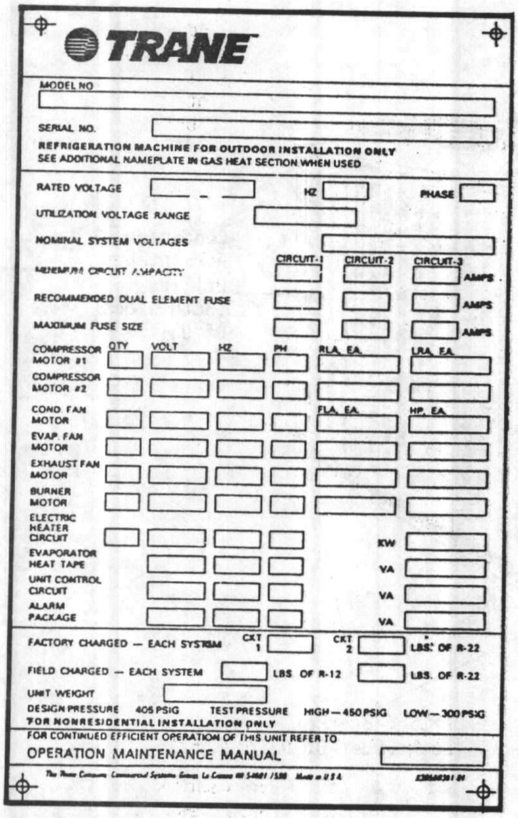
Compressor Nameplate

The Model K compressor nameplate is mounted on the compressor motor housing as shown in Figure 3.

Evaporator Nameplate

The evaporator nameplate is mounted on the top of the evaporator supply-end tube sheet. The word "nameplate" is applied to the insulation just above the nameplate (Figure 4); to view the nameplate, remove the tape over the area and spread the insulation.

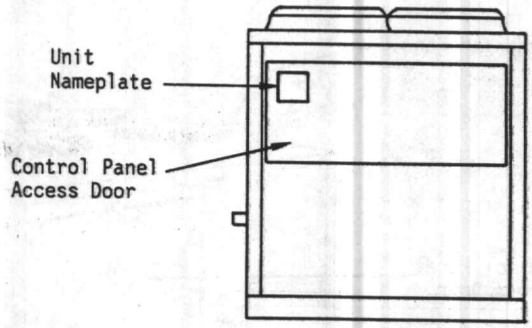
Figure 2
Typical CGAC Unit Nameplate and Nameplate Location



Typical Unit Nameplate

Art No. RF/CG-2720

CGAC-C20K, C25K, C30K



CGAC-C40K, C50K, C60K

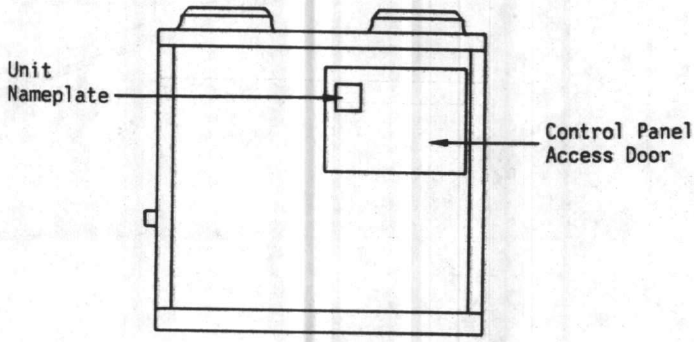


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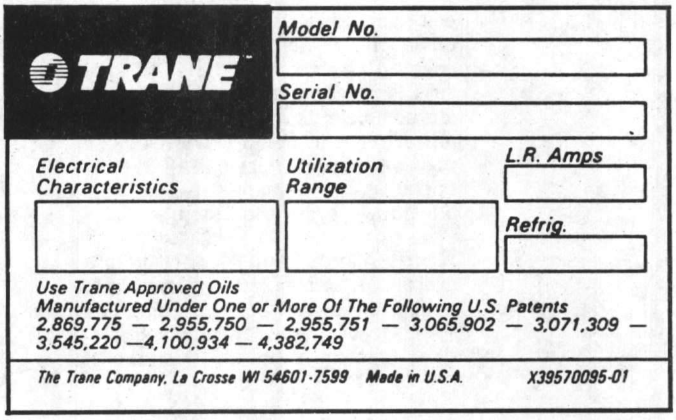
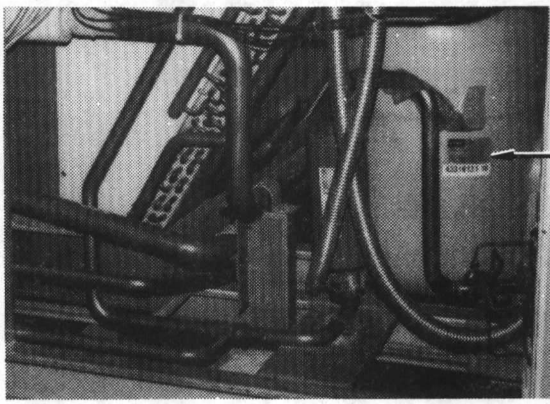
Figure 3
Typical Model K Compressor Nameplate and Nameplate Location

Typical Compressor Nameplate



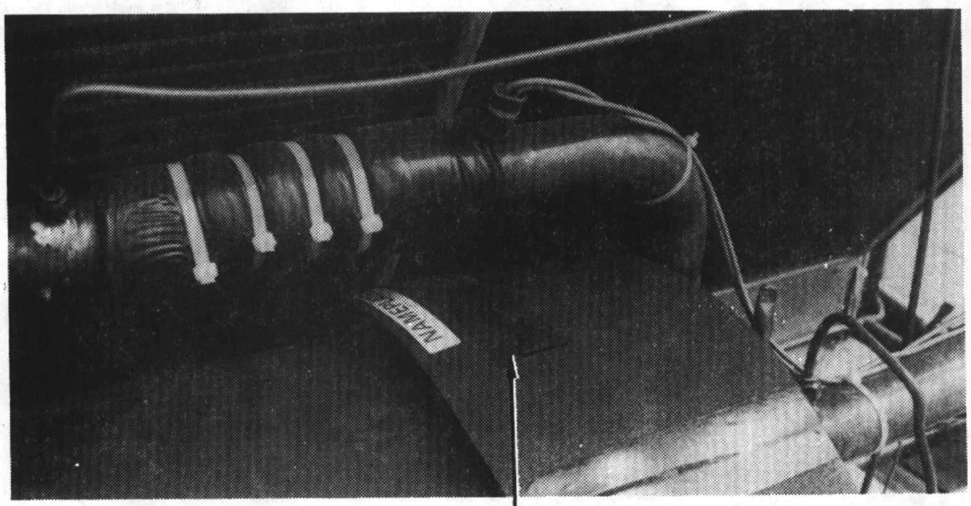
X39570095-01



Nameplate Location

Art No.
RF/CG-2736

Figure 4
Evaporator Nameplate Location



Nameplate
(Under Insulation)

Art No.
RF/CG-2722

Unit Operating Panel

CGAC unit operating switches and fuses are located on the switch panel inside the control panel (Figures 5 and 6).

Operating Switches

Unit Service Switch (1S41). Two-position toggle switch used for unit pumpdown or reset and to stop unit operation. Switch to On position to energize chiller control 1U12. If 1U12 calls for cooling and safety interlocks are complete, the compressor(s) will run. Switch to Pump Down Or Reset position to deenergize 1U12. If unit is operating, compressor(s) will go through pumpdown cycle, then stop.

Note: After turning 1S41 to On, allow a minimum of 4 minutes to elapse before turning the switch back to Pump Down or Reset, to allow the low ambient time delay function of the chiller control to elapse.

If the unit must be shutdown within 3 minutes of either compressor start, stop the compressor by turning the compressor service switch (1S5, 1S6) to Standby. This is necessary because, during this three-minute period, the low ambient delay function of the chiller control is energized (low pressure switches bypassed). Turning the unit off by switching the unit service switch (1S41) to Pump Down or Reset may allow a compressor to operate at excessively low pressure conditions.

Caution: To prevent possible damage to the evaporator or compressor, stop compressor using switch 1S5 or 1S6 if within 3 minutes of compressor start.

Compressor Service Switches (1S5, 1S6). Two-position toggle switches used to deactivate compressor control circuit for compressor service. On dual compressor units, this allows continued operation of the remaining compressor during service procedures. Turn to Operate for normal compressor operation. Turn to Stand-By to deactivate the compressor for service procedures. If the compressor is operating when switched to Stand By, it will not go through a pumpdown cycle.

Fuses

Control Circuit Fuse (1F1). 125V/10A fuse used to protect unit control circuit. Check if unit cuts out for unknown reasons.

Motor Protector Fuses (1F2, 1F3). 125V/6A fuses used to protect compressor control circuits.

Power Supply Fuse (1F10). 24V/3A fuse to protect low voltage control components (microprocessor 1U12, auxiliary relay module 1U13, etc.).

Evaporator Heater (4HR1)

The evaporator shell on all standard 60-cycle CGAC units is insulated from ambient air and protected by factory-installed, thermostatically controlled heat tapes for operation during low ambient conditions. The thermostats close to energize the heat tapes when evaporator shell temperature drops to approximately 37 F.

The installer must provide an independent 115V/60HZ/1PH power source with a fused disconnect switch to the proper terminal strip in the control panel.

Chilled Water (7B1) Pump and Interlocks

The chilled water pump is typically operated by a start/stop pushbutton (7S). If the chilled water pump overload (7K7-OL) is closed, the magnetic starter (7K7) is energized to run the chilled water pump when the pushbutton (7S) is pressed. Once the chilled water pump is running, the auxiliary contacts of the pump starter (7K7-Aux.) provide a holding circuit for the pump magnetic starter. A set of auxiliary contacts installed in series with the flow switch contacts establishes an interlock that keeps the unit from starting when the chilled water pump is not operating.

Figure 5
Unit Operating Panel for Typical CGAC Unit with Single Model K Compressor

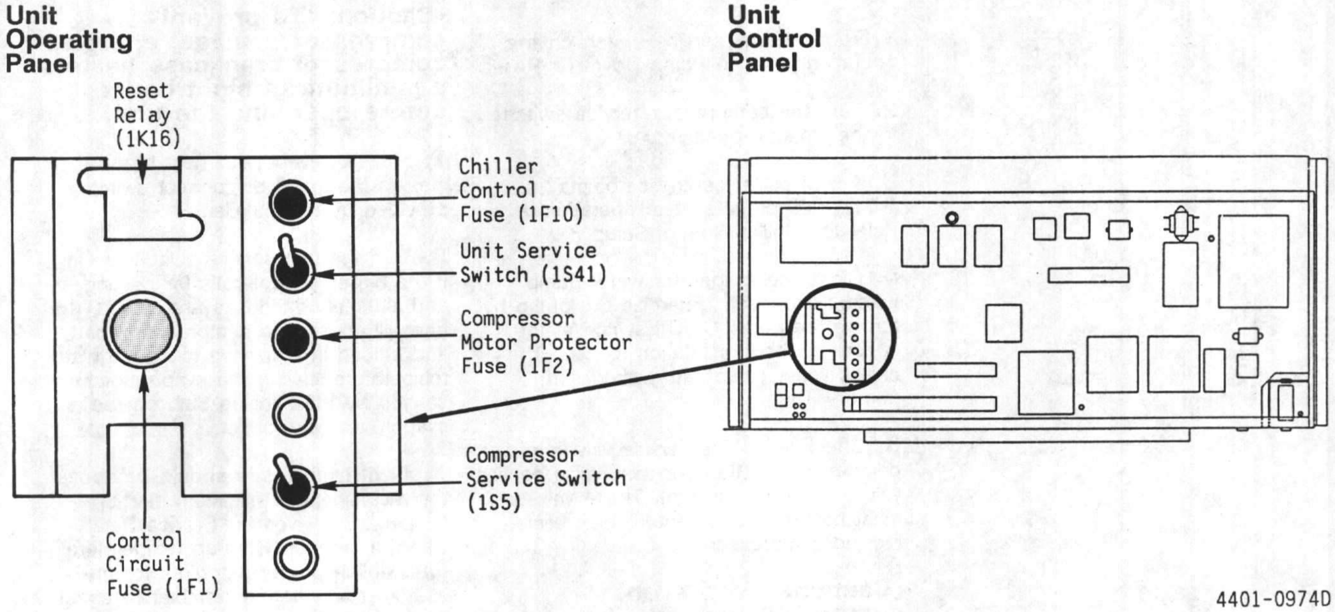
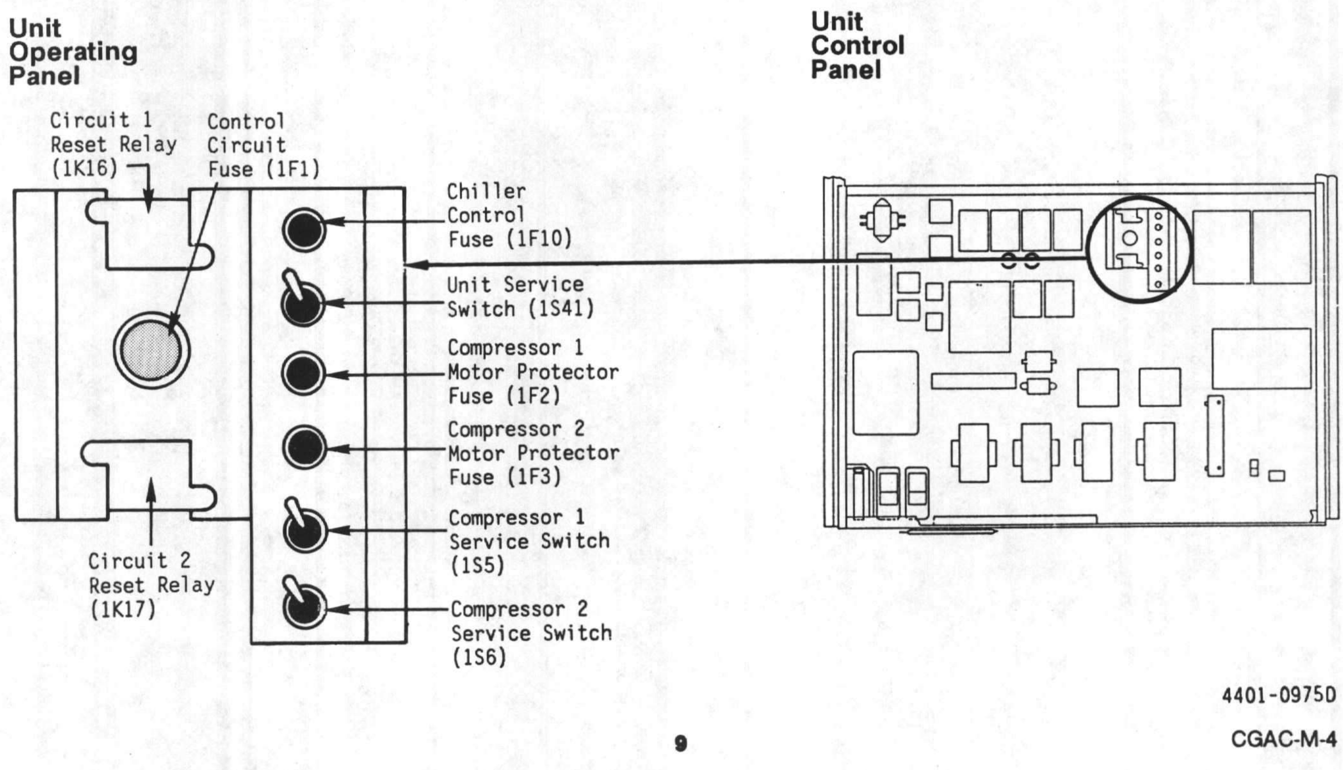


Figure 6
Unit Operating Panel for Typical CGAC Unit with Dual Model K Compressors



Start-Up Procedure

To start the unit, complete each step of this procedure, in sequence. Typical unit operating controls are illustrated in Figures 5 and 6.

1. Turn the unit service switch on the operating panel to Pump Down Or Reset.

2. Turn the compressor service switches to the Operate position.

3. Adjust chiller control setpoints (1U12) for normal system operation. Refer to "Chiller Control Setup".

4. Close the evaporator water pump fused disconnect. Energize the pump by turning the pump On/Off switch at the remote pushbutton station to On. The chilled water (evaporator) circulating pump will run.

5. Check liquid line service valves and compressor suction and discharge service valves (Figures 7 and 8). These valves must be open (backseated) before starting the compressors.

Caution: To prevent compressor damage, be certain that all refrigerant valves are open before starting the unit.

6. Energize the compressor crankcase heaters if they aren't already energized by closing the line voltage disconnect. Also close the unit-mounted disconnect, if used.

Caution: To prevent compressor damage, energize compressor crankcase heaters a minimum of eight hours before operating the unit.

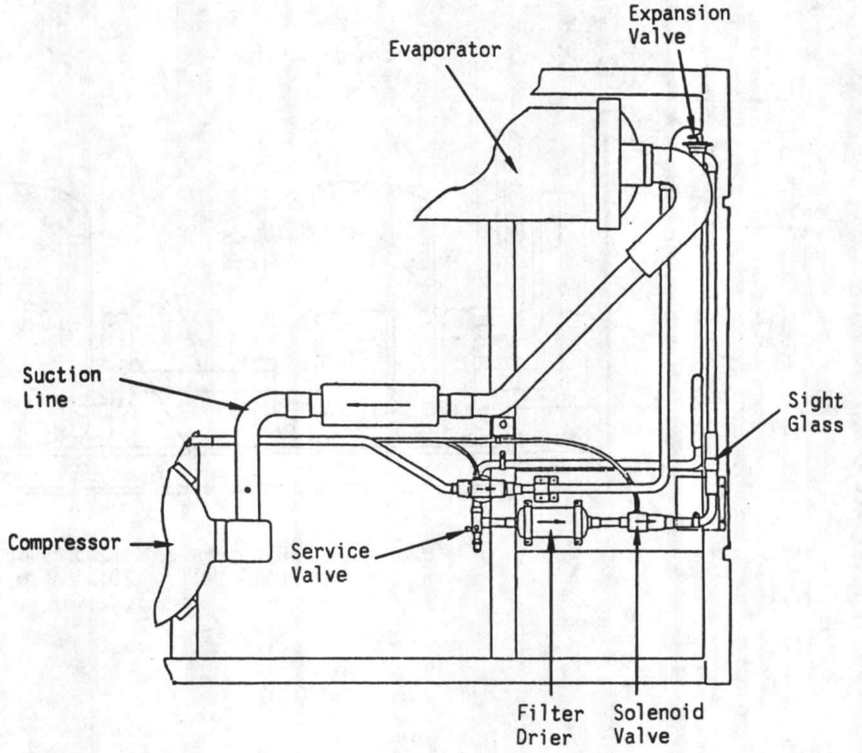
7. Energize evaporator heat tape by closing the fused disconnect switch provided by the installer.

8. Turn the unit service switch to On. If the chiller control calls for cooling and all safety interlocks are closed, the unit will start. The compressors load and unload in response to chilled water temperature leaving the evaporator as sensed by the sensing bulb on the evaporator water outlet.

Ambient temperature should be above the recommended minimum start-up temperatures given in "Service Data". Use the minimum start-up temperatures to establish proper setpoints for the customer-provided low ambient lockout thermostat, if used. Refer to the field wiring diagrams in Figures 9 and 10.

Figure 7
Typical Liquid Line Component Locations

CGAC-C30K



CGAC-C60K

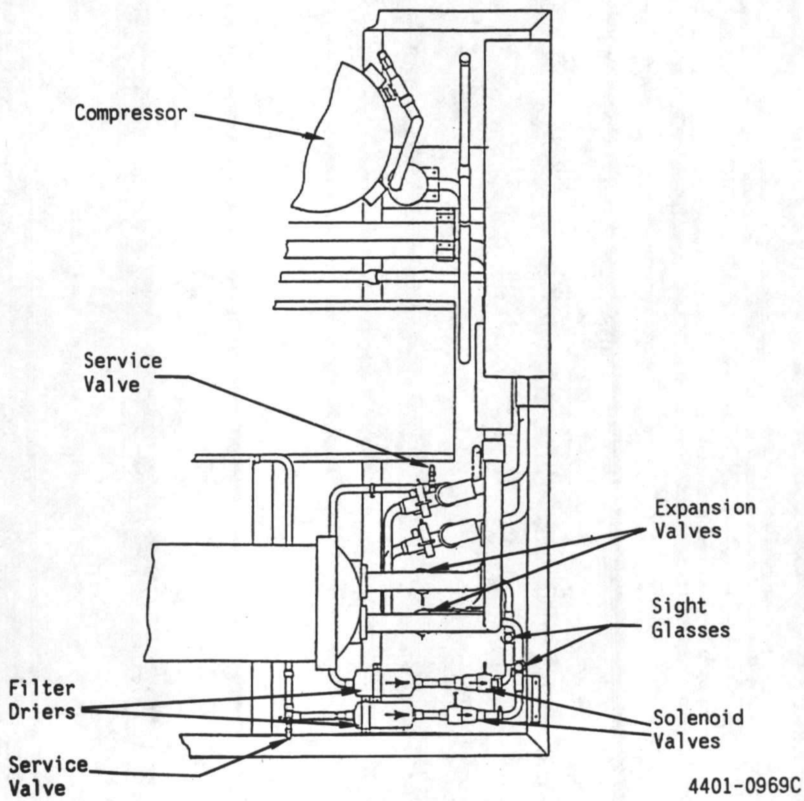


Figure 8
Typical Compressor Service Valve Locations (CGAC-C60K Shown)

Compressor Side View

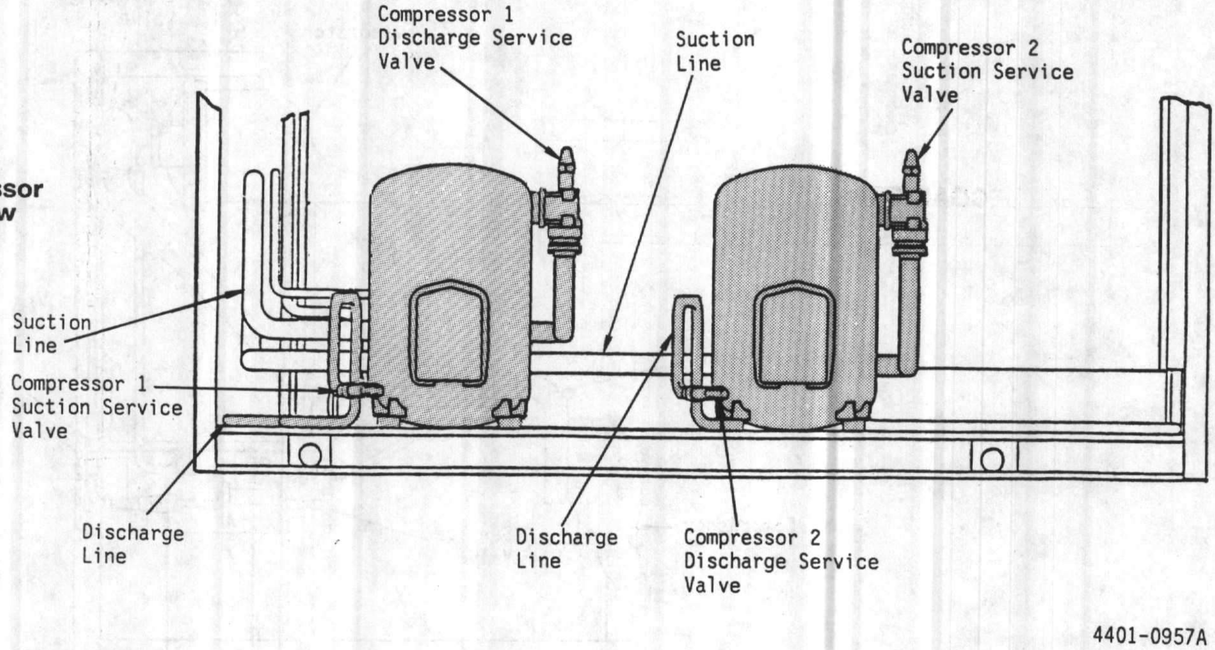
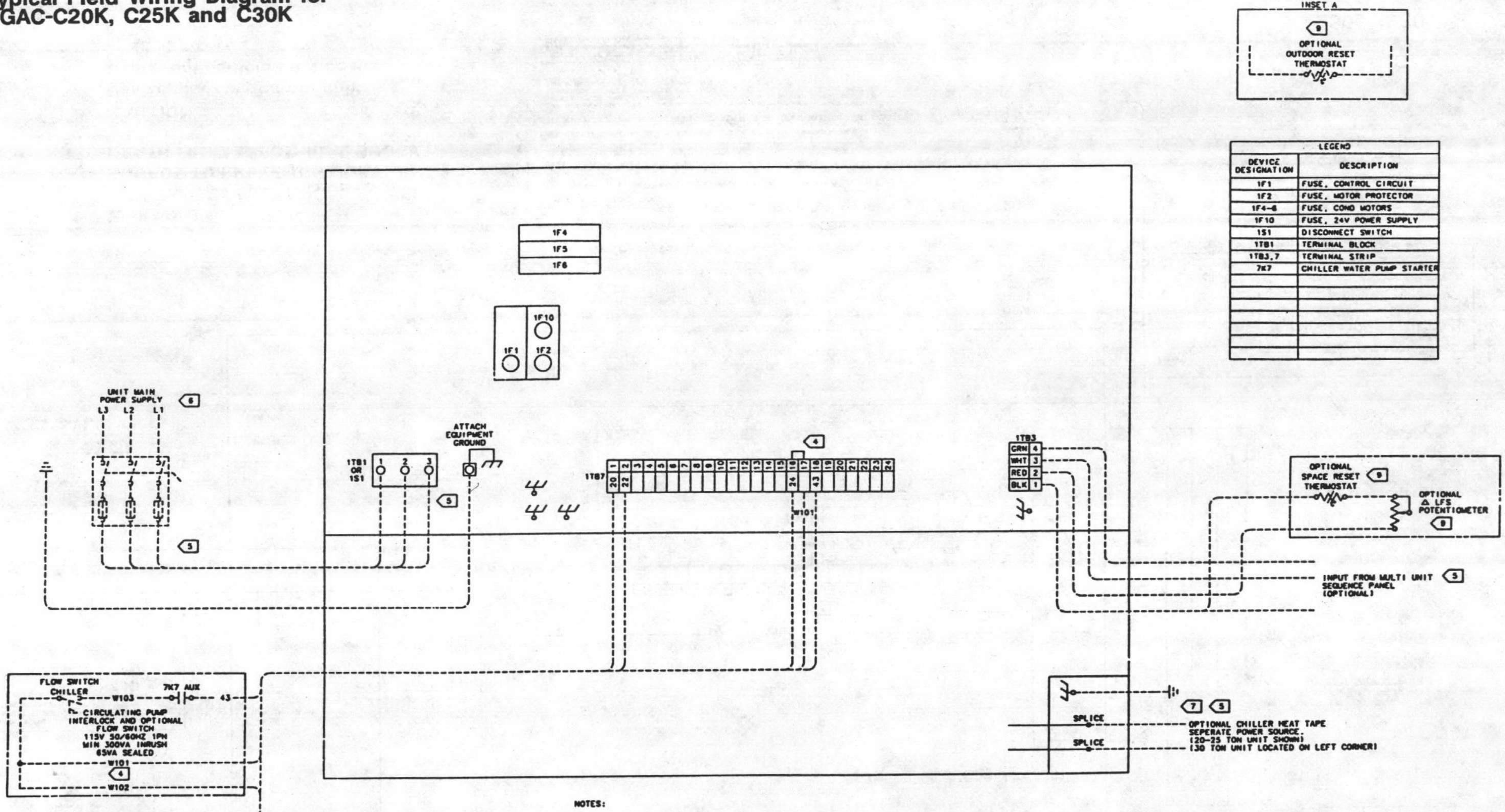
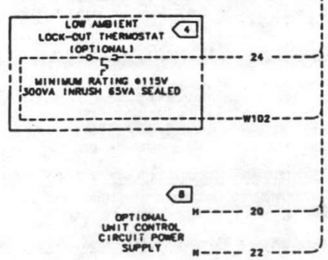


Figure 9
Typical Field Wiring Diagram for CGAC-C20K, C25K and C30K



LEGEND	
DEVICE DESIGNATION	DESCRIPTION
1F1	FUSE, CONTROL CIRCUIT
1F2	FUSE, MOTOR PROTECTOR
1F4–6	FUSE, COND MOTORS
1F10	FUSE, 24V POWER SUPPLY
1S1	DISCONNECT SWITCH
1TB1	TERMINAL BLOCK
1TB3,7	TERMINAL STRIP
7K7	CHILLER WATER PUMP STARTER



NOTES:

1. WIRE NUMBERS ARE THE SAME AS THE NODE NUMBER THAT THE WIRE IS CONNECTED TO, BUT LESS ANY SUFFIX LETTER. WHERE NODE NUMBERS ARE NOT AVAILABLE W_ NUMBERS ARE USED.
2. ALL 3-PHASE MOTORS ARE PROTECTED UNDER PRIMARY SINGLE PHASE FAILURE CONDITIONS.
3. CAUTION–DO NOT ENERGIZE UNIT UNTIL CHECK-OUT AND START-UP PROCEDURES HAVE BEEN COMPLETED.

4 WARNING–REMOVE JUMPER WHEN LOW AMBIENT LOCK-OUT THERMOSTAT IS USED. LEAD W101 IS NOT REQUIRED WHEN LOW AMBIENT LOCKOUT THERMOSTAT IS USED.

5 ALL CUSTOMER WIRING TO CONTROL PANEL TO BE COPPER CONDUCTORS ONLY.

6 SEE NAMEPLATE MARKING FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE.

7 CHILLER HEAT TAPE IS STANDARD ON ALL 60 HZ UNITS. POWER SUPPLY REQUIRED IS 115 VOLTS AND MAX FUSE SIZE IS 15 AMPS. ON 50 HZ UNITS THE HEAT TAPE IS OPTIONAL. WHEN PROVIDED FOR 380 & 415 VOLTS 50 HZ UNITS THE HEAT TAPE POWER REQUIRED IS 240 VOLTS AND MAX FUSE SIZE IS 15 AMPS.

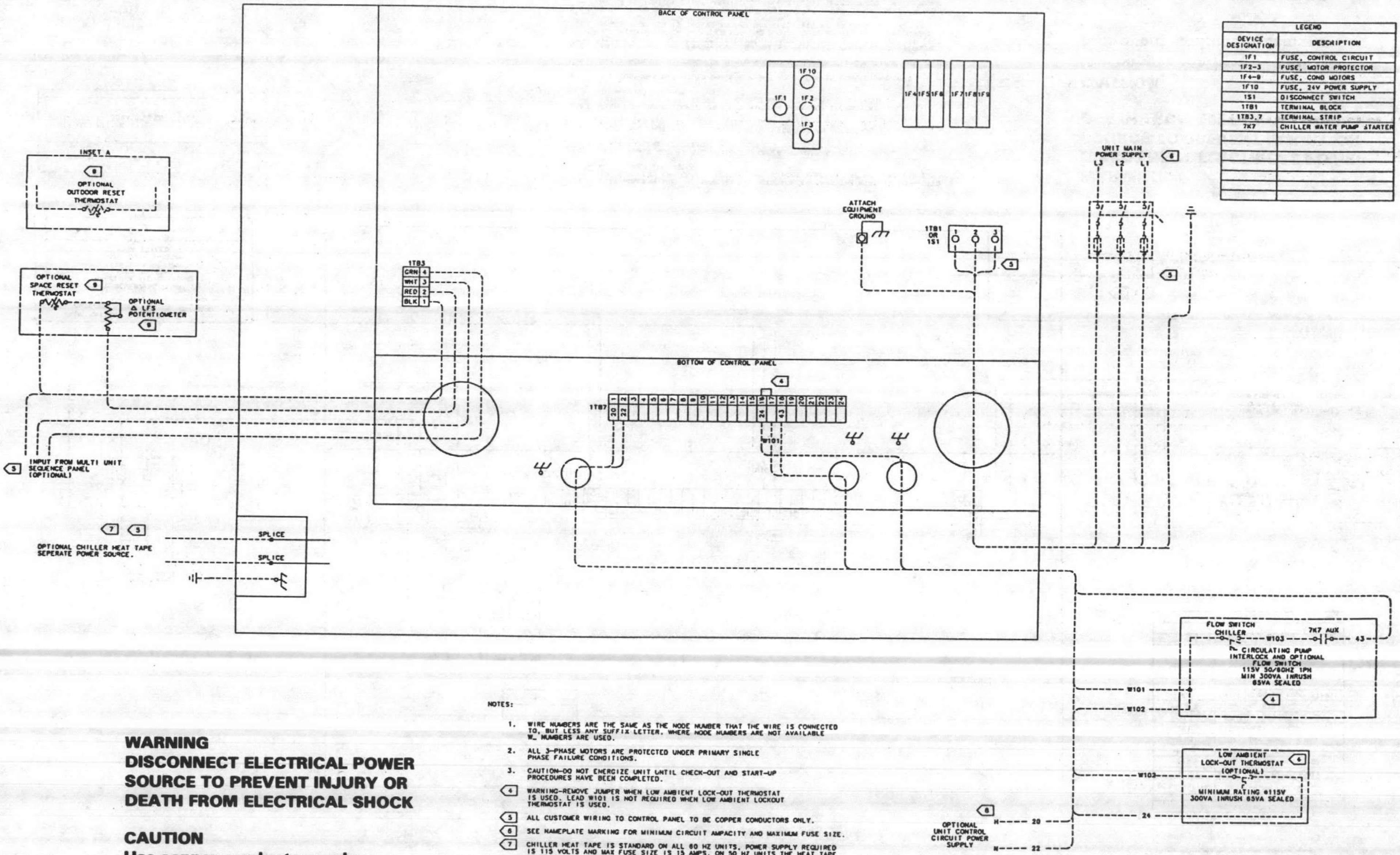
8 THIS POWER SUPPLY MAY BE CUSTOMER PROVIDED AS SHOWN OR CAN BE SUPPLIED BY AN OPTIONAL FACTORY MOUNTED CONTROL CIRCUIT TRANSFORMER. IF CUSTOMER PROVIDED THE POWER REQUIREMENTS ARE 115 VOLTS, 750 VA AND THE MAX FUSE SIZE IS 15 AMPS. IF THE OPTIONAL TRANSFORMER IS ORDERED THIS POWER SUPPLY AND LEADS 20 AND 22 ARE NOT REQUIRED.

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

2306-1929

Figure 10
Typical Field Wiring Diagram for CGAC-C40K, C50K and C60K



LEGEND	
DEVICE DESIGNATION	DESCRIPTION
1F1	FUSE, CONTROL CIRCUIT
1F2-3	FUSE, MOTOR PROTECTOR
1F4-9	FUSE, COND MOTORS
1F10	FUSE, 24V POWER SUPPLY
1S1	DISCONNECT SWITCH
1TB1	TERMINAL BLOCK
1TB3,7	TERMINAL STRIP
7K7	CHILLER WATER PUMP STARTER

NOTES:

1. WIRE NUMBERS ARE THE SAME AS THE NODE NUMBER THAT THE WIRE IS CONNECTED TO, BUT LESS ANY SUFFIX LETTER. WHERE NODE NUMBERS ARE NOT AVAILABLE W_ NUMBERS ARE USED.
2. ALL 3-PHASE MOTORS ARE PROTECTED UNDER PRIMARY SINGLE PHASE FAILURE CONDITIONS.
3. CAUTION—DO NOT ENERGIZE UNIT UNTIL CHECK-OUT AND START-UP PROCEDURES HAVE BEEN COMPLETED.

4. WARNING—REMOVE JUMPER WHEN LOW AMBIENT LOCK-OUT THERMOSTAT IS USED. LEAD W101 IS NOT REQUIRED WHEN LOW AMBIENT LOCKOUT THERMOSTAT IS USED.

5. ALL CUSTOMER WIRING TO CONTROL PANEL TO BE COPPER CONDUCTORS ONLY.

6. SEE NAMEPLATE MARKING FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE.

7. CHILLER HEAT TAPE IS STANDARD ON ALL 60 HZ UNITS. POWER SUPPLY REQUIRED IS 115 VOLTS AND MAX FUSE SIZE IS 15 AMPS. ON 50 HZ UNITS THE HEAT TAPE IS OPTIONAL. WHEN PROVIDED FOR 380 & 415 VOLTS 50 HZ UNITS THE HEAT TAPE POWER REQUIRED IS 240 VOLTS AND MAX FUSE SIZE IS 15 AMPS.

8. THIS POWER SUPPLY MAY BE CUSTOMER PROVIDED AS SHOWN OR CAN BE SUPPLIED BY AN OPTIONAL FACTORY MOUNTED CONTROL CIRCUIT TRANSFORMER. IF CUSTOMER PROVIDED THE POWER REQUIREMENTS ARE 115 VOLTS, 750 VA AND THE MAX FUSE SIZE IS 15 AMPS. IF THE OPTIONAL TRANSFORMER IS ORDERED THIS POWER SUPPLY AND LEADS 20 AND 22 ARE NOT REQUIRED.

9. △LFS RESET POTENTIOMETER USED WITH REMOTE SPACE SENSOR. FOR OUTDOOR RESET, REMOTE SPACE SENSOR AND △LFS RESET POTENTIOMETER IS NOT USED (SEE INSET A). THE NOTED OPTIONAL SPACE OR OUTDOOR RESET THERMOSTAT ARE NOT AVAILABLE IF THE MULTI UNIT SEQUENCE PANEL IS PROVIDED.

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

2306-1930

Checking Operating Conditions

Once the unit has been operating for about 30 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

[ ] Recheck evaporator water flow and pressure drop. These readings should be stable at proper levels. If pressure differential drops off, clean all evaporator water supply strainers.

[ ] Check suction and discharge pressure at the gauges on the unit (Figure 11). If the unit is not equipped with gauges, install them on the gauge valves provided on the unit if so equipped. Use a refrigerant-tight thread seal such as teflon tape.

To read pressures, remove the cap from the shut-off valve and open (backseat) the valve (Figure 12). Read the operating pressure. Close (frontseat) the valve to isolate it from the system. Replace and retighten the cap.

Caution: To minimize gauge wear, close shut-off valves to isolate the gauges when pressure readings have been taken.

Note: If the unit is not equipped with pressure gauges, take operating pressures using a manifold gauge set at these points:

<u>Discharge pressures</u> - take at compressor discharge service valve backseat port (Figure 11). Normal discharge pressure is 250 to 360 psig. Refer to "Service Data" for more specific information.

<u>Suction pressures</u> - take at compressor suction service valve backseat port (Figure 12). Normal suction pressure is 55 to 70 psig. Refer to "Service Data" for more specific information.

[ ] Check compressor oil levels. At full load, oil level should be visible about one-half of the way up on the oil level sight glass on the compressor (Figure 13). If it is not, add or remove oil as required. Refer to "Service Data" for correct oil charges and recommended oils for these units.

[ ] Check and record compressor amperage draw. Compare the readings with the compressor electrical data provided in "Service Data" and on the unit nameplate.

[ ] Check the liquid line sight glasses (Figure 7). Refrigerant flow past the sight glasses should be clear. Bubbles in the liquid line indicate either low refrigerant charge or excessive pressure drop in the liquid line. Such a restriction can often be identified by a noticeable temperature differential on either side of the restricted area.
Frost often forms on the outside of the liquid line at this point also.
Refrigerant charges for CGAC units are provided in "Service Data".

Caution: The system may not be properly charged although the sight glass is clear. Also consider superheat, subcooling and operating pressures.

[ ] Once oil level, amp draw and operating pressures have stabilized, measure system superheat. Refer to "System Superheat".

[ ] Measure system subcooling. Refer to "System Subcooling".

[ ] If operating pressure, sight glass, superheat and subcooling readings indicate refrigerant shortage, gas-charge refrigerant into each circuit. Refrigerant shortage is indicated if operating pressures are low and subcooling is also low.

Caution: If suction and discharge pressures are low but subcooling is normal, no refrigerant shortage exists. Adding refrigerant, will result in overcharging.

Add refrigerant vapor with the unit running by charging through the compressor suction service valve backseat port until operating conditions are normal.

Caution: To prevent compressor damage, do not allow liquid refrigerant to enter the suction line. Liquid charge at the liquid line service valve only.

Caution: To prevent compressor damage and insure full cooling capacity, use refrigerants specified on the unit nameplate only.

[ ] If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove refrigerant at the liquid line service valve. Do not discharge refrigerant into the atmosphere.

WARNING: To prevent injury due to frostbite, avoid skin contact with refrigerant.

[ ] If the unit is equipped with hot gas bypass, check regulating and solenoid valve for proper operation, Valve operating setpoints are provided in "Service Data".

[ ] If the unit is equipped with low ambient dampers, check for proper actuator and blade travel in relation to condensing pressure. Refer to "Service Data" for damper operating setpoints.

[ ] Once proper unit operation is confirmed, inspect for debris, misplaced tools, etc. Secure all exterior panels in place.

System Superheat

Normal superheat for each circuit is 12-15 F at full load. If superheat is not within this range, adjust expansion valve superheat setting. Expansion valve locations are shown in Figure 7. Allow 15-30 minutes between adjustments for the expansion valve to stabilize on each new setting.

System Subcooling

Normal subcooling for each circuit is 17 to 20 F at full load. If subcooling for either circuit is not in this range check superheat for the circuit and adjust, if required. If superheat is normal but subcooling is not, contact a qualified service technician.

Figure 11
Location of Optional Operating Pressure Gauges (Typical Dual Compressor Unit)

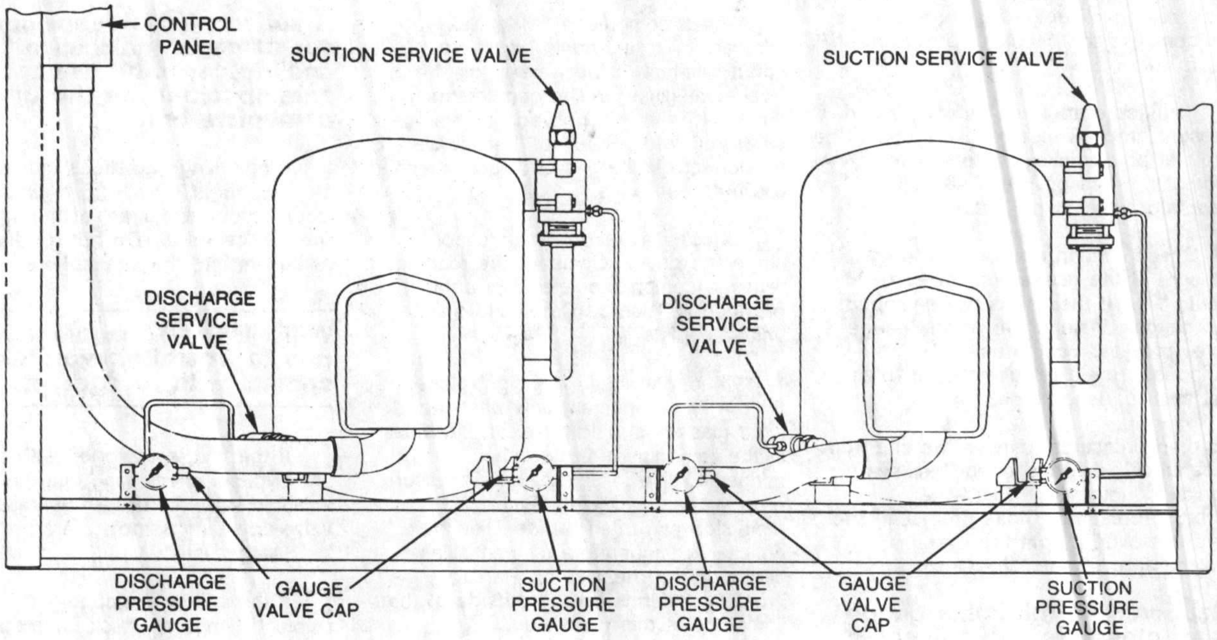


Figure 12
Typical Operating Pressure Gauge

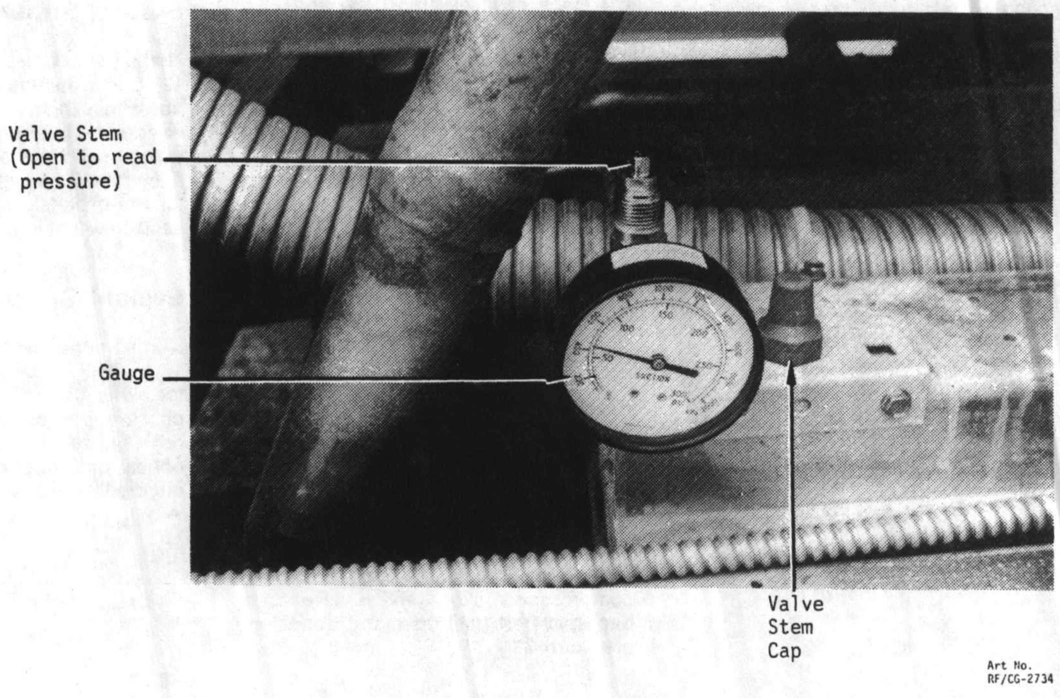


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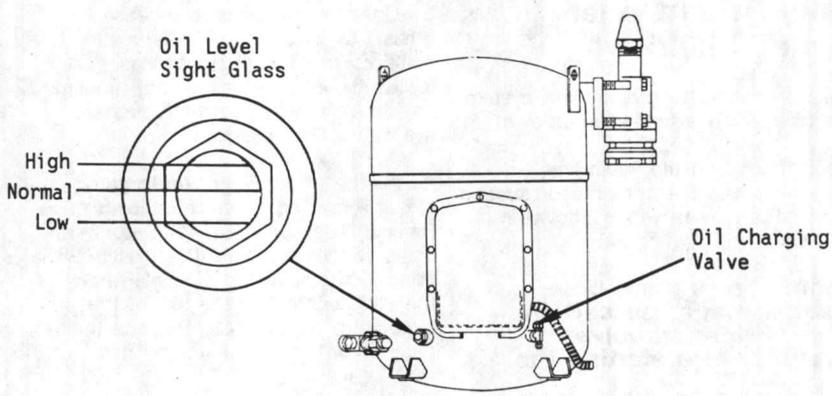
Figure 13
Model K Compressor Oil Level Sight Glass and Oil Charging Valve Locations



Temporary Shutdown and Restart

To shut the unit down for a short time, use the following procedure.

1. Turn the unit service switch (1S41) to Pump Down Or Reset. The compressor(s) continue to operate, pumping down the system and stopping as the low pressure switch(es) open to deenergize the compressor contactors. The condenser fans will deenergize at this time.

2. Leave the unit disconnect switch and the unit-mounted disconnect 1S1 (if used) closed to keep the compressor crankcase heater(s) energized.

WARNING: Do not use this procedure to shut unit down for service or repairs. To prevent injury or death due to electrical shock, service the unit only with electrical disconnects locked open.

3. Stop chilled water pump operation by turning the pump On/Off switch to Off.

To restart the unit after a temporary shutdown, restart the chilled water pump and turn the unit service switch (1S41) to On. The unit will operate normally provided the following conditions are met:

1. The chiller control (1U12) must call for cooling.

2. All system operating interlocks and safety circuits must be satisfied.

Extended Shutdown Procedure

If the system is taken out of operation for long periods of time for any reason (seasonal shutdown for example), use this procedure to prepare the system for shutdown.

1. Perform "Manual Pumpdown" procedure. Be certain to perform this procedure for both circuits.

2. Test condenser and high side piping for refrigerant leakage.

3. Open electrical disconnect switches for evaporator water pump. Lock the disconnect in open position.

Caution: Lock evaporator water pump disconnect open to prevent pump damage.

4. Close all evaporator water supply valves. Drain water from the evaporator. If unit will be exposed to sub-freezing low ambient conditions, flush evaporator with antifreeze solution or energize evaporator heaters by closing the fused disconnect provided by the installer.

Caution: To prevent freeze damage to evaporator internal components, protect with adequate strength antifreeze or be certain to energize the evaporator heater.

5. Open the unit main electrical disconnect and unit-mounted disconnect 1S1 (if used) and lock in open position.

Caution: Lock unit main disconnect open to prevent compressor damage due to accidental start-up while system is in "shutdown" condition.

System Restart After Extended Shutdown

Use this procedure to prepare the system for restart after an extended shutdown.

1. Open (backseat) the liquid line, service valves and the compressor suction and discharge service valves shown in Figure 11.

Caution: To prevent compressor damage, be certain that all refrigerant valves are open before starting the unit.

2. Close the unit main disconnect and the unit-mounted disconnect 1S1 (if used) to energize the compressor crankcase heater(s).

Caution: To prevent compressor damage, energize compressor crankcase heaters a minimum of eight hours before operating the unit.

3. Check compressor crankcase oil levels. Oil should be visible in the compressor oil level sight glass. Oil level with the compressor not running should be one-half to three-quarters of the way up the glass.

4. Fill the chilled water (evaporator) circuit if drained during shutdown. Refer to "Service Data" for evaporator liquid capacities. Vent the system while filling it. Remove the pipe plug from the vent located on the top of the evaporator (Figure 14). Replace the vent plug when the evaporator is filled.

Caution: To avoid possible equipment damage, do not use untreated -- or improperly treated -- system water.

5. Close the fused disconnect switch that provides power to the chilled water pump starter (7K7).

6. Start the chilled water pump by turning the chilled water pump On/Off switch (7S) at the pump remote pushbutton station to On. With water circulating through the chilled water system, inspect all piping connections for leakage. Make any necessary repairs.

7. With the circulating pump operating, adjust chilled water flow and check water pressure drop through the evaporator. Refer to "Water System".

8. Adjust the flow switch on the evaporator outlet piping for proper operation.

9. Stop the chilled water pump. Unit is now ready for normal operation. Refer to "Start-Up Procedure".

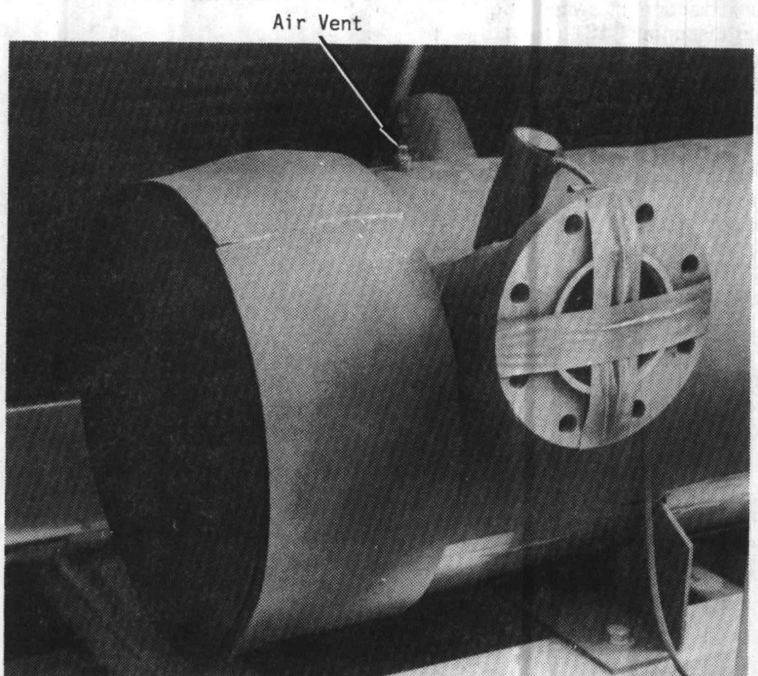
Unit Voltage

Electrical power to the unit must meet stringent requirements for the unit to operate properly. Total voltage supply and voltage imbalance between phases must be within the following tolerances.

Voltage Supply

Measure each leg of supply voltage at the line voltage disconnect switch. Readings must fall within voltage utilization range shown on the unit nameplate. If voltage of any leg does not fall within tolerance, notify the power company to correct this situation before operating the unit. Inadequate voltage to the unit will cause control components to malfunction and shorten the life of relay contacts and compressor motors.

Figure 14
Air Vent Location on Typical Evaporator Shell



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Voltage Imbalance

Excessive voltage imbalance between phases in a three-phase system will cause motors to overheat and eventually fail. Maximum allowable imbalance is 2 percent. Voltage imbalance is defined as 100 times the maximum deviation of the three voltages (three phases) subtracted from the average (without regard to sign), divided by the average voltage.

Example:
If the three voltages measured at the line voltage fused disconnect are 221 volts, 230 volts and 227 volts, the average would be:

$$\frac{221 + 230 + 227}{3} = 226 \text{ volts.}$$

The percentage of imbalance is then:

$$\frac{100(226 - 221)}{226} = 2.2\%.$$

The 2.2 percent imbalance that exists in the example above exceeds maximum allowable imbalance by 0.2 percent. This much imbalance between phases can equal as much as 20 percent current imbalance with a resulting increase in winding temperature that will decrease compressor motor life.

Water System

Water Flow Rates

Establish balanced water flow through the evaporator. Flow rates should fall between the minimum and maximum values given in "Service Data". Flow rates below minimum values will result in laminar flow, reducing heat transfer and causing either loss of TEV control or repeated nuisance low pressure cutouts. Excessively high water flow can cause damage to the tube supports and baffles in the evaporator.

Pressure Drop Measurement

Measure evaporator water pressure drop at the pressure gauge(s) on the system water piping. Pressure drop readings should approximate those shown by the pressure drop chart in Figure 15.

Manual Pumpdown for Service or Extended Shutdown

1. If the unit is running, turn the unit service switch (1S41) to Pump Down or Reset and allow the compressors to go through a normal system pumpdown. If the unit is not running, proceed to Step 2.

2. Open the unit main power disconnect switch and the unit-mounted disconnect 1S1 (if used) and adjust the chiller control (1U12) leaving fluid setpoint low enough to insure a call for cooling when the unit starts.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

3. Install a jumper across the terminals 10 to 11 (for circuit 1) and 10 to 9 (for circuit 2) of the chiller control (1U12). Install jumpers only for the circuit being pumped down.

4. Manually close the liquid line service valve for the circuit being pumped down. If both circuits are being pumped down, close both liquid line service valves (Figure 7).

5. Close the unit main power disconnect and the unit-mounted disconnect 1S1 (if used).

6. Turn the compressor service switches (1S5 and 1S6) to the Operate position.

7. Turn the unit service switch (1S41) to On. The designated lead compressor will start, followed by the lag compressor.

8. Carefully observe the suction pressure gauge for the circuit(s). When pressure drops to 2-3 psig, turn the compressor service switch (1S5 or 1S6)) for the circuit being pumped down to Standby and close (frontseat) the compressor suction and discharge service valves (Figure 7).

9. Turn the unit service switch (1S41) to Pump Down or Reset.

Note: If suction pressure rises, repeat steps 6 through 9 until pressure holds at 2-3 psig.

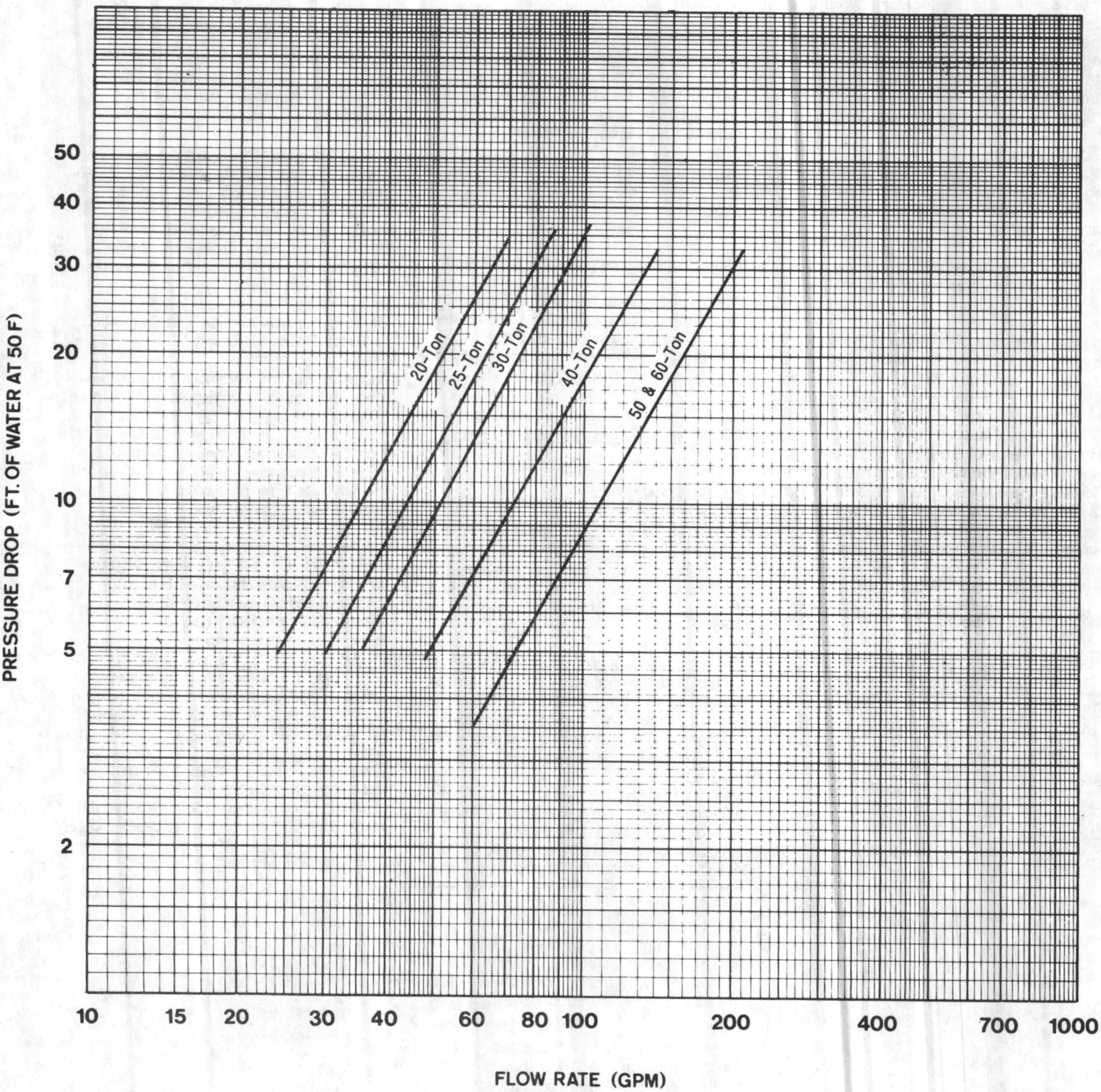
10. Once suction pressures are stable, open all disconnect switches and remove the jumpers from chiller control terminals 9, 10 and 11.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

11. Lock the unit main disconnect or unit-mounted disconnect in open (Off) position to prevent accidental compressor operation while circuit is pumped down.

Caution: To prevent damage due to compressor operation during pumped down condition, lock disconnect switches open.

Figure 15
Evaporator Water Pressure Drop Chart for CGAC-C20K thru C60K Units



Refer to "Model Number Description" to determine evaporator designation for any unit.

Electrical Control System

Controls for CGAC units are classified either as "operational controls" or "unit safety" controls. Figures 16 and 17 identify the locations of all unit control devices. Refer to "Service Data" for control operating setpoints.

Safety Controls

High Pressure Switches (2B1S2, 3B2S3)

The high pressure switches (2B1S2 and 3B2S3), located in the compressor terminal junction boxes (Figure 16 and 17), prevent compressor operation at high discharge pressures which can result from insufficient condenser air flow.

If discharge pressure increases to a point higher than the cut-out setting of the high pressure switch, the switch contacts open, stopping compressor operation. The contacts automatically reset once the system pressure falls below the cut-in setting of the control. If the contacts of the high pressure switch open, the reset relay is energized.

To restart the compressor, insure that the high pressure switch contacts have closed and reset the reset relay by turning the unit service switch (1S41) to Pump Down Or Reset and back again to On. There will be a 4-5 minute time delay before compressor restart.

Compressor Motor Overloads (1U1, 1U2)

The compressor motor overloads (1U1 and 1U2) are located in the unit control panel. These devices prevent compressor operation if compressor motor current draw exceeds the setting of the overloads. If compressor motor current draw exceeds the "must trip" setting of the overload, its normally closed contacts open, stopping compressor operation. If compressor motor overload contacts open, the reset relay is energized. To restart the compressor, reset the reset relay by turning the unit service switch (1S41) to Pump Down Or Reset and back again to On. There will be a 4-5 minute time delay before compressor restart.

The "must hold" and "must trip" setpoints of the overloads are set at the factory. A label showing these values is affixed to the face of the overload. These setpoints are given in "Service Data".

Reset Relays (1K16, 1K17)

The reset relays are located in the unit control panel as shown in Figures 16 and 17. They are used to prevent repeated compressor cycling if a high pressure switch ((2B1S2, 3B2S3), compressor motor overload (1U1, 1U2) or low water temperature protection contacts (1UK29) open. This is necessary since the high pressure switches, the compressor overloads and low water temperature contacts located in the compressor safety circuit, reclose automatically. If the contacts of one of these devices open during compressor operation, sufficient voltage is developed across the reset relay coil to open the relay contacts.

There is not enough voltage, however, for the rest of the unit control circuit. Compressor contactors (1K3, 1K4) and the liquid line solenoid valves (4L1, 4L2) are deenergized.

To restart the compressor, correct the malfunction that caused the safety contol to cut out and turn the unit service switch (1S41) to Pump Down Or Reset and back again to On. There will be a 4-5 minute time delay before compressor restart.

Caution: To prevent unit damage, do not reset the control circuit until the cause of the safety lockout is identified and corrected.

Chilled Water Flow Sensor

A flow sensor (flow switch or pressure differential switch) should be installed in the chilled water piping. The sensor, in conjunction with the chilled water pump motor starter interlock, prevents chiller operation if water flow through the evaporator is interrupted or becomes restricted. If a mechanical flow sensing device is used, it should be installed in the evaporator chilled water outlet piping.

Operational Controls

Chiller Control and Auxiliary Relay Module (1U12, 1U13)

The solid-state, microprocessor-based chiller control (1U12) and auxiliary relay module (1U13) are used to maintain leaving chilled water temperature within a desired range. Multiple-stage capacity control of each unit is accomplished by loading and unloading each compressor.

The chiller control and auxiliary relay module, located in the control panel (Figures 16 and 17), also provide the special operating and safety features described below:

Evaporator Freeze Protection. The low temperature cutout feature prevents the unit from operating if the leaving chilled solution temperature approaches its freezing point as sensed by 4RT1 located in the evaporator water outlet. This is accomplished through the 1UK29 contacts of the auxiliary relay module 1U13. The standard setpoint for low water temperature control cutout is 35 F. If a setpoint other than 35 F is required, contact The Trane Company.

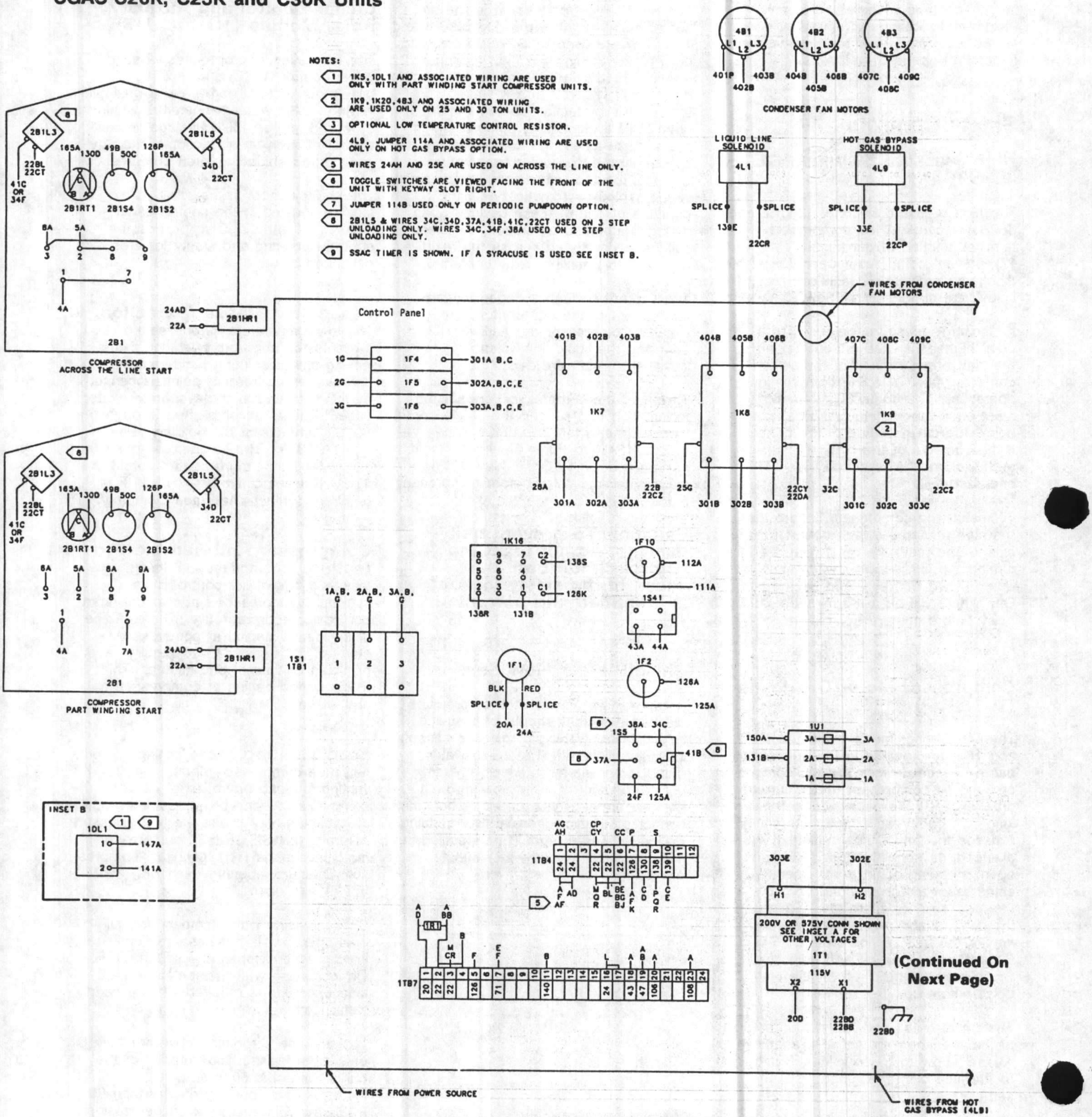
Compressor Anti-Recycle Protection. The anti-recycle timing feature of the chiller control limits individual compressor starts to one start per compressor each five minutes. The timing period begins at compressor start-up. This feature also requires a minimum off-time of one minute. This timing period begins at compressor shut-down.

Load Limiting. Load-limiting prevents nuisance compressor tripouts by preventing full load operation of either compressor whenever excessive evaporator loading may cause the high pressure controls, (2B1S2, 3B2S3), compressor motor overloads (1U1, 1U2) or compressor winding temperature sensors (2B1RT1, 3B2RT1) to open.

On decreasing water temperature, full load operation is not permitted until leaving water temperature falls to 56 F. On increasing water temperature, part load operation is required when leaving water temperature increases to 64 F.

Note: The setpoints above are valid only if the leaving fluid setpoint of the chiller control is 60 F or lower. If leaving fluid setpoint is greater than 60 F, load limit is energized on decreasing water temperature at 94 F and on rising leaving water temperature at 100 F.

Figure 16
Typical Component Locations for CGAC-C20K, C25K and C30K Units



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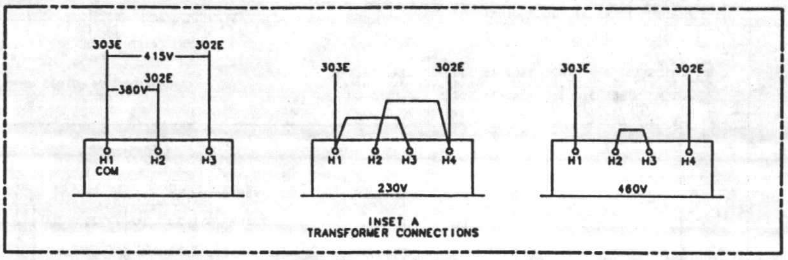
Component Legend (Outside Control Panel)	
2B1	Compressor 1
2B1HR1	Compressor 1 Crankcase Heater
2B1L3/2B1L5	Compressor 1 Unloader Solenoids
2B1RT1	Compressor 1 Winding Sensor
2B1S2	Ckt 1 High Pressure Switch
2B1S4	Ckt 1 Low Pressure Switch
4B1	Fan Motor 1 - Circuit 1
4B2	Fan Motor 2 - Circuit 1
4B3	Fan Motor 3 - Circuit 1
4L1	Ckt 1 Liquid Line Solenoid Valve
4L9	Ckt 1 Hot Gas Bypass Solenoid Valve
4RT1	Leaving Chilled Water Sensing Bulb



WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

Control Panel Legend	
1DL1	Compressor 1 PWS Time Delay
1DL7	Thermal Time Delay
1F1	Control Circuit Fuse
1F2	Compressor 1 Mtr Protector Fuse
1F4,5,6	Fuse, Condenser Fan Motor 4B1,2,3
1F10	24V Power Supply Fuse
1K3	Compressor 1 Contactor
1K5	Compressor 1 PWS Contactor
1K7	Fan Motor 4B1 Contactor
1K8	Fan Motor 4B2 Contactor
1K9	Fan Motor 4B3 Contactor
1K16	Ckt 1 Reset Relay
1K18	Ckt 1 Cooling Relay
1K20	Circuit 1 Fan Relay
1K45	Pump Down Relay
1R1	Transient Suppressor
1R2	Low Temperature Resistor
1S1	Unit-Mounted Disconnect Switch
1S5	Compressor 1 Service Switch
1S41	Unit Service Switch
1S42	Ckt 1 Fan Temperature Control
1T1	Control Power (115V) Transformer
1T15	24V Transformer
1TB1	Line Power Terminal Block
1TB3	Term. Strip: MUAA & Setpt. Reset
1TB4	Terminal Strip
1TB5	Terminal Strip
1TB7	Term. Strip: System Interconn.
1U1	Compressor 1 Current Overload
1U12	Microprocessor Chiller Control
1U13	Auxiliary Relay Module
GND	Equipment Ground Connections

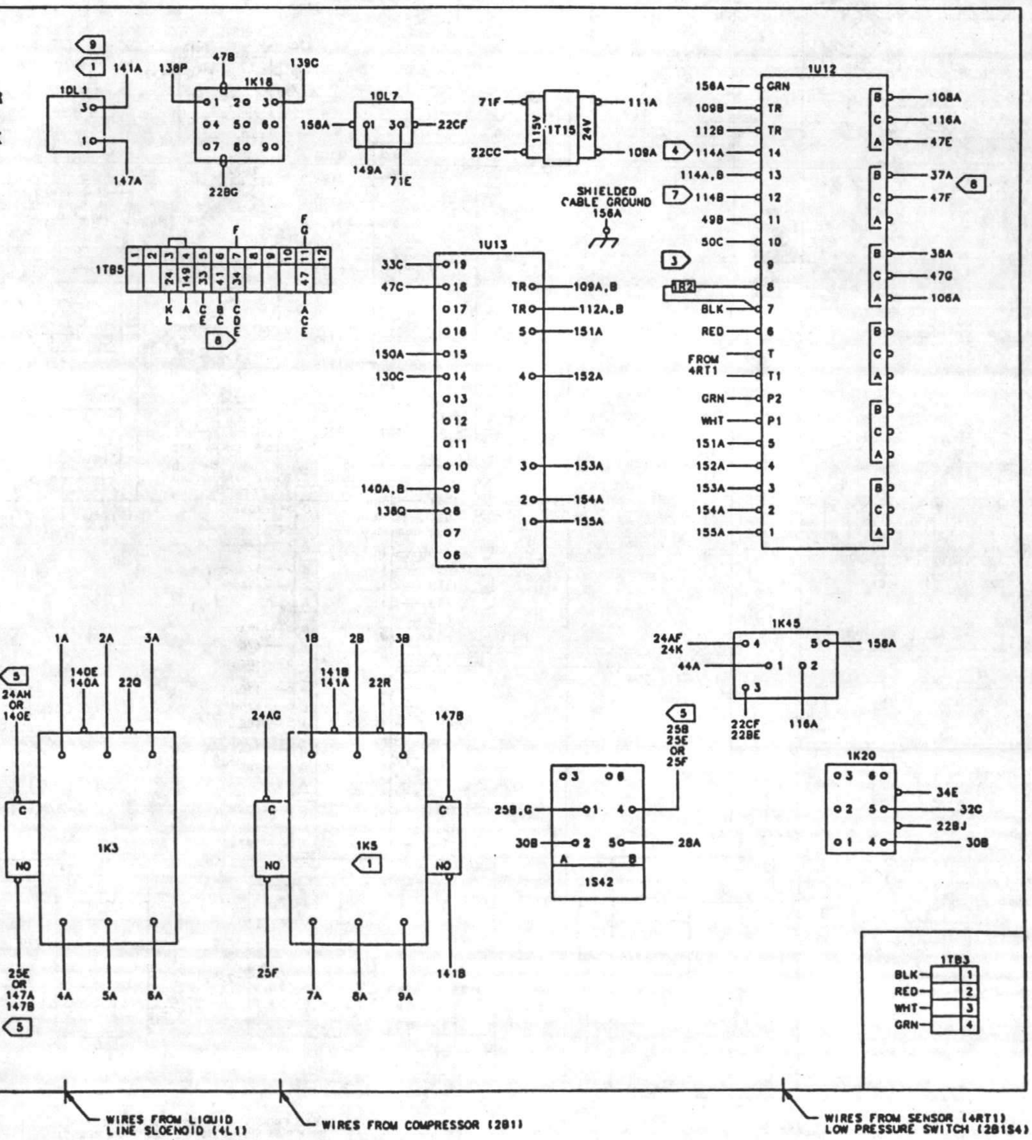


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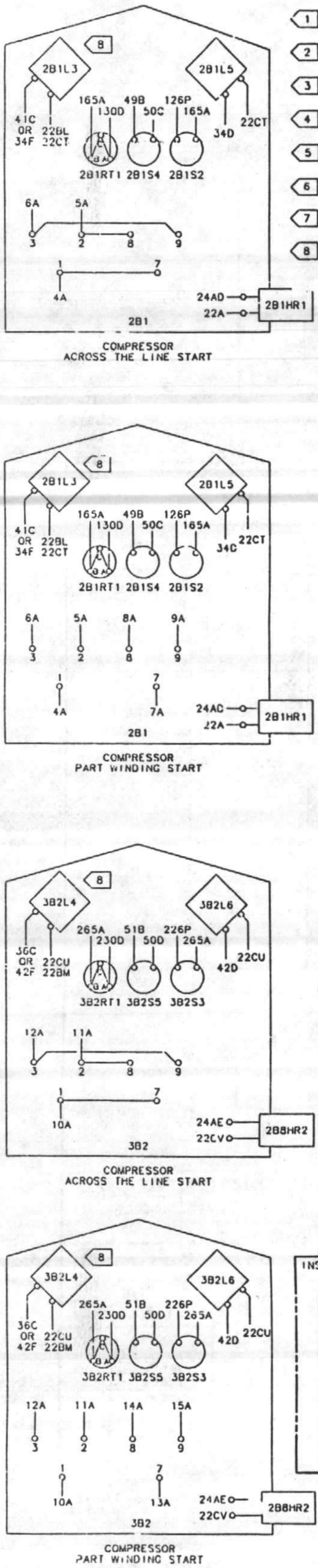
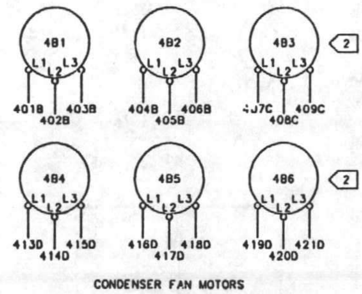
Figure 17
Typical Component Locations for CGAC-C40K, C50K and C60K Units

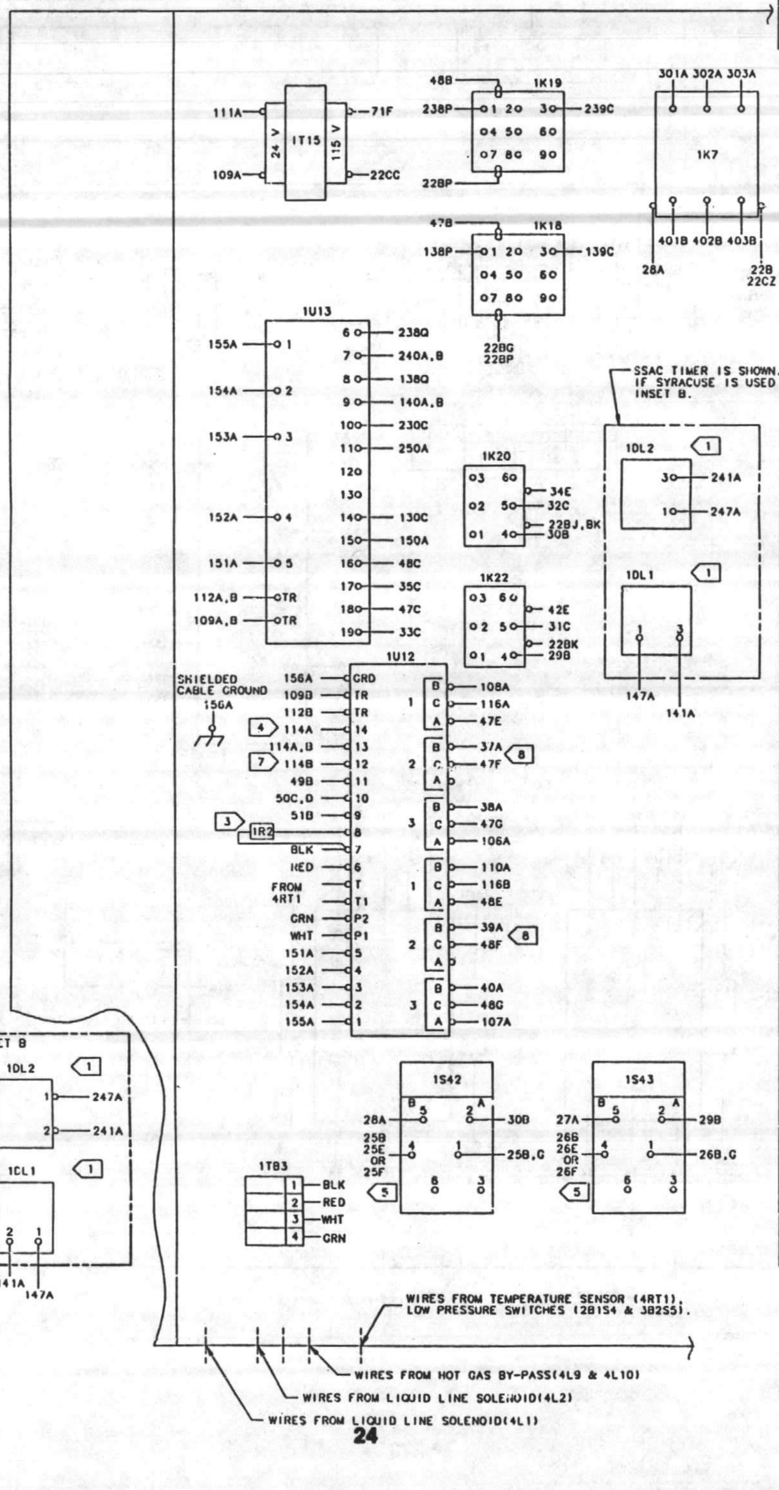


NOTES:

1. 1K5, 1K6, 1DL1, 1DL2 AND ASSOCIATED WIRING ARE USED ONLY WITH PART WINDING START COMPRESSOR UNITS.
2. 1K9, 1K13, 1K20, 1K22, 4B3, 4B6 AND ASSOCIATED WIRING ARE USED ONLY ON 50 AND 60 TON UNITS.
3. OPTIONAL LOW TEMPERATURE CONTROL RESISTOR.
4. 4L9, 4L10, JUMPER 114A AND ASSOCIATED WIRING ARE USED ONLY ON HOT GAS BYPASS OPTION.
5. WIRES 24AH, V, 25E AND 26E ARE USED ON ACROSS THE LINE ONLY.
6. TOGGLE SWITCHES ARE VIEWED FACING THE FRONT OF THE UNIT WITH KEYWAY SLOT RIGHT
7. JUMPER 114B USED ONLY ON PERIODIC PUMPDOWN OPTION.
8. 2B1L5, 3B2L6 & WIRES 34C, 34D, 36B, 36C, 37A, 39A, 41B, 41C, 42C, 42D, 22CT, 22CU USED ON 6 STEP UNLOADING ONLY. WIRES 34C, 34F, 38A, 40A, 42C & 42F USED ON 4 STEP UNLOADING ONLY.



Component Legend (Outside Control Panel)	
2B1	Compressor 1
2B1HR1	Compressor 1 Crankcase Heater
2B1L3/2B1L5	Compressor 1 Unloader Solenoids
2B1RT1	Compressor 1 Winding Sensor
2B1S2	Compressor 1 High Pressure Switch
2B1S4	Compressor 1 Low Pressure Switch
3B2	Compressor 2
3B2HR2	Compressor 2 Crankcase Heater
3B2L4/3B2L6	Compressor 2 Unloader Solenoids
3B2RT1	Compressor 2 Winding Sensor
3B2S3	Compressor 2 High Pressure Switch
3B2S5	Compressor 2 Low Pressure Switch
4B1	Fan Motor 1 - Circuit 1
4B2	Fan Motor 2 - Circuit 1
4B3	Fan Motor 3 - Circuit 1
4B4	Fan Motor 4 - Circuit 2
4B5	Fan Motor 5 - Circuit 2
4B6	Fan Motor 6 - Circuit 2
4L1	Ckt 1 Liquid Line Solenoid Valve
4L2	Ckt 2 Liquid Line Solenoid Valve
4L9	Ckt 1 Hot Gas Bypass Solenoid Valve
4L10	Ckt 2 Hot Gas Bypass Solenoid Valve
4RT1	Leaving Chilled Water Sensing Bulb



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Control Panel Legend	
1DL1	Compressor 1 PWS Time Delay
1DL2	Compressor 2 PWS Time Delay
1DL7	Thermal Time Delay
1F1	Control Circuit Fuse
1F2	Compressor 1 Mtr Protector Fuse
1F3	Compressor 2 Mtr Protector Fuse
1F4,5,6	Fuse, Condenser Fan Motor 4B1,2,3
1F4	Fuse, Condenser Fan Motor 4B1
1F5	Fuse, Condenser Fan Motor 4B2
1F6	Fuse, Condenser Fan Motor 4B3
1F7	Fuse, Condenser Fan Motor 4B1
1F8	Fuse, Condenser Fan Motor 4B2
1F9	Fuse, Condenser Fan Motor 4B3
1F10	24V Power Supply Fuse
1K3	Compressor 1 Contactor
1K4	Compressor 2 Contactor
1K5	Compressor 1 PWS Contactor
1K6	Compressor 2 PWS Contactor
1K7	Fan Motor 4B1 Contactor
1K8	Fan Motor 4B2 Contactor
1K9	Fan Motor 4B3 Contactor
1K11	Fan Motor 4B4 Contactor
1K12	Fan Motor 4B5 Contactor
1K13	Fan Motor 4B6Contactor
1K16	Ckt 1 Reset Relay
1K17	Ckt 2 Reset Relay
1K18	Ckt 1 Cooling Relay
1K19	Ckt 2 Cooling Relay
1K20	Circuit 1 Fan Relay
1K22	Circuit 2 Fan Relay
1K45	Pump Down Relay
1R1	Transient Suppressor
1R2	Low Temperature Resistor
1S1	Unit-Mounted Disconnect Switch
1S5	Compressor 1 Service Switch
1S6	Compressor 2 Service Switch
1S41	Unit Service Switch
1S42	Ckt 1 Fan Temperature Control
1S43	Ckt 2 Fan Temperature Control
1T1	Control Power (115V) Transformer
1T15	24V Transformer
1TB1	Line Power Terminal Block
1TB3	Term. Strip: MUAA & Setpt. Reset
1TB4	Terminal Strip
1TB5	Terminal Strip
1TB7	Term. Strip: System Interconn.
1U1	Compressor 1 Current Overload
1U2	Compressor 2 Current Overload
1U12	Microprocessor Chiller Control
1U13	Auxiliary Relay Module
GND	Equipment Ground Connections

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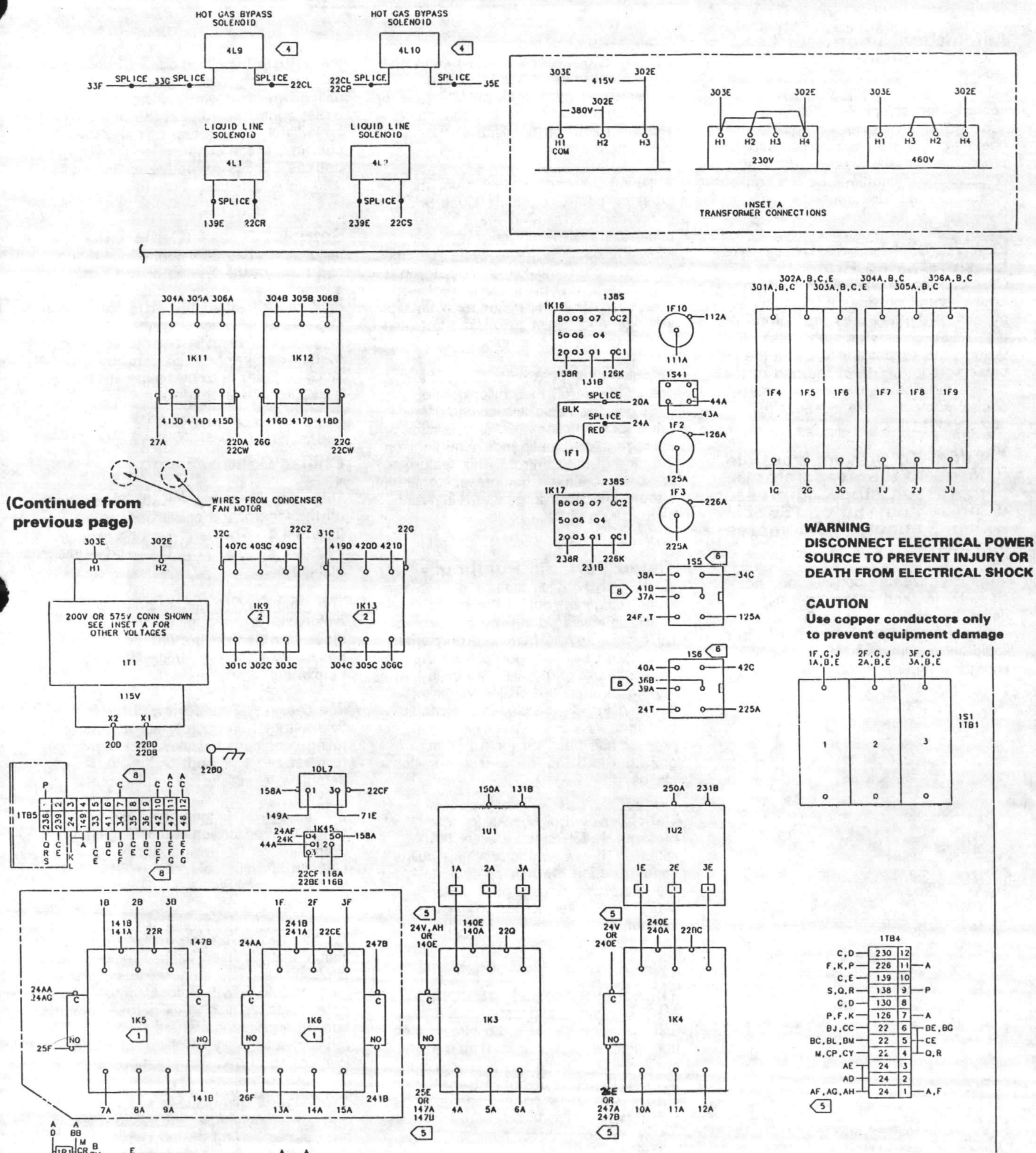

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

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Automatic Compressor Lead-Lag Sequencing. Any time both compressors are shut down due to no call for cooling from the chiller control, the compressor lead/lag sequencing is reversed to equalize operating time for each compressor. When the unit shuts down, the first compressor to stop will be the first to start on the next operating cycle.

Low Ambient Time Delay and Loss-of-Charge Protection. On a call for a compressor start, the chiller control provides a three-minute bypass of the low pressure control (2B1S4 or 3B2S5) to allow enough pressure to build in the evaporator to close the low pressure control. If, at the end of the three-minute delay, the low pressure control contacts have closed, the compressor will run.

Caution: To prevent possible damage to the evaporator or compressor, stop compressor using switch 1S5 or 1S6 if within 3 minutes of compressor start.

If the low pressure control does not close by the end of the three-minute delay, the chiller control will deenergize the compressor but keep the liquid line solenoid valve (4L1 or 4L2) energized (open) for one minute.

If the low pressure control does not close during the one-minute period, the chiller control will close the liquid line solenoid valve, lock out compressor operation and energize a diagnostic indicating light on the face of the chiller control.

If, during the one-minute period, the low pressure control contacts close, the chiller control will start the compressor. The chiller control will allow the compressor to cycle five times (during a constant call for cooling) in response to low pressure control operation. The chiller control maintains a ten-second minimum off-time between each attempted compressor start.

After five attempted restarts on the low pressure control, the chiller control will close the liquid line solenoid valve, lock out compressor operation and energize a diagnostic indicating light on the face of the control. This feature prevents continued compressor operation if there has been a loss of refrigerant charge from either circuit.

Timed Periodic Pumpout (Optional). This feature is used to pump refrigerant out of the evaporator at regular intervals during the compressor Off cycle. This is permitted only when there is no call for cooling from the chiller control and chilled water is flowing through the chiller (water flow-sensing device closed). Periodic pumpout will occur whenever either compressor has been off for a minimum of one hour and the low pressure switch closes.

The chiller control checks for low pressure switch closure every 60 minutes. If evaporator pressure builds enough during the unit off-cycle to close the low pressure control of either circuit, the chiller control will start and run the compressor until the low pressure control re-opens.

Timed Hot Gas Bypass (Optional). The hot gas bypass option allows unit operation below the minimum step of unit unloading, pulling in 1UK28 in the auxiliary relay module and energizing the hot gas bypass solenoid valve (4L9 or 4L10). The chiller control energizes hot gas bypass when the cooling load falls below the compressor minimum stage of unloading (1U12 first-stage contacts remain closed).

The unit will operate for 30 minutes in the hot gas bypass mode. If there is no call for cooling during this time, the unit will pump down and stop. The chiller control will restart the unit immediately on a return call for cooling. These units are equipped with hot gas bypass on both circuits to allow lead-lag sequencing.

Setpoint Reset (Optional). This feature provides continuous monitoring and reset of the leaving chilled water setpoint in response to changes in outdoor air temperature or to temperature changes in a selected zone. The magnitude of reset is determined by system design conditions and by how much ambient or zone temperature deviates from these conditions.

Chiller Control Setup

There are three setpoint adjustment dials on the face of the chiller control (Figure 18). They are: Leaving Fluid Setpoint, F; Design Δ T, F; and Number of Stages.

The <u>number of stages setpoint</u> is factory-set at the number of control steps provided on the unit. It is not necessary to change this setting for normal unit operation.

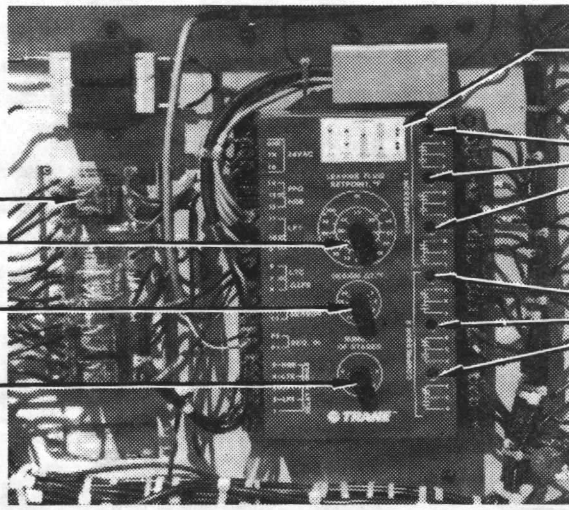
The design Δ T setpoint and the leaving fluid setpoint are factory set at ARI rating conditions. It may be necessary to reset either or both of these setpoints to satisfy job requirements.

Set the <u>design Δ T setpoint</u> (Figure 18) at the desired chilled water temperature drop through the evaporator. This setpoint is adjustable from 4 F to 20 F in 2 F increments.

The <u>leaving fluid setpoint</u> dial (Figure 18) has two calibration scales. The inside scale is used for low temperature applications. The range of this scale is -20 F to +40 F in 5 F increments. The outer scale is used in all normal comfort cooling applications where there is no requirement for glycol or an unusually low leaving chilled water temperature.

The range of this scale is +40 F to +100 F in 5 F increments. Set this dial for the desired leaving chilled water temperature at the evaporator water outlet.

Figure 18
Chiller Control (1U12) Components and Auxiliary Relay Module (1U13)



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Chiller Control Operation

Each time chiller control (1U12) is energized, it will initiate a four-minute start mode. During this start delay, the "start mode" LED on the face of the chiller control will be energized (Figure 19). If leaving chilled water temperature (as sensed by the chiller control sensing bulb in the evaporator water outlet) is below the chiller control leaving fluid setpoint at the end of this four-minute timing period, the start mode LED will deenergize without starting the compressor.

When leaving chilled water temperature rises above the leaving fluid setpoint, the chiller control first stage contacts close. This will provide power to the Compressor 1 contactors. When the chiller control first stage contacts close, the number 1 LED for Compressor 1 will energize (Figure 19).

Once the unit is operating normally, the chiller control will load, unload and cycle the compressors on and off in response to the perceived cooling load at the evaporator water outlet. The rate at which the chiller control loads or unloads the unit is determined by two factors: the temperature change rate of the chilled water leaving the evaporator, and the temperature differential between actual leaving water temperature and the leaving fluid setpoint as set on the chiller control (Figure 19).

Chiller Control Operating Indicators

The operating mode of the unit is indicated at all times by the red LED's on the face of the chiller control (Figure 19). Operating modes include:

Compressor 1 - Step 1 Loaded
Compressor 1 - Steps 1 and 2 Loaded
Compressor 1 - Full Load
Compressor 1 - Full Load, Compressor 2 - Step 1 Loaded
Compressor 1 - Full Load, Compressor 2 - Steps 1 and 2 Loaded
Compressor 1 - Full Load, Compressor 2 - Full Load
Load Limit Operation.

Chiller Control Diagnostic Indicators

The red LED's on the chiller control also display five different diagnostic states which can occur during operation. A label mounted on the front of the control above the leaving fluid setpoint dial (Figure 19) identifies the diagnostic conditions.

These conditions, illustrated in Figure 19, include the following:

Start Mode
Setpoint/Low Temperature Control Overlap
Compressor 1 - Low Pressure Lockout
Compressor 2 - Low Pressure Lockout
Low Temperature Control Lockout.

Start Mode. The start mode diagnostic indicator (Figure 19) will light immediately when the chiller control is energized. This indicates that the control is functioning normally, proceeding through its four-minute start time delay. The start mode diagnostic will also energize any time that the chiller control is repowered when the unit is reset after a safety lockout or that power is removed from the control for any other reason.

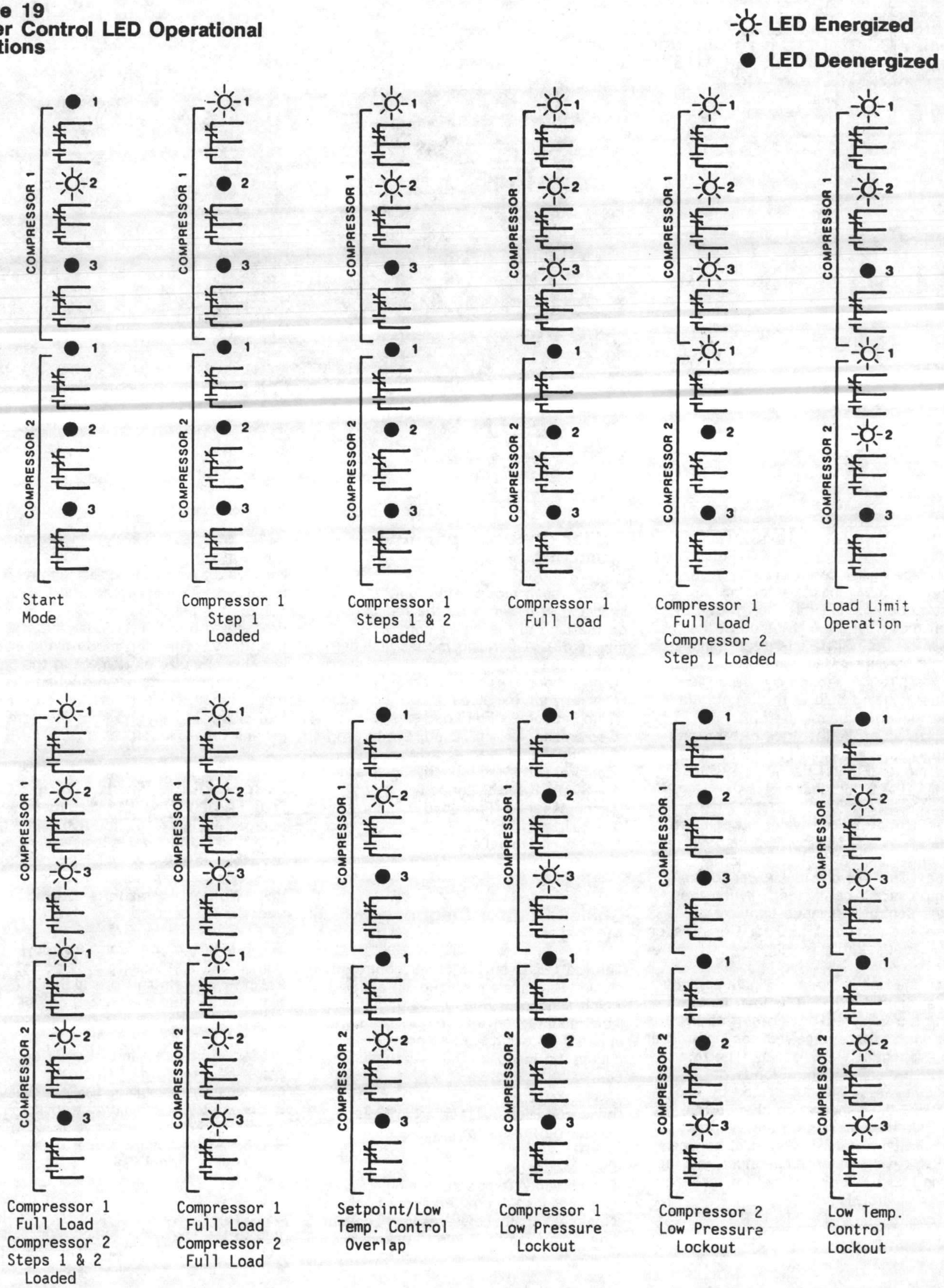
Setpoint/Low Temperature Control Overlap. If this diagnostic energizes (Figure 19), the minimum permitted leaving water temperature is too close to the low water temperature (freezestat) cutout setting for the unit. No unit operation is allowed under these conditions.

To correct this condition and allow normal unit operation, slowly adjust the leaving fluid setpoint to a higher temperature until the control setpoint overlap diagnostic lights go off.

Note: Turn the setpoint dials on the chiller control slowly. Once the setpoints are established, allow the chiller control a minimum of 10-15 seconds to compute the value of the new setpoints and compare this to the low temperature cutout limit.

If the desired leaving fluid setpoint or design △ T setpoint cannot be selected due to the low water temperature limit (35 F), contact The Trane Company for information on special applications.

Figure 19
Chiller Control LED Operational Functions



Low Temperature Lockout. The low temperature lockout diagnostic (Figure 19) will energize any time leaving water temperature falls to the low water temperature limit for the unit. This diagnostic indicates that a potential freeze condition was detected during operation. The chiller control is locked out from further operation and the diagnostic will remain energized until the condition is corrected and the unit manually reset. Refer to "Evaporator Freeze Protection".

Compressor 1/Compressor 2 Low Pressure Lockout. The diagnostic lights for Compressor 1 or Compressor 2 low pressure lockout (Figure 19) will energize and lock out the compressor if either low pressure control (2B1S4, 3B2S5) opens during normal operation. This condition for one compressor does not affect the operation or loading of the remaining compressor which may continue to operate normally.

The compressor and chiller control are prevented from further operation until the unit control circuit is manually reset. Refer to "Reset Relays" and "Low Ambient Time Delay and Loss of Charge Protection".

Part Winding Start Timers (1DL1, 1DL2)

The part winding start timer is used on each compressor that utilizes a part winding starter. When compressor contactor 1K3 or 1K4 closes, a set of 1K3 or 1K4 auxiliary contacts also close to energize the timer and provide a 0.5-second time delay before pulling in the second contactor. When the 0.5-second time delay has elapsed, contactors 1K5 or 1K6 are energized and held in through an auxiliary contact on the contactors.

Compressor Unloader Solenoid Valves

The compressor unloader solenoids for the model K compressor deenergize to load the compressor and energize to unload. Unloader solenoids for CGAC units with model K compressors are 2B1L3 and 2B1L5 for compressor 1 and 3B2L4 and 3B2L6 for compressor 2.

Low Pressure Switches (2B1S4, 3B2S5)

The low pressure switches (2B1S4 and 3B2S5) prevent compressor overheating due to extended periods of operation at extremely low suction pressures and are used to provide a pumpdown cycle and loss of charge protection for each compressor circuit. The normally closed contacts of the low pressure switches close on a rise in suction pressure and open on a drop in pressure at the setpoints given in "Service Data".

Hot Gas Bypass Regulating Valve

The hot gas bypass regulating valves (Figure 20) are adjustable modulating control valves located on a branch hot gas line off the compressor discharge line. The valves act as evaporator pressure regulators by opening on a decrease in suction pressure to maintain a desired minimum evaporating pressure regardless of a decrease in evaporator external loading. When evaporator (suction) pressures are above the valve's setpoints, they remain closed. As suction pressures fall below the valve's setpoints, the valves begin to open. If suction pressures continue to drop, the valves open proportionally to keep evaporating pressure up.

Valve Setpoint. Hot gas bypass valves are adjustable through a 0-80 psig range. They should be set to begin opening at 69 psig suction pressure. The valves should be full open at 61 psig. The hot gas bypass system should be set up to maintain a net Δ T across the evaporator of 0 F at minimum step of unloading (during hot gas bypass operation).

Condenser Fan Operation

Condenser fan locations are shown in "Service Data". Fan sequencing is as follows:

20-Ton Unit

Fan 2 starts with compressor start, stops when the compressor stops. Fan 1 starts when ambient temperature rises above 73 F, stops when ambient temperature falls to 65 F.

25 and 30-Ton Unit

Fan 2 starts with compressor start, stops when the compressor stops. Fan 1 starts when ambient temperature rises above 73 F, stops when ambient temperature falls to 65 F. Fan 3 starts with second stage call for cooling from the chiller control (1U12) when ambient temperature is above 53 F, stops when ambient temperature falls below 45 F.

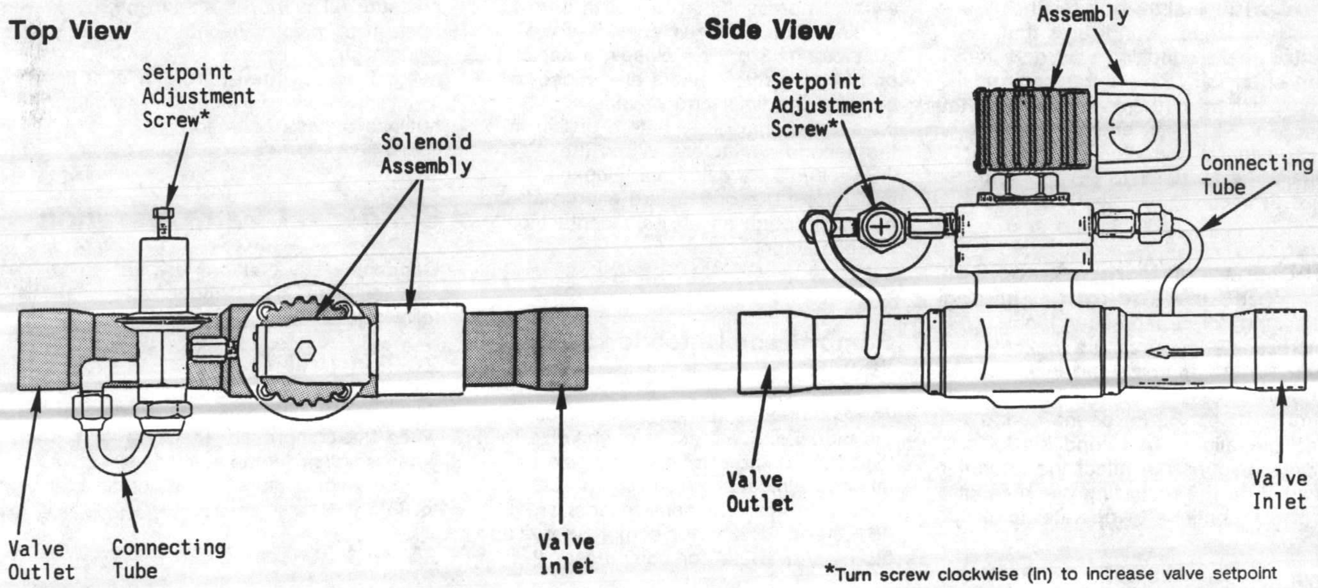
40-Ton Unit

Fan 2 starts and stops with compressor 1. Fan 5 starts and stops with compressor 2. Fan 1 starts when ambient temperature is above 73 F, stops when ambient temperature falls below 65 F. Fan 4 starts with compressor 2 when ambient temperature is above 73 F, stops when ambient temperature falls to 65 F.

50 and 60-Ton Unit

Fan 2 starts and stops with compressor 1. Fan 5 starts and stops with compressor 2. Fans 1 and 3 start with compressor 1 when ambient temperature rises to 73 F, stop when ambient temperature falls to 65 F. Fans 4 and 6 start with compressor 2 when ambient temperature reaches 53 F, stop when ambient falls to 45 F.

Figure 20
Typical Hot Gas Bypass Regulating Valve



*Turn screw clockwise (in) to increase valve setpoint and counterclockwise (out) to decrease setpoint.

Maintenance

Periodic Maintenance

Perform all maintenance procedures and inspections at the recommended intervals. This will prolong the life of the equipment and reduce the possiblity of costly equipment failures.

Use an "Operator's Log" such as the one at the back of this manual to record a weekly "operating conditions history" for this unit. The operating log for this unit can be a valuable diagnostic tool for service personnel. By noticing trends in the operating conditions, the operator can often foresee and prevent problem situations before they become serious.

If the unit does not operate properly during maintenance inspections, refer to "Trouble Analysis".

Weekly Maintenance

Once the unit has been operating for about 30 minutes and the system has stabilized, check operating conditions and complete the checkout procedures that follow.

[ ] Check compressor oil levels. Oil should be visible in the sight glass when the compressor is running. Refer to "Checking Operating Conditions".

Operate the compressors at full load for a minimum of three to four hours when checking oil level, and check level every 30 minutes. If oil is not at proper level after this period, have a qualified service representative add or remove oil as required. Refer to "Service Data" for recommended refrigerant oils and correct oil charges for these units.

[ ] Check suction pressure and discharge pressure at the gauges on the unit. Refer to "Checking Operating Conditions".

[ ] Check the liquid line sight glasses. Refer to "Checking Operating Conditions". Refrigerant charges for CGAC units are provided in "Service Data".

[ ] If operating pressures and sight glass conditions seem to indicate refrigerant shortage, measure system superheat and system subcooling. Refer to "System Superheat" and "System Subcooling".

[ ] If operating conditions indicate an overcharge, slowly (to minimize oil loss) remove refrigerant at the liquid line service valve. Do not discharge refrigerant into the atmosphere.

WARNING: To prevent injury due to frostbite, avoid skin contact with refrigerant.

Monthly Maintenance

[ ] Perform all weekly maintenance procedures.

[ ] Measure and record system superheat. Refer to "System Superheat".

[ ] Measure and record system subcooling. Refer to "System Subcooling".

[ ] Manually rotate condenser fans to insure proper orifice clearance.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

Annual Maintenance

[ ] Perform all weekly and monthly maintenance procedures.

[ ] Have a qualified service technician check the setting and function of each control and inspect the condition of and replace compressor and control contactors if needed.

[ ] If chiller is not piped to drain facilities, make sure drain is clear to carry away system water.

[ ] Drain water from evaporator and associated piping systems. Inspect all piping components for leakage, damage, etc. Clean out any in-line water strainers.

[ ] Clean and repaint any corroded surface.

[ ] Check low ambient dampers for proper operation.

[ ] Clean condenser coils. Refer to "Coil Cleaning".

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

[ ] Inspect the expansion valve sensing bulbs for cleanliness. Clean if required. Sensing bulbs must make good contact with suction lines and be properly insulated.

[ ] Clean condenser fans. Check fan assemblies for proper orifice clearance and for motor shaft misalignment, abnormal end-play or vibration and noise.

WARNING: To prevent injury or death due to contact with rotating parts, open and lock all electrical disconnects.

Maintenance Procedures

This section describes specific maintenance procedures which must be performed as a part of the normal maintenance program for this unit. Be certain that electrical power to the unit is disconnected before performing these procedures.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

Coil Cleaning

Clean the refrigerant coil at least once each year (or more frequently if the unit is located in a "dirty" environment) to help main proper unit operating efficiency. Follow the detergent manufacturer's instructions as closely as possible to avoid potential damage to the coils.

To clean the refrigerant coil, a soft brush and sprayer (i.e., either garden pump-up type or high-pressure) must be used. In addition, a high-quality detergent is required; suggested brands include "SPREX A.C.", "OAKITE 161", "OAKITE 166", and "COILOX".

Note: If the detergent is strongly alkaline (i.e., has a pH value greater than 8.5) after mixing, an inhibitor must be added.

Chemically Cleaning the Evaporator

The chilled water system is a closed loop. It should not accumulate an appreciable amount of scale or sludge. If the chiller is fouled, first try to dislodge foreign material by backflushing the system several times. If this does not work, chemically clean the chiller.

Chemical cleaning is the most satisfactory method of cleaning scale from water vessels. With this treatment, scale is dissolved and flushed away by circulating a chemical solution around the tubes and headers.

CAUTION: Do not use an acidic type cleaning agent that will damage the steel, galvanized steel and copper internal evaporator components.

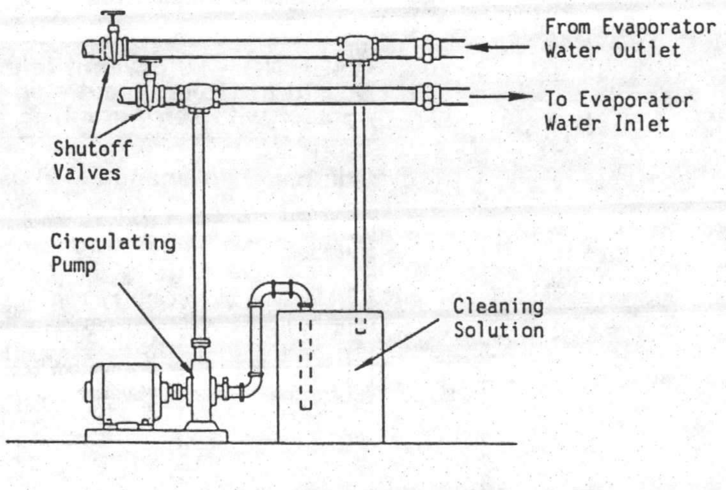
With this information, water treatment firms will be able to recommend a suitable chemical for this purpose. If water treatment is not available, consult a chemical supply house.

Figure 21 illustrates a typical chemical cleaning arrangement. All materials used in the chemical (external) circulating system, quantity of cleaning material, duration of cleaning and any safety precautions relative to the handling of the cleaning agent must be provided or approved by the supplier of the cleaning agent.

Water Treatment

The use of untreated or improperly treated water in these units may result in the formation of scale, erosion, corrosion, algae or slime. It is recommended that the services of a qualified water treatment specialist be engaged to determine what treatment, if any, is required. The Trane Company assumes no responsibility for equipment failure that results from the use of untreated or improperly treated water.

Figure 21
Typical Circulating Arrangement for Chemical Cleaning of Evaporator



Trouble Analysis

Preliminary Trouble Inspection

If operational difficulties are encountered, be sure to perform these preliminary checks before referring to the troubleshooting charts:

[ ] Check the chiller control (1U12) to ensure that all setpoints are set correctly, and that it is getting control power.

[ ] Verify that the unit is receiving electrical supply power, and that the fuses in the fused disconnect switches are intact.

[ ] Check the evaporator for proper water supply and condenser for proper air flow. Check the flow switches for proper operation, and take pressure drop readings across the evaporator and Δ T readings across the condenser coils.

After completing the preliminary checks described above, be sure to inspect the unit for other obvious problems such as leaking water connections, broken or disconnected wires, etc. If everything appears to be in order, but the unit still fails to operate properly, refer to the following troubleshooting charts and contact a qualified service technician.

Troubleshooting Charts

The troubleshooting charts that follow are provided to serve as an aid for identifying malfunctions that may occur. Within each chart are three columns: (1) the Symptom column describes what the unit is doing; (2) the Probable Cause column identifies the most likely sources of the problem; and, (3) the Recommended Action column describes what should be done to correct the problem.

Note: The troubleshooting charts that follow are provided only to help identify the cause of an operating malfunction. If this happens, The Trane Company recommends that qualified service personnel be contacted to ensure proper diagnosis and repair procedures.

WARNING: To avoid injury or death due to electrical shock never open access panels to inspect or service the unit without first opening all disconnect switches.

Compressor Short Cycles

Symptom	Probable Cause	Recommended Action
Normal operation except too frequent starting and stopping.	Intermittent contact in electrical control circuit.	Repair or replace faulty control.
L.L. solenoid valve hisses when closed. High temperature differential on each side of valve.	Leaky liquid line solenoid valve.	Repair or replace solenoid valve.
Rapid cycling on low pressure control. Bubbles in liquid line sight glass.	Refrigerant shortage.	Repair refrigeant leak and recharge.
Compressor will not load or unload.	Inoperative compressor unloading system.	Repair or replace faulty control.

Compressor Runs Continuously

Symptom	Probable Cause	Recommended Action
Low temperature in conditioned area.	Chiller control malfunction or set incorrectly.	Reset or test and replace chiller control.
	"Welded" control contacts in motor starter circuit.	Replace contacts.
	Liquid line solenoid valve stuck open.	Repair or replace solenoid valve.
Compressor noisy. Discharge pressure too low. Suction pressure too high.	Leaky valves in compressor.	Repair or replace compressor.
Leaving chilled water temperature too high.	Excessive system load.	Reduce load. Reduce water flow if needed.
	Chiller control malfunction or set incorrectly.	Reset, or test and replace chiller control.

Compressor Fails to Start

Symptom	Probable Cause	Recommended Action
Chiller control (1U12) "Start Mode" LED energized.	Chiller control has not completed 4-minute "Start-Mode" time delay.	Allow 1U12 to complete "Start Mode" LED will deenergize after 4 minutes and unit will run.
Chiller control (1U12) "Setpoint/ Low Temp. Overlap" LED energized.	Minimum allowed leaving chilled water temperature too close to low temperature cutout (freezestat) setpoint.	Adjust "leaving fluid setpoint" of 1U12 to higher temperature.
Chiller control (1U12) "Low Temperature Lockout" LED energized.	Leaving chilled water temperature below low temperature control (freezestat) setpoint.	Allow leaving chilled water temperature to rise. Operate at higher "leaving fluid setpoint" or install proper "low temperature resistor".
Chiller control (1U12) "Low Pressure Lockout" LED energized.	Suction pressure too low due to refrigerant loss.	Check system charge. Repair leak and recharge.
	Suction pressure too low due to operation below minimum operating ambient.	Add low ambient damper kit.
	Suction pressure too low due to inoperative liquid line solenoid valve.	Repair or replace solenoid valve.
	Suction pressure too low due to inoperative low ambient damper(s).	Repair or replace low ambient damper components.
No current on line side of motor starter.	Power failure.	Check for blown line fuse or broken lead.
	Disconnect switch open.	If system is in working order, close disconnect.
Voltage present on line side of fuse. No voltage on motor side.	Fuse blown.	Replace fuse. Check load on compressor.
Improper voltage reading.	Low voltage.	Call power company.
Full voltage at motor terminals. Motor will not run.	Motor burned out.	Replace or repair compressor or motor.
Motor starter inoperative.	Motor starter contacts or holding coil burned out.	Repair or replace motor starter.
Motor starter holding coil not energized.	Open control circuit.	Locate control, determine cause and correct.
Compressor will not run.	Frozen compressor. Locked-up or internally damaged.	Repair or replace compressor.
High pressure switch open.	Discharge pressure too high.	Refer to "Discharge Pressure Too High".
Motor starter will not pull in.	Motor overload contacts open.	Determine cause and correct. Reset overload.
Flow switch contacts open.	Restricted or no water flow. Flow switch malfunction.	Restore water flow. Test flow switch and repair or replace.

Compressor Is Noisy

Symptom	Probable Cause	Recommended Action
Compressor knocks. Too frequent starting and stopping.	Internal compressor damage.	Repair or replace compressor.
Excessively cold suction line due to liquid floodback to compressor.	TEV set incorrectly.	Check and adjust superheat.
	TEV sensing bulb dirty, not properly insulated or loose on suction line.	Inspect sensing bulb. Clean, tighten or reinsulate as needed.
	TEV stuck open.	Clean, repair or replace TEV.

System Short of Capacity

Symptom	Probable Cause	Recommended Action
Superheat reading high. Suction pressure unstable.	Flash gas in liquid line.	Check refrigerant charge and add refrigerant if needed.
High temperature differential on either side of filter drier or solenoid valve.	Restricted drier core or solenoid valve orifice.	Replace drier or clean/replace solenoid valve.
Compressor short-cycling.	TEV sticking or partially blocked.	Repair or replace TEV.
Oil foaming in compressor. Leaving chilled water temperature too high or too low.	TEV adjusted incorrectly.	Check and adjust superheat.
Insufficient water pressure drop across evaporator.	Reduced water flow. Water supply problem or obstruction in water line.	Restore water supply or remove obstruction from water line.

Suction Pressure Too High

Symptom	Probable Cause	Recommended Action
Excessively cold suction line due to liquid floodback to compressor.	TEV overfeeding.	Check and adjust superheat. TEV sensing bulb must be clean, insulated, have good contact with suction line.
	TEV stuck open.	Clean, repair or replace TEV.
Compressor runs continuously.	Evaporator overloaded.	Refer to "Compressor Runs Continuously".
Compressor noisy. Leaving chilled water temp. too high or too low.	Compressor suction valves damaged.	Remove head, inspect valves and replace damaged valves.

Suction Pressure Too Low

Symptom	Probable Cause	Recommended Action
Bubbles in liquid line sight glass.	Refrigerant loss.	Check system charge. Repair leak and recharge.
High temperature differential on either side of filter drier or solenoid valve.	Restricted drier core or solenoid valve orifice.	Replace drier or clean/replace solenoid valve.
No refrigerant flow through TEV.	TEV power element charge lost.	Replace TEV.
Loss of system capacity.	TEV sticking or partially blocked.	Clean/repair or replace TEV.
Insufficient water pressure drop across evaporator.	Reduced water flow. Water supply problem or obstruction in water line.	Restore water supply or remove obstruction from water line.

Discharge Pressure Too High

Symptom	Probable Cause	Recommended Action
Excessively cold air leaving condenser. Insufficient Δ T through condenser. Good air flow.	Refrigerant overcharge.	Slowly remove refrigerant to obtain proper subcooling reading.
	Air or non-condensible gas in system.	Remove contaminant from the system.
Air leaving condenser too cold. Insufficient Δ T through condenser.	Condenser coil blocked.	Clean condenser coil.
Leaving chilled water temperature too hot.	Excessive system load.	Reduce load. Reduce water flow if needed.

Discharge Pressure Too Low

Symptom	Probable Cause	Recommended Action
Insufficient Δ T through condenser coil.	Low temperature condensing air.	Provide adequate head pressure controls.
Bubbles in liquid line sight glass.	Refrigerant loss.	Check system charge. Repair leak and recharge.
Suction pressure rise exceeds 5 psig/minute after system shutdown.	Damaged or leaking compressor discharge valves.	Remove head, inspect and replace damaged or worn valves.

Compressor Loses Oil

Symptom	Probable Cause	Recommended Action
Excessively cold suction line due to liquid floodback to the compressor.	TEV set incorrectly. Refrigerant carries oil out of compressor.	Check and adjust superheat.
	TEV sensing bulb dirty, not properly insulated or loose on suction line. Refrigerant carries oil out of compressor.	Inspect sensing bulb. Clean, tighten or replace as needed.
	TEV stuck open. Refrigerant carries oil out of compressor.	Clean, repair or replace TEV.
Oil level too low.	Insufficient oil charge.	Add oil to proper system charge.
Oil level gradually drops.	Plugged liquid line filter drier.	Replace filter drier or drier core.
Compressor stops and starts too often. Low oil level.	Compressor short-cycling.	Refer to "Compressor Short Cycles".
Oil evident on and around compressor.	Compressor crankcase fittings leak.	Repair leaks and recharge system with proper oil charge.
Oil leaves sight glass rapidly.	Defective unloader "O" rings.	Repair or replace compressor.

Chiller Control (1U12) Test Procedure

To determine whether or not the chiller control module (1U12; see Figures 16, 17 and 18) is functioning properly, obtain TOL-101 (which includes a diagnostic plug and necessary resistor) from Trane LaCrosse and perform the checkout procedure outlined below:

1. Deenergize the CGAC unit.

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

2. Disconnect wires 116A and 116B from terminal 2 of relay 1K45, all wires connected to the terminals on the left side of the chiller control (1U12) and all external connections to the auxiliary relay module (1U13) except for the 24 VAC supply power wires to each control, ground wire and the five wires which connect the chiller control and auxiliary relay module. See Figures 22 and 23 for electrical schematics of the wiring connected to these controls.

3. Insulate the exposed ends of all of the leads removed in Step 2; this is important since some of these leads will be "hot" when the panel is re-energized.

WARNING: Use care when measurements or adjustments must be made with the power on to prevent injury or death due to electrical shock.

4. Remove the red diagnostic port cover from the bottom of the chiller control module and insert the diagnostic plug from TOL-101.

5. Energize the unit control panel and observe the LED indicator lights; none of the LEDs should be illuminated at this time.

6. Measure the power supply voltage between the 24 VAC input terminals (i.e., Terminals TR and TR) on the chiller control module; the reading obtained should be 25 ± 5 VAC.

If the power supply voltage does not fall within the acceptable range, check for a defective fuse or 24 VAC transformer.

7. Measure the power supply voltage between Terminals TR and TR (i.e., the 24 VAC input terminals) on the auxiliary relay board; again, the reading obtained should be 25 ± 5 VAC.

If the power supply voltage does not fall within the acceptable range, check for a defective fuse or 24 VAC transformer.

8. At this time all output relays on the chiller control and the auxiliary relay module should be in their deenergized state; measure the resistance across all relay contact terminals to verify that this is true. (On the auxiliary relay board all contacts should be open except between terminals 12 and 13.)

If any of the relay contacts are not in the correct state the component on which that relay is mounted must be replaced.

Caution: Complete the following procedure in the sequence given. Any step completed out of sequence will require a restart of the entire test.

9. Turn the "Leaving Fluid Setpoint" knob on the chiller control (1U12) to the full counterclockwise position.

10. Momentarily short chiller control Terminals P1 to T1; the No. 1 LED of "Compressor 1" should light.

If this does not occur, remove and reinsert the diagnostic plug (TOL-101); then repeat Step 10. If the "Compressor 1, No. 1" LED still fails to energize, replace the chiller control (1U12).

11. Slowly rotate the "Leaving Fluid Setpoint" knob clockwise, pausing at least 10 seconds at each setting given below. As the dial is rotated up through the "Leaving Fluid Setpoint" temperature settings, the remaining LEDs will light at the following points (the "Compressor 1, No. 1" LED is already on; see Step 10):

Dial Setting	Energizes LED
46±2 F	Comp. 1 - No. 2
58±2 F	Comp. 1 - No. 3
70±2 F	Comp. 2 - No. 1
82±2 F	Comp. 2 - No. 2
94±2 F	Comp. 2 - No. 3

If the LEDs fail to light as indicated above, replace the chiller control (1U12).

12. Slowly rotate the "Leaving Fluid Setpoint" knob counterclockwise, pausing at each setting given in Step 11. Each LED will go off in turn, reversing the sequence in Step 11. The "Compressor 1, No. 1" LED will not go out, however, even when the dial is returned to full counterclockwise position.

13. Turn the "Design Δ T" knob to the full counterclockwise position.

14. Momentarily short chiller control Terminals P2 to T1; the No. 1 LED of "Compressor 1" should remain lit.

If this does not occur, replace the chiller control (1U12).

15. Slowly rotate the "Design Δ T" knob clockwise, pausing at least 10 seconds at each setting given below. As the dial is rotated up through the "Design Δ T" temperature settings, the remaining LEDs will light at the following points (the "Compressor 1, No. 1" LED is already on; see Step 14):

Dial Setting	Energizes LED
5.6±1 F	Comp. 1 - No. 2
8.8±1 F	Comp. 1 - No. 3
12.0±1 F	Comp. 2 - No. 1
15.2±1 F	Comp. 2 - No. 2
18.4±1 F	Comp. 2 - No. 3

If the LEDs fail to light as indicated above, replace the chiller control (1U12).

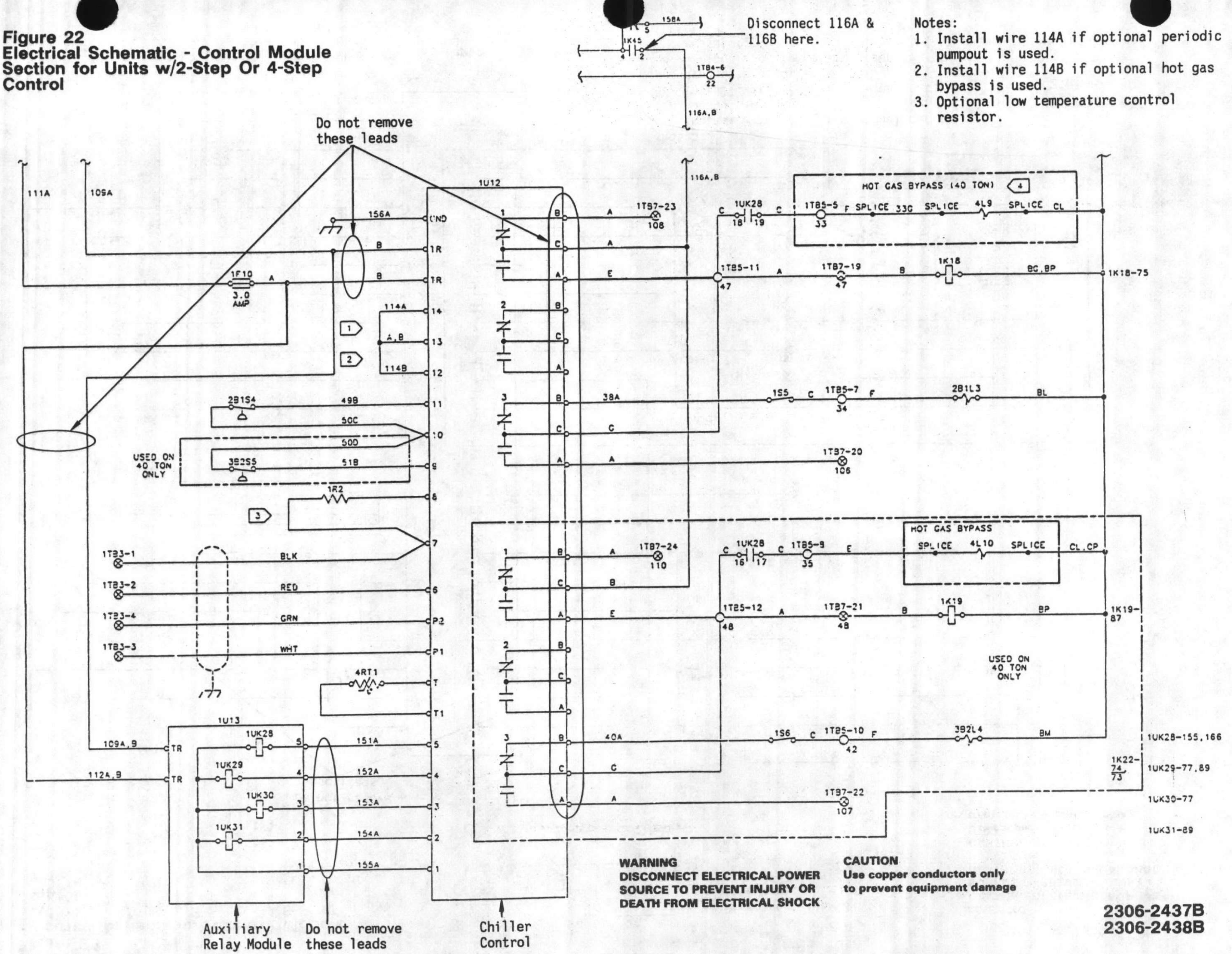
16. Slowly rotate the "Design Δ T" knob counterclockwise, pausing at each setting given in Step 15. Each LED will go off in turn, reversing the sequence in Step 15. The "Compressor 1, No. 1" LED will not go out, however, even when the dial is returned to full counterclockwise position.

17. Turn the "Number of Stages" knob to the full counterclockwise position.

18. Momentarily short chiller control Terminals P1 to T1; the "Compressor 1, No. 1" LED remains lighted and the "Compressor 1, No. 2" LED should also light.

If this does not occur, replace the chiller control (1U12).

Figure 22
Electrical Schematic - Control Module Section for Units w/2-Step Or 4-Step Control



Notes:
1. Install wire 114A if optional periodic pumpout is used.
2. Install wire 114B if optional hot gas bypass is used.
3. Optional low temperature control resistor.

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage

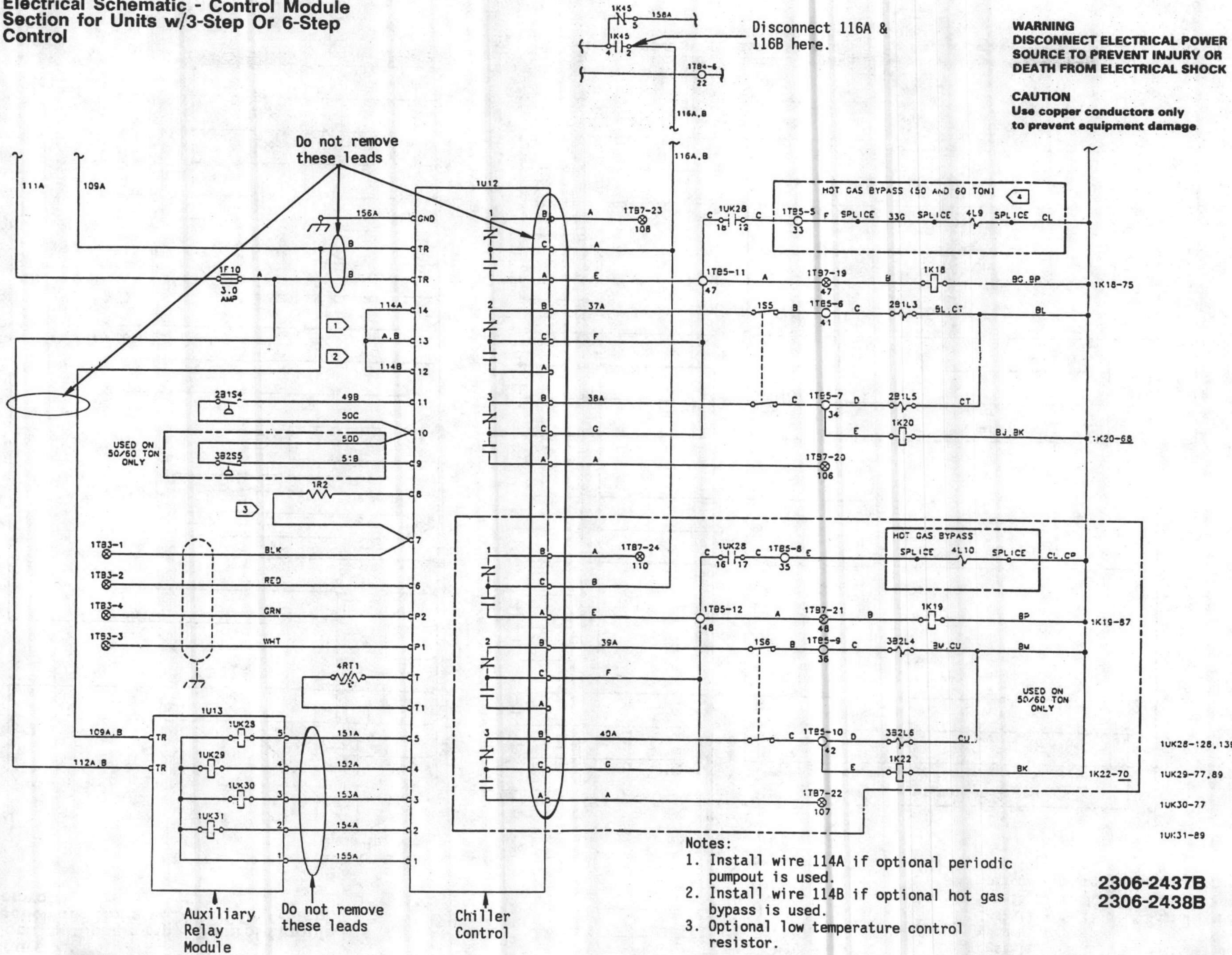
2306-2437B
2306-2438B

CGAC-M-4

Figure 23
Electrical Schematic - Control Module Section for Units w/3-Step Or 6-Step Control

WARNING
DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK

CAUTION
Use copper conductors only to prevent equipment damage



Notes:
1. Install wire 114A if optional periodic pumpout is used.
2. Install wire 114B if optional hot gas bypass is used.
3. Optional low temperature control resistor.

2306-2437B
2306-2438B

19. Slowly rotate the "Number of Stages" knob clockwise, pausing at least 10 seconds at each setting given below. As the dial is rotated up through the "Number of Stages" settings, the remaining LEDs will light at the following points (the "Compressor 1, No. 1 and No. 2" LEDs are already on; see Step 18):

Dial Setting	Energizes LED
3	Comp. 1 - No. 3
4	Comp. 2 - No. 1
6	Comp. 2 - No. 2 & 3

If the LEDs fail to function in this manner, replace the chiller control (1U12).

20. Slowly rotate the "Number of Stages" knob counterclockwise, pausing at each setting given in Step 19. Each LED will go off in turn, reversing the sequence in Step 19. The "Compressor 1, No. 1 and No. 2" LEDs will not go out, however, even when the dial is returned to full counterclockwise position.

21. Momentarily short chiller control Terminals T to T1; the "Compressor 1, No. 1 LED" remains lighted, but the "Compressor 1, No. 2" LED should go out.

Measure voltage between terminals 1 and 4 on the chiller control. The reading should be 9 to 13 VDC.

If the LEDs do not function properly, or if the voltage reading is not within the specified range, replace the chiller control (1U12).

22. Momentarily short chiller control Terminals 6 to 7; the short must be held for 5 seconds. The No. 2 and 3 LEDs of "Compressor 2" should light, and the "Compressor 1, No. 1" LED should turn off.

If this does not occur, replace the chiller control (1U12).

23. Momentarily connect a resistor (rated between 100 and 1000 ohms supplied in TOL 101) across chiller control Terminals 7 and 8; maintain this connection for at least 5 seconds. All six of the main control LEDs should light.

All of the control relay contacts should switch; measure the resistance across the relay contact terminals to verify this has occured.

If this does not occur, replace the chiller control (1U12).

24. Momentarily short chiller control Terminals 9 to 10; the short must be held for 5 seconds. All except the No. 3 LED of "Compressor 2" should turn off at this time.

Measure voltage between terminals 1 and 2 on the chiller control. The reading should be 9 to 13 VDC.

If the LEDs do not function properly, or if the voltage reading is not within the specified range, replace the chiller control (1U12).

25. Momentarily short chiller control Terminals 10 to 11; the short must be held for 5 seconds. The No. 3 LED of "Compressor 1" should light and the No. 3 LED of "Compressor 2" should turn off at this time.

Measure voltage between terminals 1 and 3 on the chiller control. The reading should be 9 to 13 VDC.

If the LEDs do not function properly, or if the voltage reading is not within the specified range, replace the chiller control (1U12).

26. Momentarily short chiller control Terminals 12 to 13; the short must be held for 5 seconds. The No. 2 LEDs of both "Compressor 1" and "Compressor 2" should light and the No. 3 LED of "Compressor 1" should turn off at this time.

Measure voltage between terminals 1 and 5 on the chiller control. The reading should be 9 to 13 VDC.

If the LEDs do not function properly, or if the voltage reading is not within the specified range, replace the chiller control (1U12).

27. Momentarily short chiller control Terminals 13 to 14; the short must be held for 5 seconds. The No. 1 LED of "Compressor 2" should light and the No. 2 LEDs of both "Compressor 1" and "Compressor 2" should turn off.

If this does not occur, replace the chiller control (1U12).

All of the relays on the auxiliary relay module (1U13) should also pull in at this time; measure the resistance across the relay contact terminals to verify that this has occurred.

If the resistance measured across the relay terminals indicates that any of the relays have not pulled in, measure the DC voltage between Terminals 1 (Common) and 2 (LP2), Terminals 1 and 3 (LP1), Terminals 1 and 4 (LTC), and Terminals 1 and 5 (HGB) on the auxiliary relay module. Each of the readings obtained should be 9 to 13 VDC.

a. If any of the voltages measured is higher than 13 VDC, replace the chiller control (1U12).

b. If all of the voltages measured are lower than 13 VDC but one or more of the relays have not closed, replace the auxiliary relay module (1U13).

Test Procedure for Chiller Control Sensing Bulb (4RT1)

WARNING: To prevent injury or death due to electrical shock, open and lock all electrical disconnects.

Disconnect the leaving water sensor (4RT1) leads from Terminals T and T1 on the chiller control (1U12). See Figures 22 and 23.

To determine whether or not the sensor is functioning properly, measure the resistance across the sensor leads; then, compare the reading obtained with the resistance-to-temperature conversion chart provided below:

Temperature	Resistance
90 F	3516.2 Ohms
80 F	3498.2 Ohms
70 F	3450.0 Ohms
60 F	3401.8 Ohms
50 F	3353.4 Ohms
40 F	3304.8 Ohms
30 F	3256.3 Ohms
20 F	3207.5 Ohms
10 F	3159.7 Ohms
0 F	3109.7 Ohms

If the resistance measured across the sensor leads does not correspond to the actual leaving water temperature, replace the sensor.

OPERATOR'S MAINTENANCE LOG (1)

DATE	WEEKLY MAINTENANCE INSPECTION											
	COMPRESSOR(S)						SIGHT GLASS/MOISTURE INDICATOR				WATER TEMP. (°F)	
	COMPRESSOR 1			COMPRESSOR 2 (2)			SIGHT GLASS 1		SIGHT GLASS 2 (2)			
	OIL LEVEL	SUCT.(3) PRESS.	DSCHG. PRESS.	OIL LEVEL	SUCT. PRESS.	DSCHG. PRESS.	REFRIG. CONDITION	MOISTURE LEVEL	REFRIG. CONDITION	MOISTURE LEVEL	EWT (WATER ENT. EVAPORATOR)	LWT (WATER LVG. EVAPORATOR)
	☐ OK ☐ LOW			☐ OK ☐ LOW			☐ OK ☐ BUBBLES	☐ DRY ☐ WET	☐ OK ☐ BUBBLES	☐ DRY ☐ WET		
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	☐ OK ☐ LOW			☐ OK ☐ LOW			☐ OK ☐ BUBBLES	☐ DRY ☐ WET	☐ OK ☐ BUBBLES	☐ DRY ☐ WET		
	☐ LOW ☐ OK			☐ LOW ☐ OK			☐ BUBBLES ☐ OK	☐ WET ☐ DRY	☐ BUBBLES ☐ OK	☐ WET ☐ DRY		

1. Perform each inspection once per week with the unit operating.
2. Record operating pressures in psig. Available only if the unit is equipped with pressure gauges.

For further information on this product or other Trane products, refer to the "Trane Service Literature Catalog", ordering number IDX-IOM-1. This catalog contains listings and prices for all service literature sold by Trane. The catalog may be ordered by sending a $20.00 check to: The Trane Company, Service Literature Sales, 3600 Pammel Creek Road, La Crosse, WI 54601.

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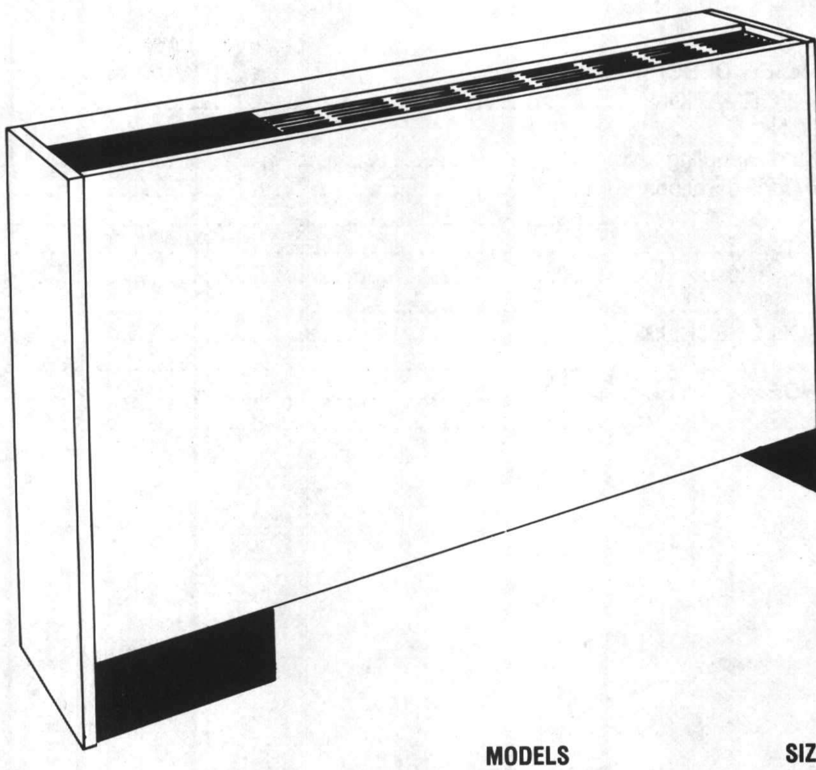
Installation Maintenance

Library	**Service Literature**
Product Section	**Air Term. Devices & Htg. Products**
Product	**Fan-Coil Air Conditioners - Unitrane**
Model	**UNT**
Literature Type	**Installation-Maintenance**
Sequence	**1B**
Date	**March 1985**
File No.	**SV-TD-FCAC-UNT-IM-1B-385**
Supersedes	**UNT-IM-1A (Aug 82)**
Ordering No.	**UNT-IM-1B**

Since the Trane Company has a policy of continuous product improvement, it reserves the right to change specifications and design without notice. The installation and servicing of the equipment referred to in this booklet should be done by qualified, experienced technicians.

UNITRANE®
FAN-COIL AIR CONDITIONERS



MODELS	SIZES
A - Vertical Concealed	(02-12)
B - Vertical Cabinet	(02-12)
C - Horizontal Concealed	(02-12)
D - Horizontal Cabinet	(02-12)
E - Horizontal Recessed	(02-06)
H - Vertical Recessed	(02-06)
K - Low Vertical Concealed	(02-06)
L - Low Vertical Cabinet	(02-06)

COMMERCIAL SYSTEMS GROUP
LA CROSSE, WISCONSIN 54601-7599
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LITERATURE CHANGES:

A- Drain hose clamp eliminated; installation and maintenance checklists, recessed model weights, grille free air table, valve shipping bracket removal note, paint instructions added; installation procedures rearranged; filter access panel removal clarified; electric coil table updated.

B- Size nomenclature changed; unit leveling instructions added; unit dimensions for Models E and H; dimension correction to duct; filter access panel drawing revised; drain line pitch note added.

TABLE OF CONTENTS

MODEL NUMBER DESCRIPTION

Trane products are identified by a multiple character model number that precisely identifies a particular type of unit. An explanation of the multiple character number is shown below. It will enable the owner or Service Engineer to define operation, components and accessories.

B 2 5 A L 04

MODEL TYPE
A - Vertical Concealed
B - Vertical Cabinet
C - Horizontal Concealed
D - Horizontal Cabinet
E - Horizontal Recessed
H - Vertical Recessed
K - Low Vertical Concealed
L - Low Vertical Cabinet

OUTLET
Vertical
1 - Integral Top Grille
2 - Quadrifuser Top Grille
3 - Top Duct Collar
Horizontal
1 - Integral Front Grille
2 - Quadrifuser Front Grille
3 - Front Duct Collar
Low Vertical
1 - Integral Top Grille
2 - Quadrifuser Top Grille
3 - Top Duct Collar

UNIT SIZE
02
03
04
06
08
10
12

AUXILIARY COIL TYPE
0 - None
E - Electric
L - Water

MAIN COIL TYPE
A - Standard Water
D - High Temperature Rise Water

INLET
Vertical
2 - Return Air Toe Space
3 - 0 to 25% Fresh Air Back
5 - 0 to 100% Fresh Air Back-Mixing Base
Horizontal
1 - Integral Back Grille
2 - Exposed Fan
4 - Back Duct Collar
6 - Integral Bottom Grille
Low Vertical
2 - Return Air Toe Space
3 - 0 to 25% Fresh Air Back

***NOTE:** All High-Capacity Fan-Coil units will have an "H" as the last character (i.e. B25AL04H).*

GENERAL INFORMATION

UniTrane® Fan-Coil units are room air conditioners designed for cooling and heating load capabilities of 200 to 1400 cfm. Horizontal models, in concealed, recessed, or cabinet installations, are suspended from the uppermost ceiling by installer-supplied threaded rods or lag screws. Vertical floor units are also available in concealed, recessed or cabinet models. Low Vertical floor units are concealed or cabinet models that can be installed under low windows or other wall obstructions.

Basic unit components, as shown in Figure 1, consist of a water coil, an auxiliary water or electric coil, flat filters, a condensate drain pan, one or two fans, and a fan motor. A variety of motor controls, valve packages and other options are available for special units.

To determine specific options, refer to the unit model number and the Model Number Description given here. The sales order will further identify unit details and accessories.

An Installation Checklist is given at the end of the Installation section of this manual. Complete the checks after installation is accomplished to ensure proper and safe operation of the unit.

Fan-Coil units which are equipped with any steam applications are considered "special." The installer is responsible for the piping connections for these units.

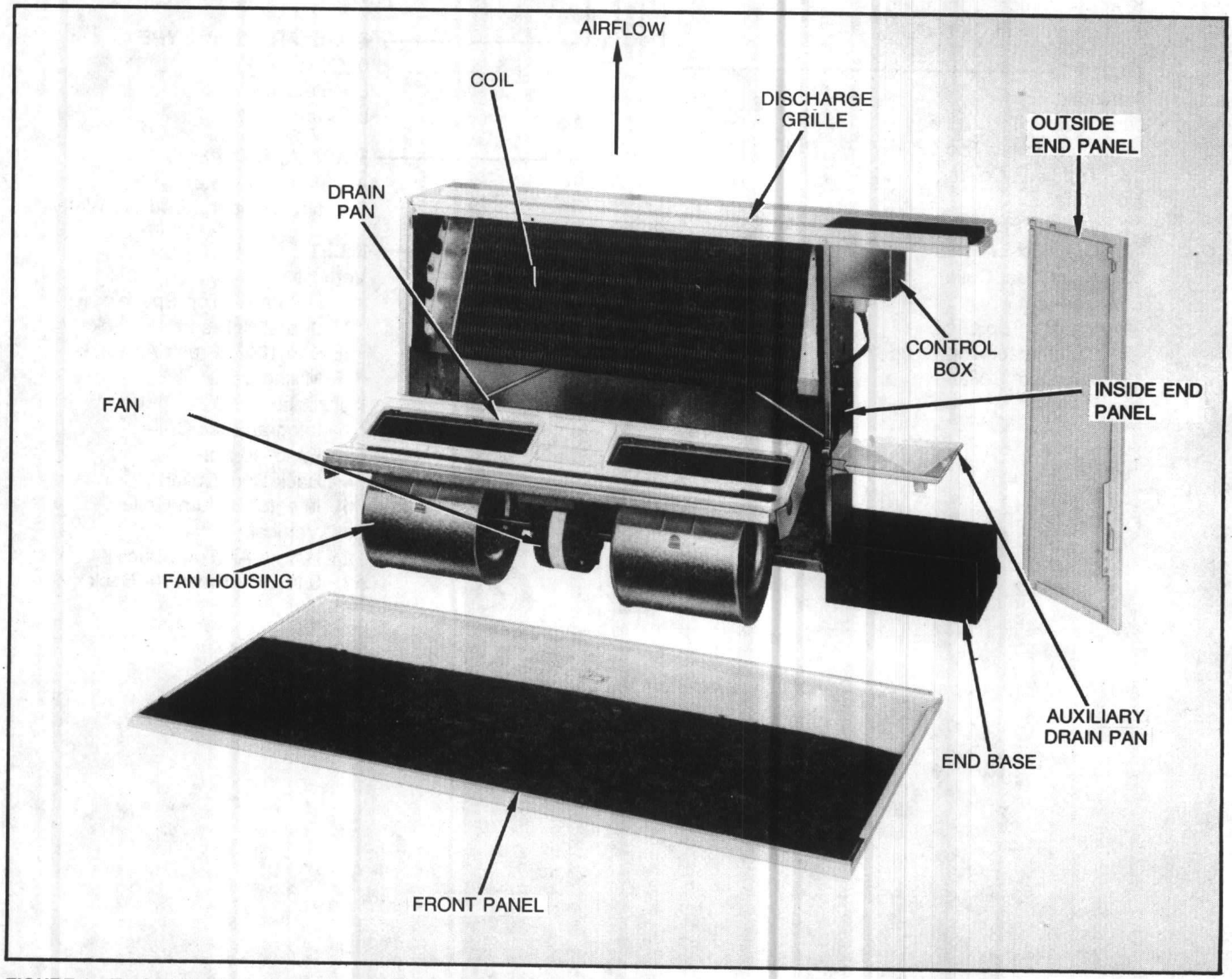


FIGURE 1 - Typical UniTrane Components (Vertical Cabinet Model Shown)

INSTALLATION

RECEIVING AND HANDLING

UniTrane® Fan-Coil units are packaged in individual cartons for maximum protection during shipment, as well as for easy handling and storage on the job site. Tagging information is provided on each carton to properly locate the unit in the floor plan.

To protect against loss from in-transit damage, complete the following upon receipt of the units:

1. Inspect individual pieces of the shipment before accepting it. Check for rattles, bent corners on cartons or other visible indications of shipping damage.
2. If a carton has apparent damage, open it immediately and inspect the contents before accepting the unit. Do not refuse the shipment. Make specific notations concerning the damage on the freight bill. Check the unit casing, fan rotation, coils, condensate pan, factory-wired conduit, filters and all options or accessories.
3. Inspect the unit for concealed damage before it is stored and as soon as possible after delivery. **Concealed damage must be reported to the delivering carrier within 15 days.**
4. Do not move damaged material from the receiving location if possible. It is the receiver's responsibility to provide reasonable evidence that concealed damage was not incurred after delivery.
5. If concealed damage is discovered, stop unpacking the shipment. Retain all internal packing, cartons and crates. Take photos of the damaged material if possible.
6. Notify the carrier's terminal of damage immediately by phone and mail if any damage is found. Request an immediate joint inspection of the damage by the carrier and consignee.
7. Notify the Trane sales representative of the damage and arrange for repair. Do not repair the unit, however, until damage is inspected by the carrier's representative.

Refer to the Installation Considerations in this manual before setting the unit in place. For approximate shipping weights, see Table 1.

INSTALLATION CONSIDERATIONS

For proper installation and operation, check each of the following before mounting the units:

1. Allow adequate space for the unit and free air or service clearances. See Figures 2 through 14 for unit dimensions. For specific unit dimensions, refer to the sales submittals. For servicing and routine maintenance, leave the area clear around the front panels, end panels and toe space in accordance with local or national electric codes. Provide removable panels in the ceiling for horizontal units. See Table 2 for grille minimum free air areas.
2. Before installing any unit, make sure proper allowances have been made at each unit location for piping and electrical connections. Refer to the sales submittals.
3. Check that the floor is strong enough to support unit weights, as given in Table 1. For ceiling units, adequate support rods must be supplied by the installer.
4. All units must be mounted level. For vertical or low vertical floor units, prepare the floor to be level before mounting. Use threaded rods to level ceiling-suspended units.
5. Set unit level by checking the casing. Do not use coils or drain pan for checking level as they are pitched as shipped to provide proper drainage.
6. The Trane Company (and the industry in general) recommends a condensate connection line pitch of 1" drop per foot.
7. Before installing a concealed or recessed unit, be sure the opening is the correct size. For recessed units, the front panel must attach properly to the unit and conceal the wall opening. Generally, the recess opening should be 2 inches less than the overall width and height of the front panel. Refer to specific submittals for dimensions.
8. The installation of Model C32-U units (horizontal concealed, with duct collar outlet and exposed fan inlet) must meet the requirements of N.F.P.A. Standard 90A or 90B with regard to the use of concealed ceiling spaces as return air plenums.
9. Normal painting practice dictates that the surface should be free of oil, grease and dirt and should be scuff sanded prior to painting.

   If latex paints are to be used, an intermediate alkyd primer coat must be used for best adhesion after proper preparation of the surface. In lieu of the intermediate alkyd primer coat, other surface preparation methods for latex paint such as liquid sandpaper or hand sanding results in good adhesion in some cases. This is true only when a high grade latex paint is used.

TABLE 1 - Approximate Shipping Weights (Pounds)

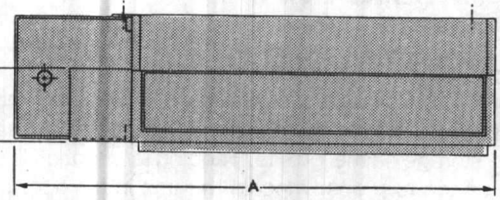
UNIT SIZE	CABINET MODELS	CONCEALED MODELS
02	65	55
03	80	65
04	95	80
06	115	100
08	185	125
10	215	150
12	235	170

TABLE 2 - Grille Free Air Area Minimums (Square Inches)

UNIT SIZE	MODELS					
	VERTICAL		HORIZONTAL		LOW VERTICAL	
	INLET	OUTLET	INLET	OUTLET	INLET	OUTLET
02	65	62	102	82	56	50
03	82	87	144	115	78	73
04	94	99	164	132	100	95
06	129	138	226	182	133	129
08	187	226	306	285	—	—
10	235	283	396	356	—	—
12	283	339	488	428	—	—

NOTE: ARI capacities are obtained with grille free areas in this table.

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G
02	1	28 7/16"	20"	20 15/16"	19 11/16"	17"	19 15/16"	19¾"
03	1	36 7/16"	28"	28 15/16"	27 11/16"	25"	27 15/16"	27¾"
04	2	40 7/16"	32"	32 15/16"	31 11/16"	29"	31 15/16"	31¾"
06	2	52 7/16"	44"	43 15/16"	43 11/16"	41"	43 15/16"	43¾"



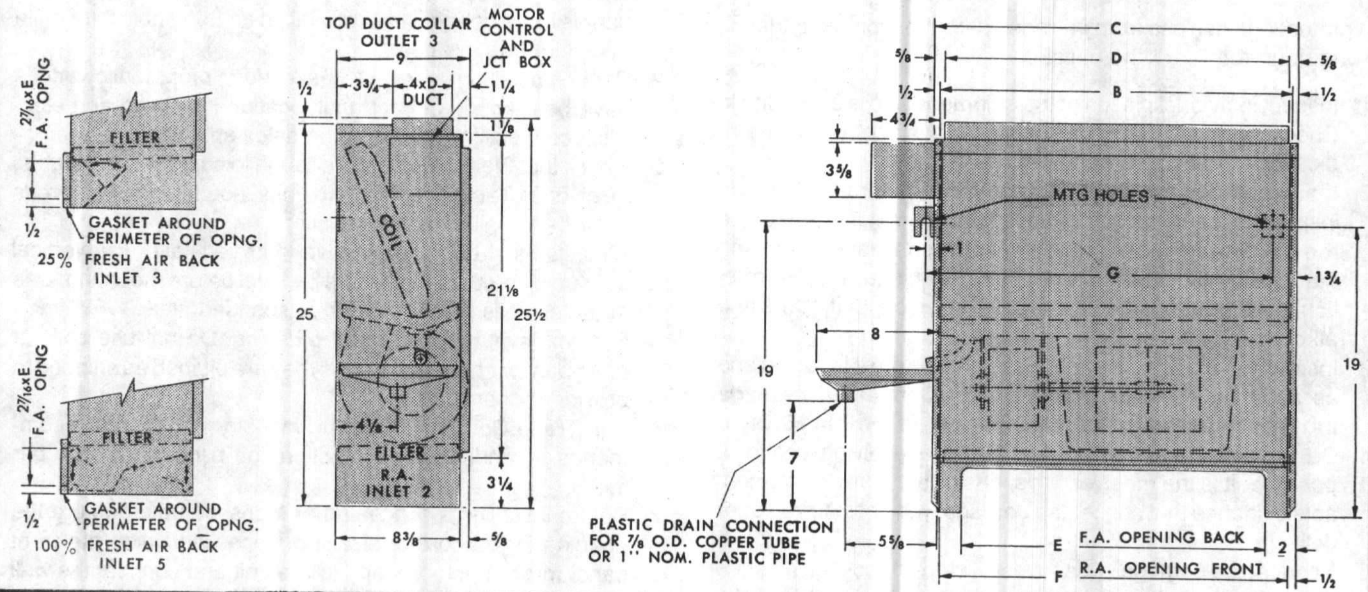
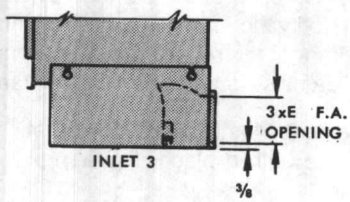
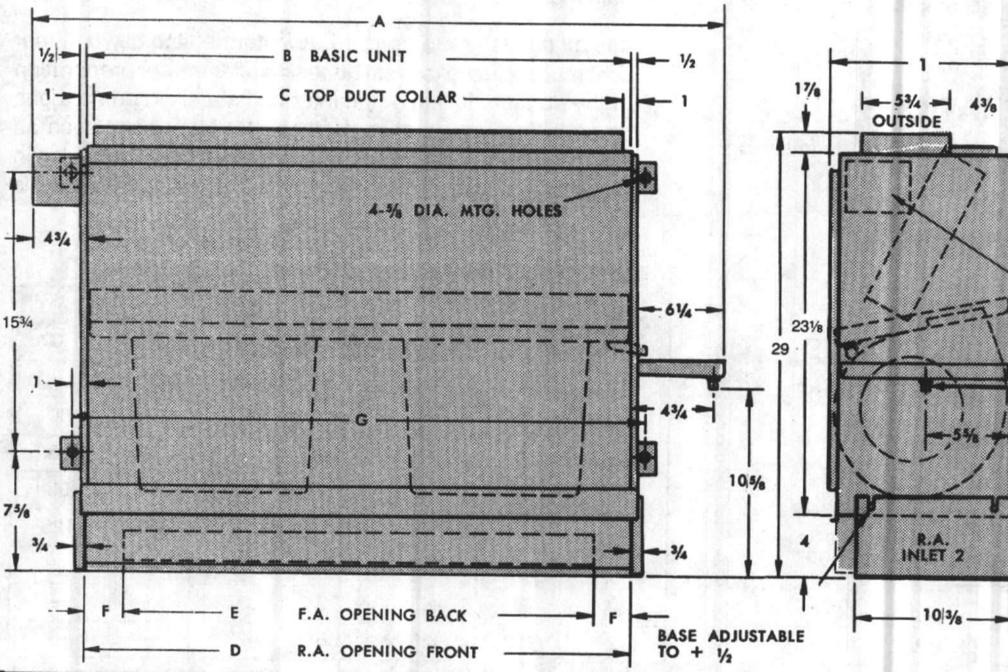


FIGURE 2 - Unit Dimensions for Model A (Vertical Concealed) Units, 02 to 06 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G
08	2	57½"	46½"	45½"	46¾"	39"	4⅝"	48½"
10	2	69½"	58½"	57½"	58¾"	48⅞"	5¾"	60½"
12	2	81½"	70½"	69½"	70¾"	58¾"	6¾"	72½"





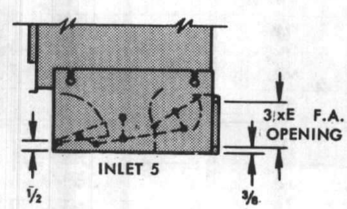


FIGURE 3 - Unit Dimensions for Model A (Vertical Concealed) Units, 08 to 12 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F
02	1	31½"	20"	19¾"	17"	19 15/16"	19¾"
03	1	39½"	28"	25¾"	25"	27 15/16"	27¾"
04	2	43½"	32"	31¾"	29"	31 15/16"	31¾"
06	2	55½"	44"	43¾"	41"	43 15/16"	43¾"

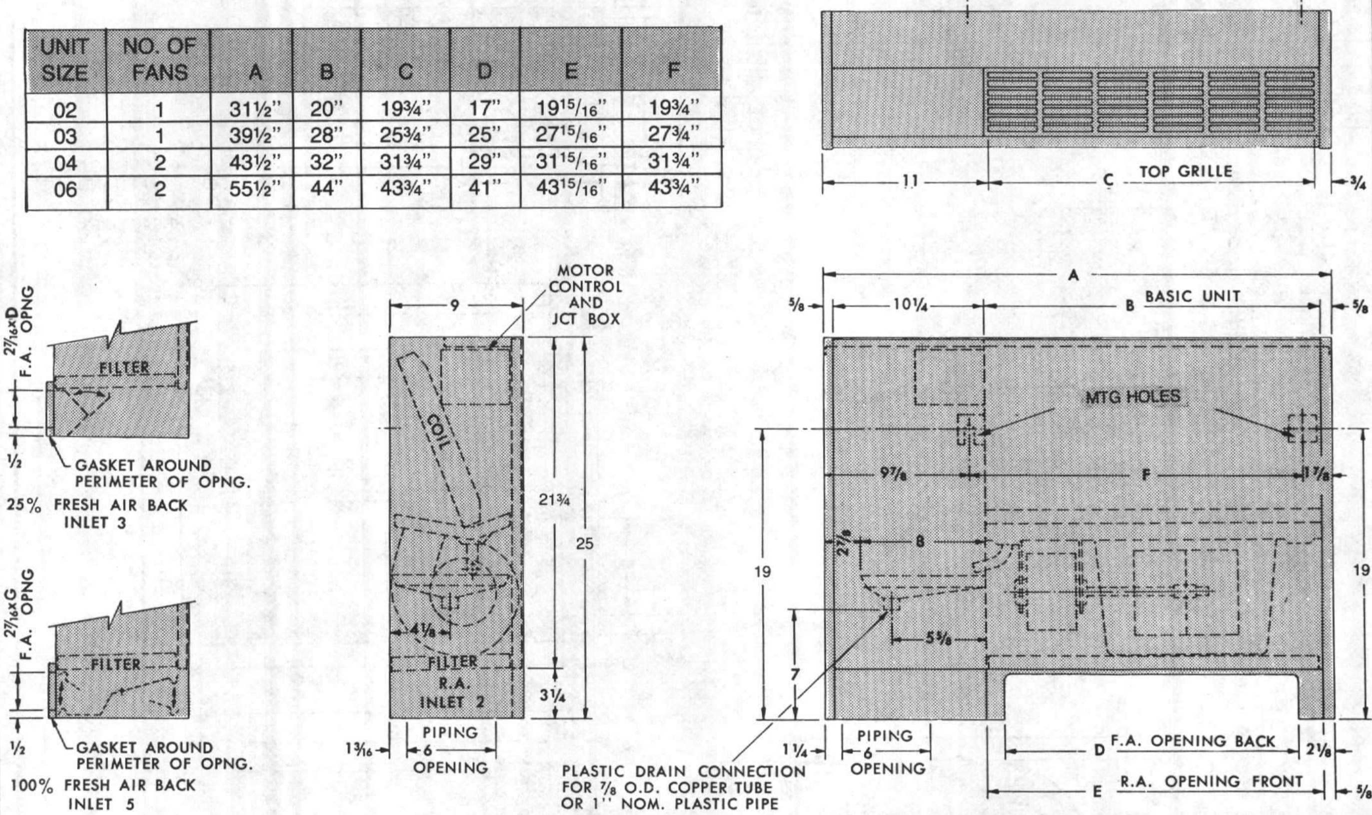


FIGURE 4 - Unit Dimensions for Model B (Vertical Cabinet) Units, 02 to 06 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G	H
08	2	60"	46½"	47¾"	48½"	46¾"	39"	8⅞"	12⅛"
10	2	72"	58½"	59¾"	60½"	58¾"	48⅞"	10"	13⅛"
12	2	84"	70½"	70¾"	72½"	70¾"	58¾"	11"	14¼"

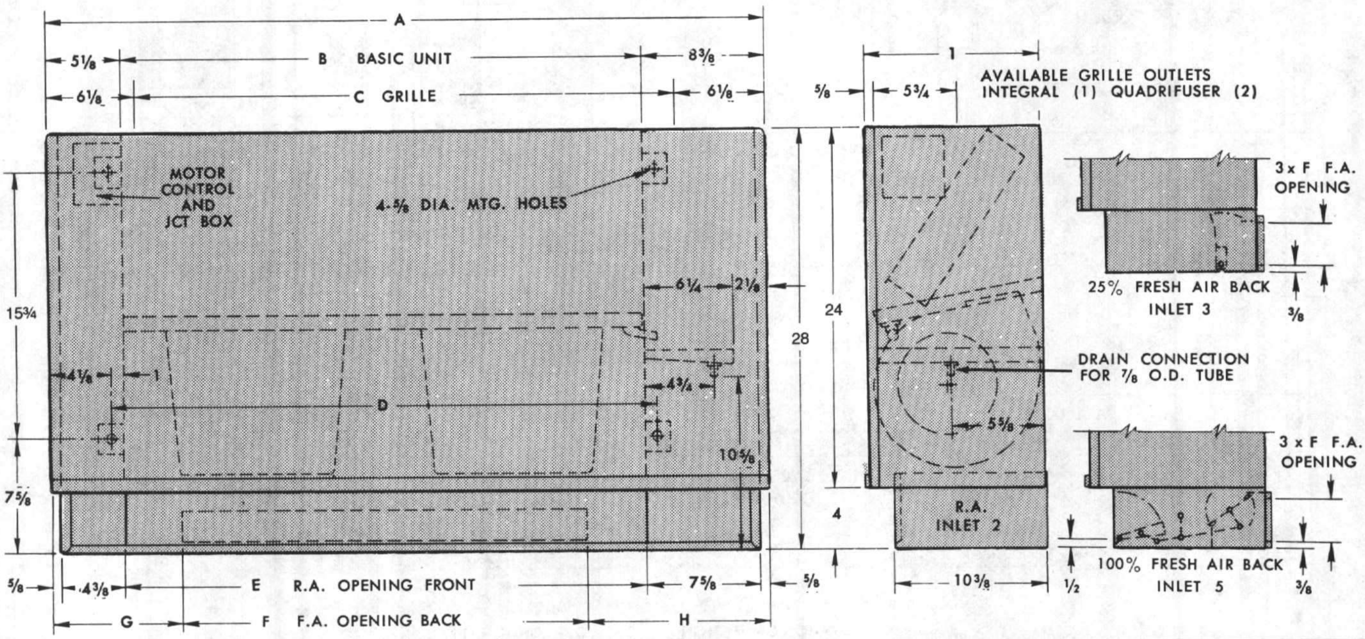
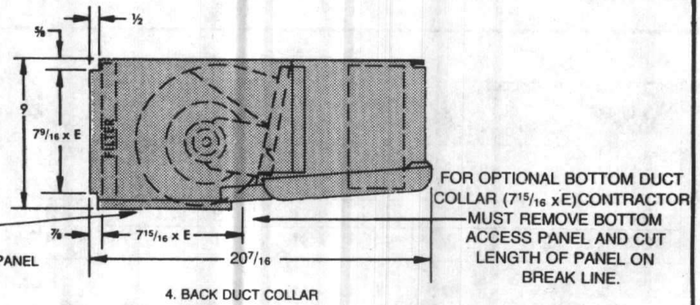


FIGURE 5 - Unit Dimensions for Model B (Vertical Cabinet) Units, 08 to 12 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E
02	1	25⅛"	23"	18⅜"	20¾"	20"
03	1	33⅛"	31"	26⅜"	28¾"	28"
04	2	37⅛"	35"	30⅜"	32¾"	32"
06	2	49⅛"	47"	42⅜"	44¾"	44"



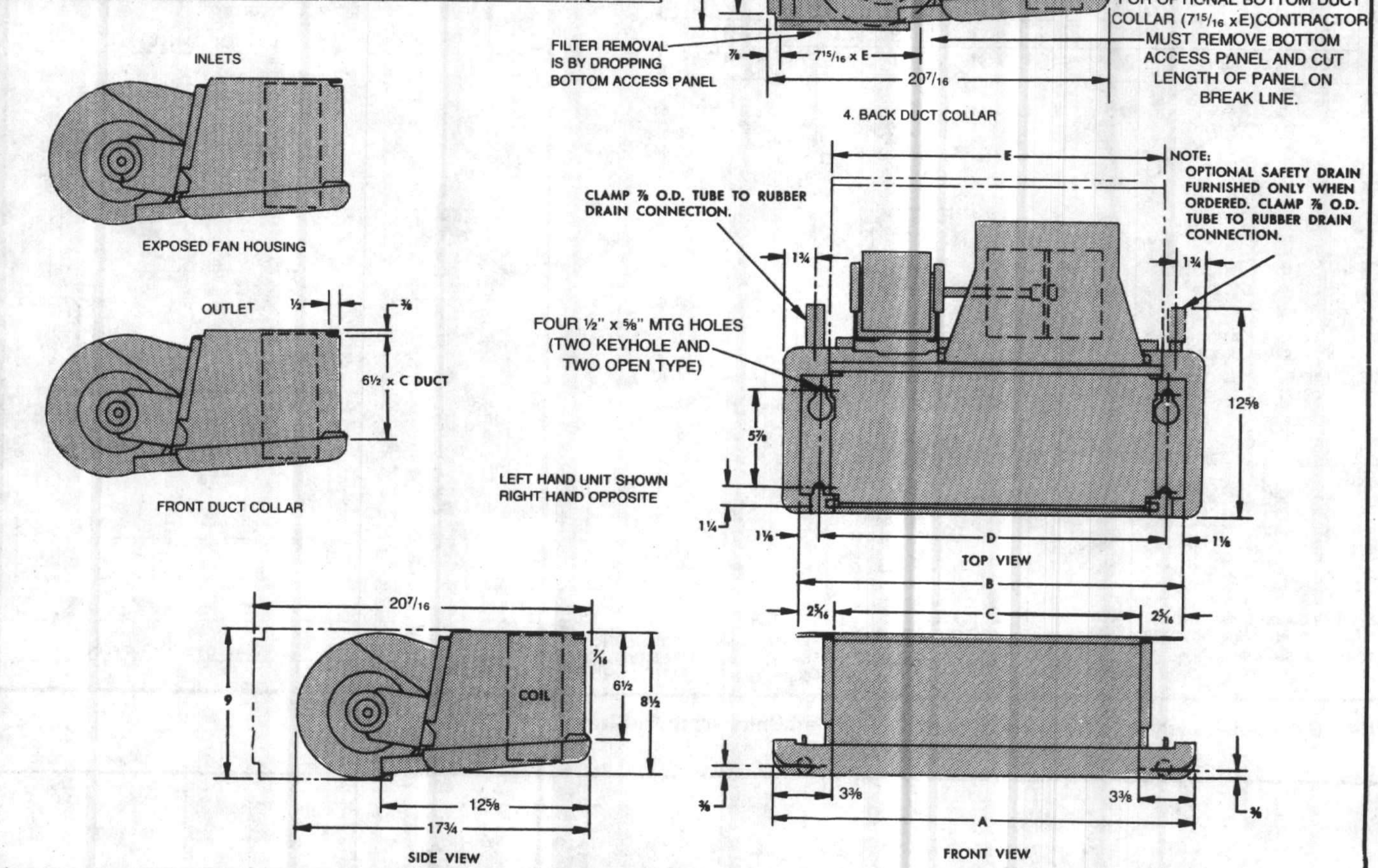
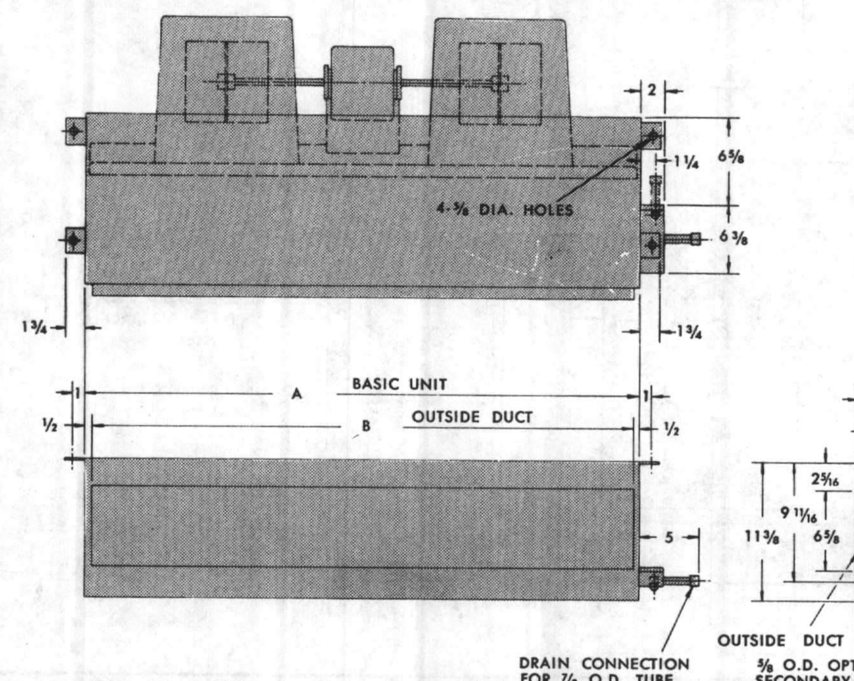


FIGURE 6 - Unit Dimensions for Model C (Horizontal Concealed) Units, 02 to 06 Sizes

UNIT SIZE	NO. OF FANS	A	B
08	2	46½"	45½"
10	2	58½"	57½"
12	2	70½"	69½"



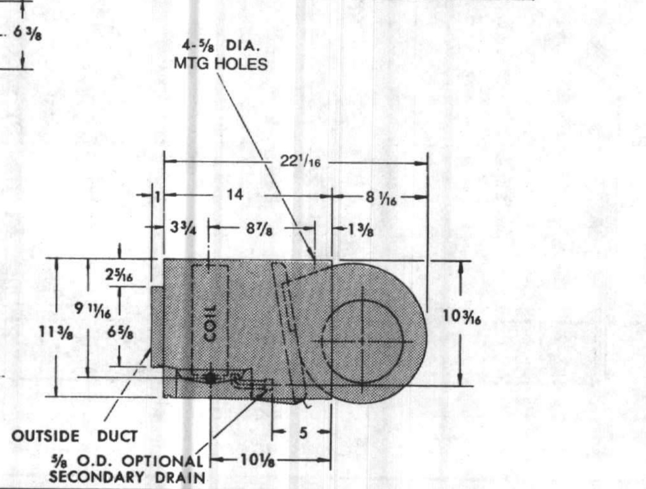
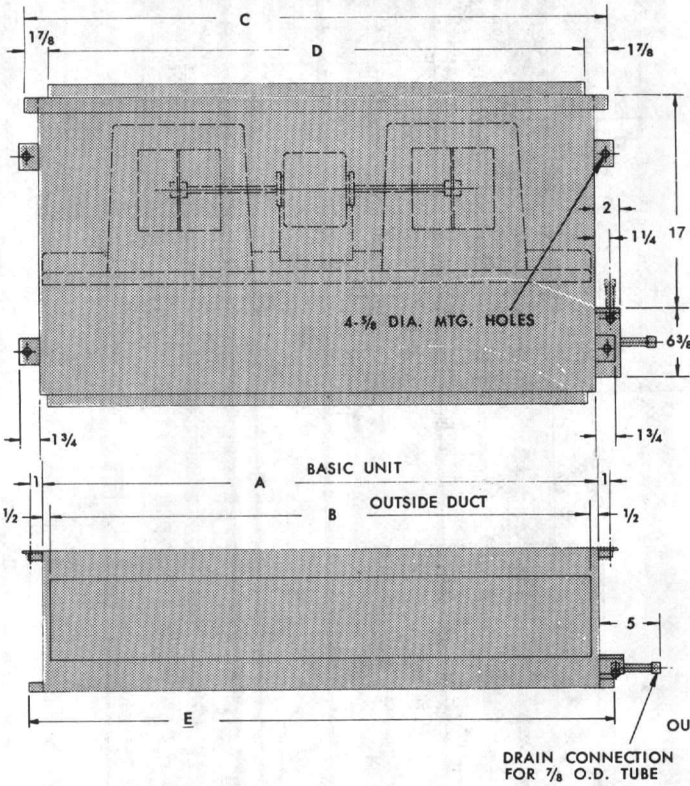


FIGURE 7 - Unit Dimensions for Model C32 (Horizontal Concealed) Units, 08 to 12 Sizes



UNIT SIZE	NO. OF FANS	A	B	C	D	E
08	2	46½"	45½"	48¾"	45"	47⅜"
10	2	58½"	57½"	60¾"	57"	59⅜"
12	2	70½"	69½"	72¾"	69"	71⅜"

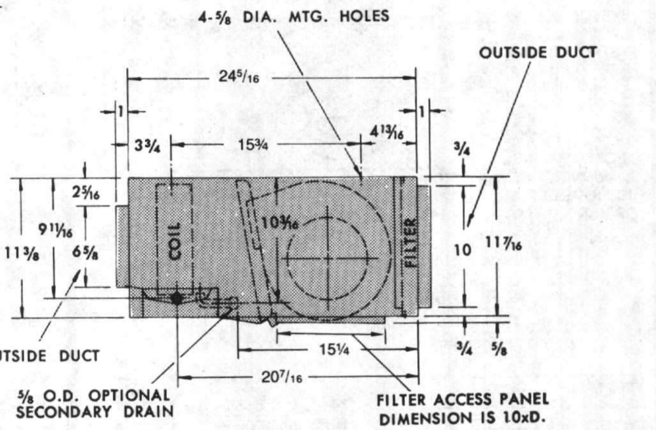
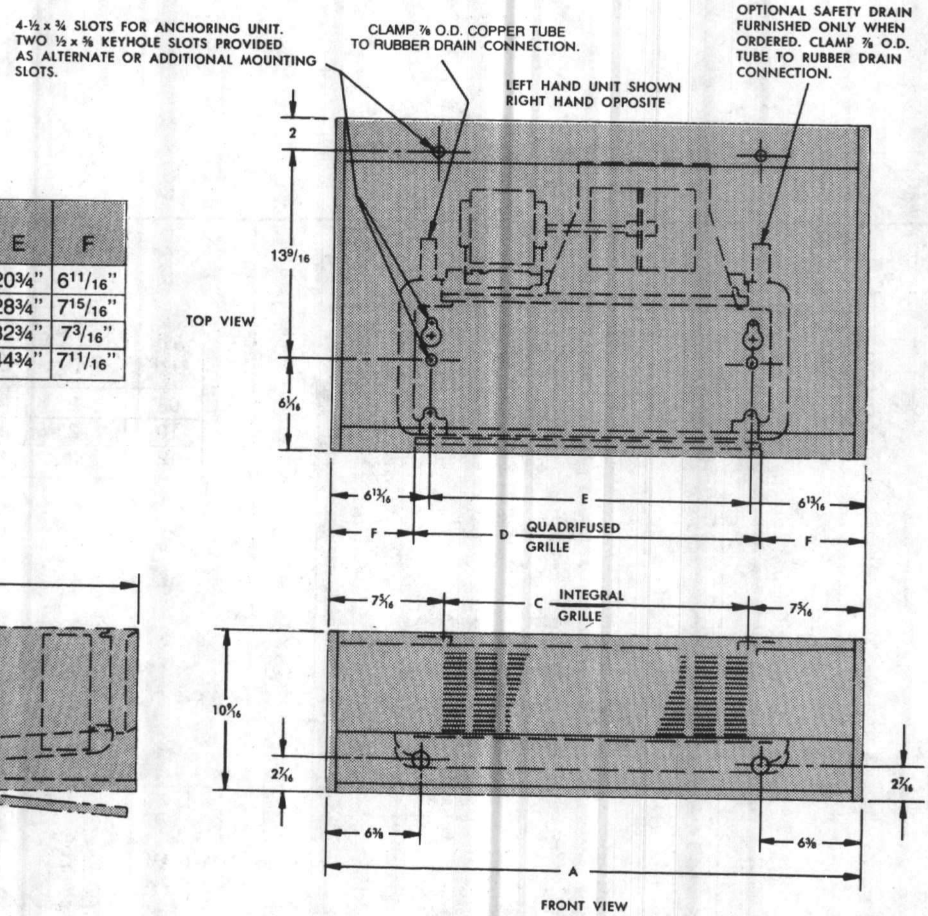
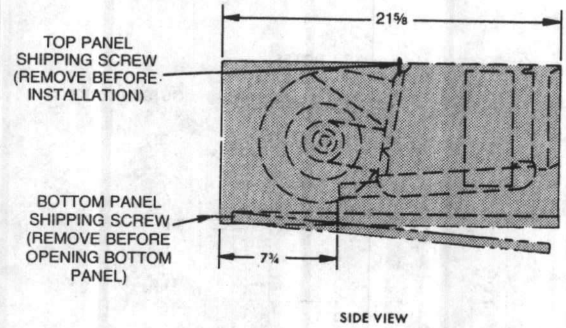


FIGURE 8 - Unit Dimensions for Model C34 (Horizontal Concealed with Inlet Plenum) 08 to 12 Sizes

UNIT SIZE	NO. OF FANS	A	C	D	E	F
02	1	34⅜"	19¾"	21"	20¾"	6¹¹/₁₆"
03	1	42⅜"	27¾"	26½"	28¾"	7¹⁵/₁₆"
04	2	46⅜"	31¾"	32"	32¾"	7³/₁₆"
06	2	58⅜"	43¾"	43"	44¾"	7¹¹/₁₆"





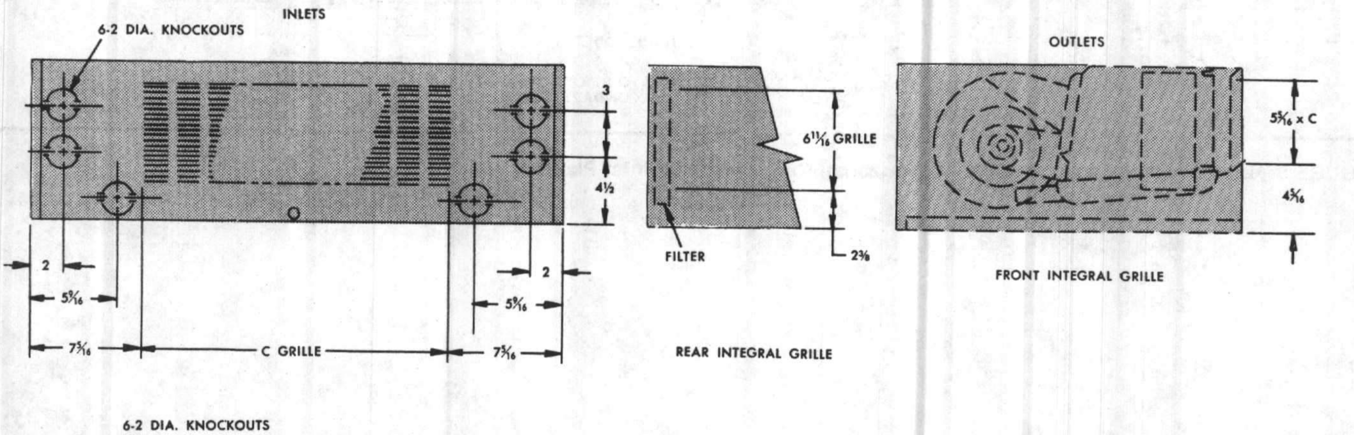


FIGURE 9 - Unit Dimensions for Model D (Horizontal Cabinet) Size 02 to 06

UNIT SIZE	NO. OF FANS	A	B	C	D	G
08	2	60"	46½"	38¾"	45¾"	10⅝"
10	2	72"	58½"	55¼"	57¾"	8⅜"
12	2	84"	70½"	66¼"	69¾"	8⅞"

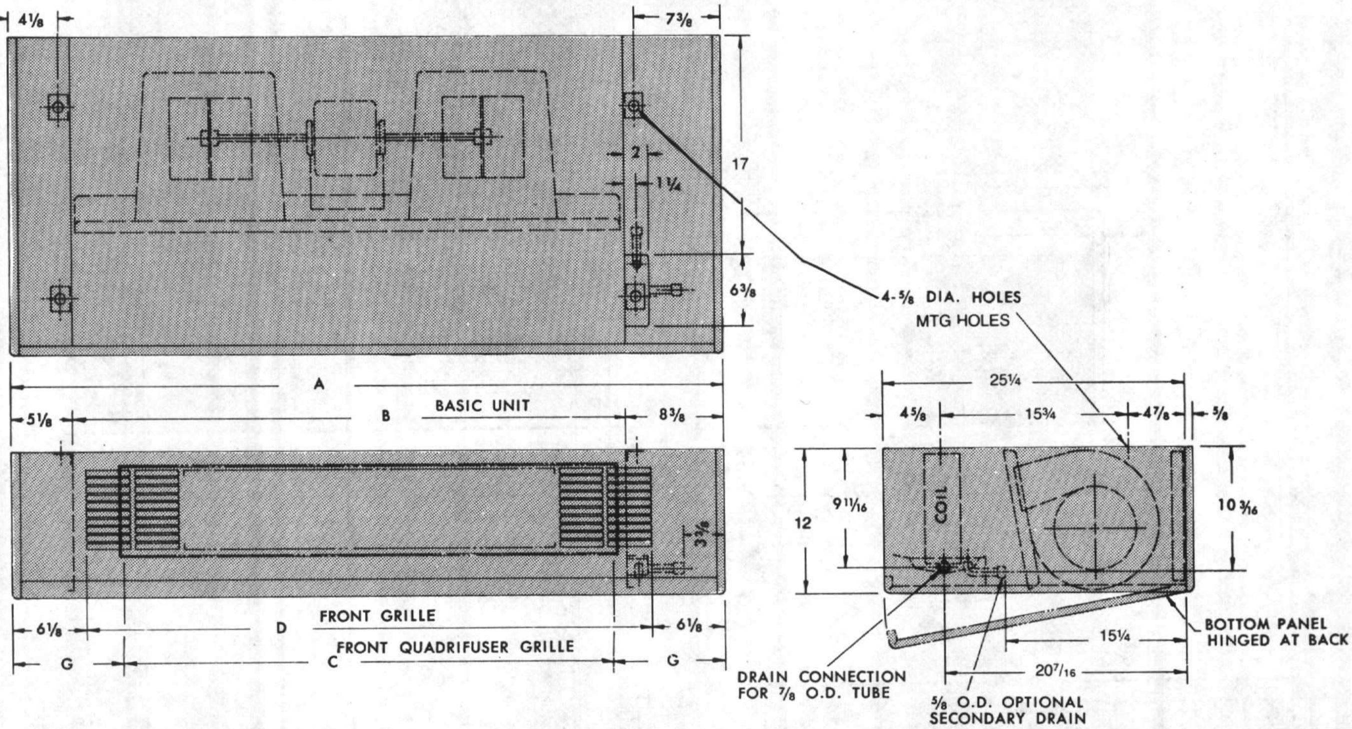


FIGURE 10 - Unit Dimensions for Model D (Horizontal Cabinet) Units, 08 to 12 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G
02	1	36 3/16"	34 9/16"	18½"	19¾"	32¼"	33 1/16"	35 1/16"
03	1	44 3/16"	42 9/16"	26½"	27¾"	40¼"	41 1/16"	43 1/16"
04	2	48 3/16"	46 9/16"	30½"	31¾"	44¼"	45 1/16"	47 1/16"
06	2	60 3/16"	58 9/16"	42½"	43¾"	56¼"	57 1/16"	59 1/16"

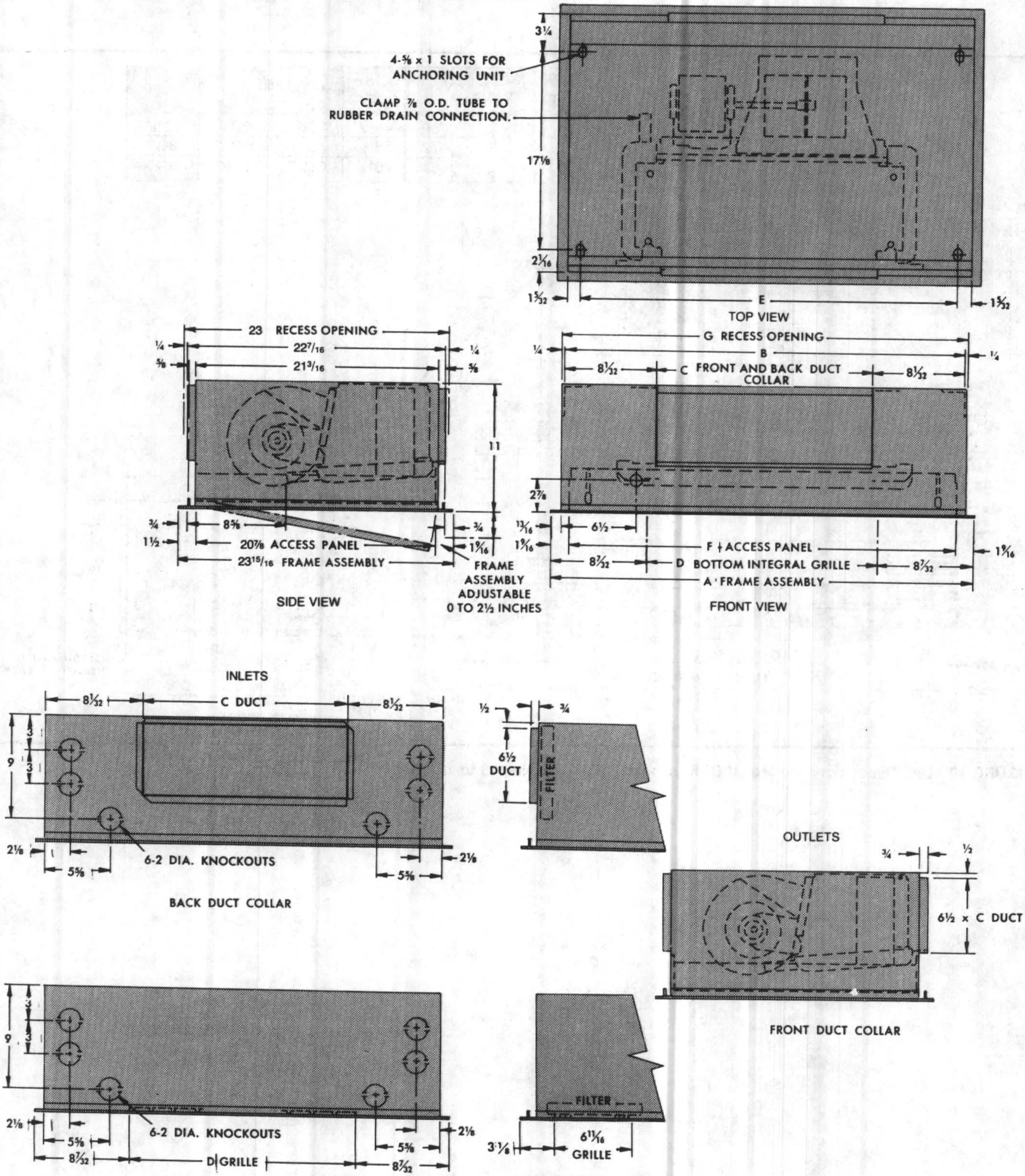
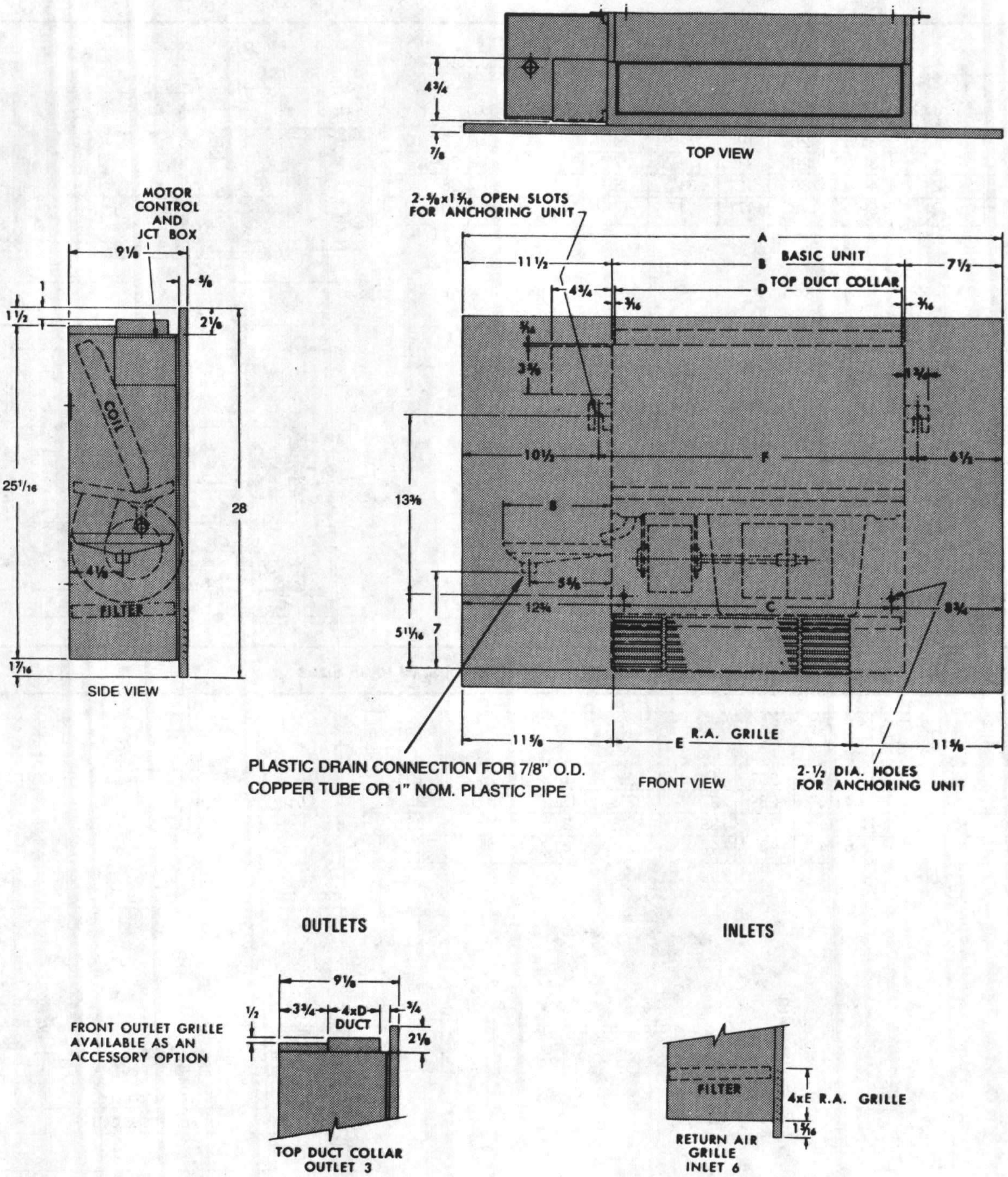


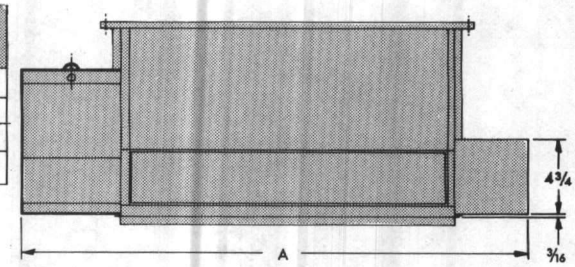
FIGURE 11 - Unit Dimensions for Model E (Horizontal Recessed) Sizes 02-06



UNIT SIZE	NO. OF FANS	A	B	C	D	E	F
02	1	39"	20"	17½"	19¹¹/₁₆"	15¾"	22"
03	1	47"	28"	25½"	27¹¹/₁₆"	23¾"	30"
04	2	51"	32"	29½"	31¹¹/₁₆"	27¾"	34"
06	2	63"	44"	41½"	43¹¹/₁₆"	39¾"	46"

FIGURE 12 - Unit Dimensions for Model H (Vertical Recessed) Sizes 02-06

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G
02	1	31½"	20"	19"	15½"	19 15/16"	3 19/32"	22 11/16"
03	1	39½"	28"	27"	15½"	27 15/16"	7 19/32"	30 11/16"
04	2	47½"	36"	35"	31"	35 15/16"	3 27/32"	38 11/16"
06	2	59½"	48"	47"	31"	47 15/16"	9 27/32"	50 11/16"



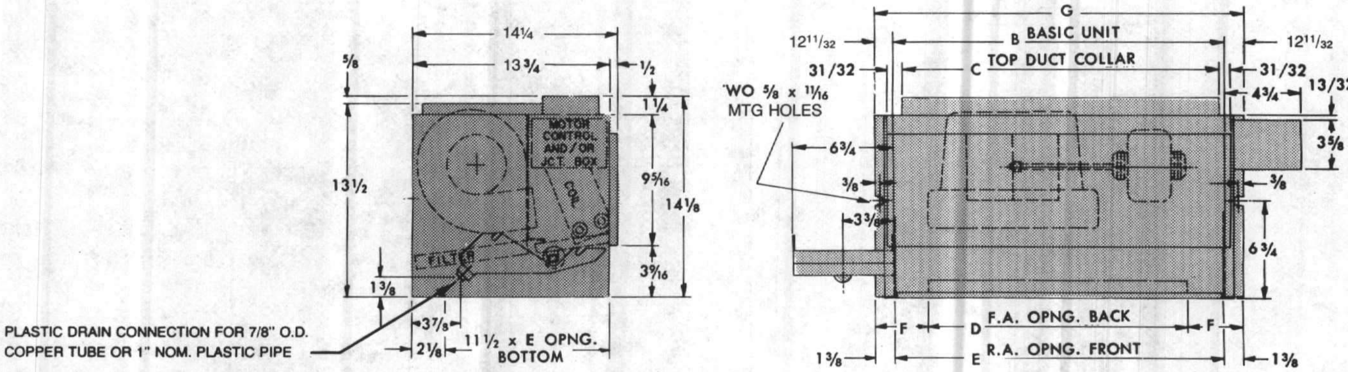
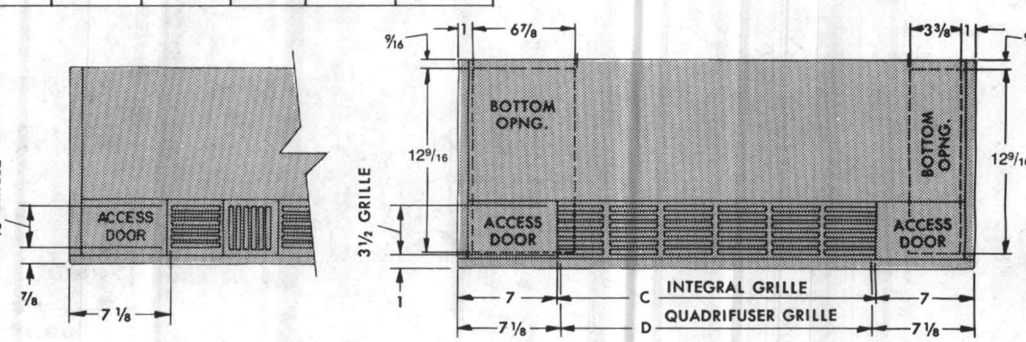


FIGURE 13 - Unit Dimensions for Model K (Low Vertical Concealed) Units, 02 to 06 Sizes

UNIT SIZE	NO. OF FANS	A	B	C	D	E	F	G
02	1	33¾"	20"	19¾"	19½"	15½"	9⅛"	19¾"
03	1	41¾"	28"	27¾"	27½"	15½"	13⅛"	25¾"
04	2	49¾"	36"	35¾"	35½"	31"	9⅜"	35¾"
06	2	61¾"	48"	47¾"	47½"	31"	15⅜"	47¾"



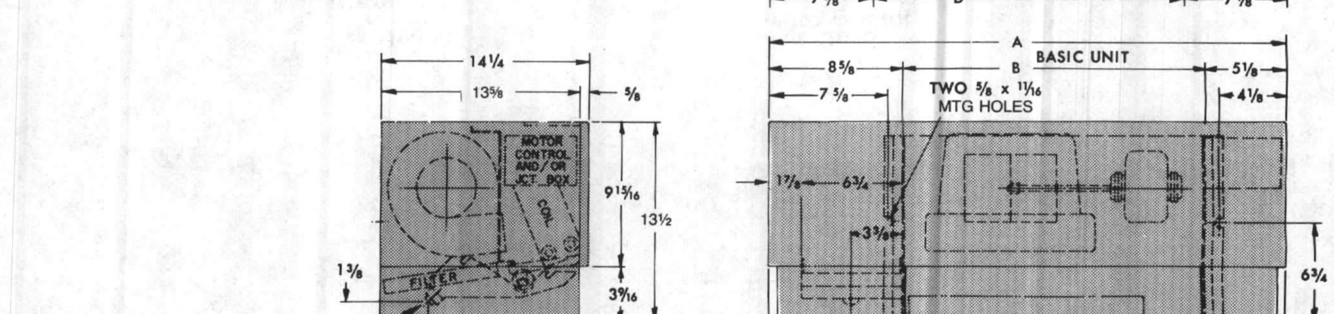


FIGURE 14 - Unit Dimensions for Model L (Low Vertical Cabinet) Units, 02 to 06 Sizes

MOUNTING

VERTICAL AND LOW VERTICAL UNITS

All floor models are attached to the wall with the brackets provided, through the mounting holes in the rear of the unit. Mounting fasteners are to be supplied by the installer.

NOTE: *Before installing the vertical recessed unit (Model H), check the recess opening to be sure that the front panel will attach properly to the unit and will conceal the wall opening. The recess opening should be two inches less than the overall width and height of the front panel.*

To install vertical and low vertical models, complete the following:

1. For unit sizes 08 to 12, mark and prepare the mounting holes in the wall. For unit sizes 02 to 06, install the mounting bracket that is supplied with the unit, as shown in Figure 15. ***NOTE:*** *The mounting bracket is found attached to the inside end panel either above or below the auxiliary drain pan.* The bracket anchoring bolts should be selected according to wall construction and supplied by the installer.
2. Set the unit in place on the mounting bracket.
3. Remove the unit front panel. For cabinet models, the front panel will drop forward after it has been pulled upward approximately 1/2-inch. For the recessed unit, loosen two Allenhead screws before lifting the panel up. On concealed units, the panel is removed by loosening the sheet metal screws.
4. Remove the unit end panel. For cabinet unit sizes 02 to 06, release the two screws on the front edge of the panel and slide it forward. For cabinet unit sizes 08 to 12, remove the four screws and lift off panel. All other vertical units have open end pockets.
5. Level the unit casing and attach the unit to the wall (08 to 12 unit sizes).
6. Remove the shipping brace from under the fan board and place the filter, if ordered, in the filter channel.
7. Complete piping and wiring to the unit, as instructed in the next sections of this manual. Always replace the unit front and end panels before starting the unit.

CAUTION: Failure to replace the end panels and filters before starting the unit may result in equipment damage due to motor overload and dirty coils.

HORIZONTAL UNITS

Horizontal units are designed to be suspended from the ceiling on threaded rods or lag screws furnished by the installer. Holes are provided at the top of the unit. The ceiling opening must be large enough for the unit installation.

NOTE: *When installing Model C32-U units, the requirements of NFPA Standard 90A or 90B must be followed, regarding the use of concealed ceiling spaces as return air plenums.*

To install a horizontal model, complete the following:

1. On cabinet models 02-06, remove the shipping screw through the access hole and in the top panel, as shown in Figure 9. Lower the hinged bottom panel by turning the Allenhead locks at the front edge of the bottom panel.
2. Install the suspension rods or suspension device, as furnished by the installer.
3. Hoist the unit into position. See Table 1 for unit weights.
4. Level the unit on its casing and tighten the mounting bolts or lag screws.
5. If supplied, remove the shipping brace from under the fan board and install the air filter (optional).
6. Complete piping and wiring connections, as given in this manual. Replace all unit panels before starting the unit.

CAUTION: Failure to replace end panels and filters before starting the unit may result in equipment damage due to motor overload and dirty coils.

DUCT CONNECTIONS

The Trane Company recommends 24 gauge galvanized sheet metal duct to be supplied by the installer. Duct collars are provided at the unit air outlet of all concealed and recessed units, except for horizontal concealed sizes 02-06 as shown in Figure 6. A duct connection is provided for the 02-06 horizontal concealed units. See Figure 16 for horizontal unit duct dimensions and configuration. To attach, slip the duct into the unit and fasten the duct and unit flange together with screws.

To use the optional bottom duct connection on horizontal units, remove the bottom access panel and cut it along the break as shown in Figure 17. Re-install the panel piece A on the bottom of the unit. Remove the filter and attach ductwork at the new duct location. Install the access panel piece B on the back duct collar and attach securely. Use holes provided.

NOTE: *The original filter cannot be used when the bottom duct connection is used on horizontal units. A special filter arrangement must be provided by the installer.*

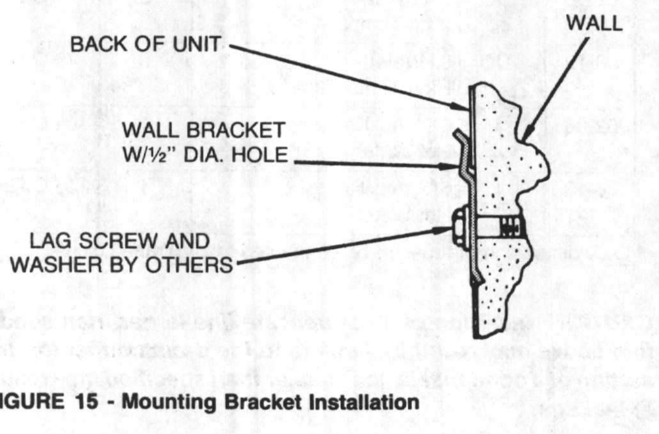
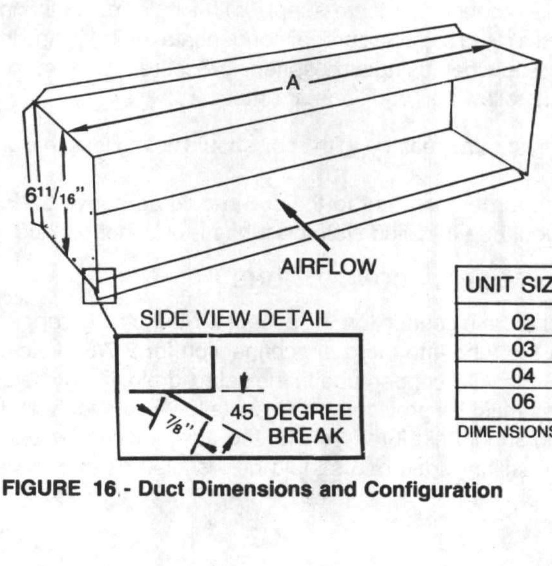


FIGURE 15 - Mounting Bracket Installation



UNIT SIZE	A
02	18½
03	26½
04	30½
06	42½

DIMENSIONS - IN.

FIGURE 16 - Duct Dimensions and Configuration

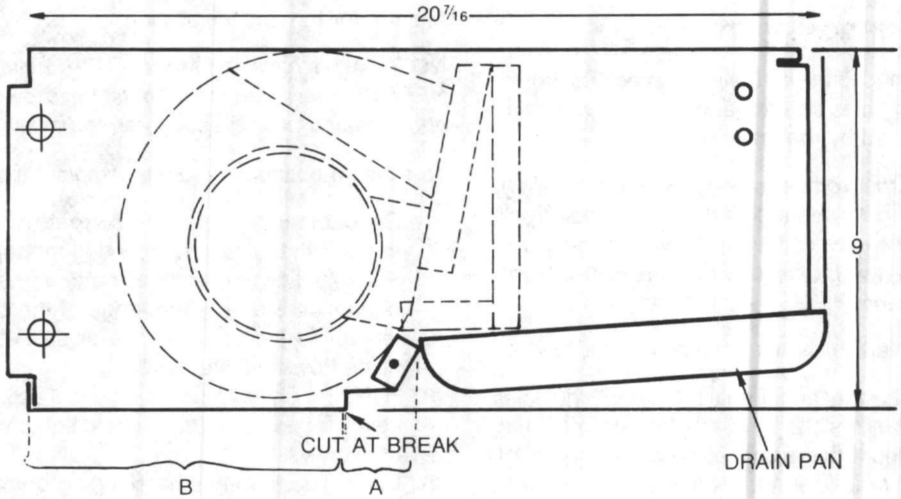


FIGURE 17 - Filter Access Panel Removal

PIPING

COIL CONNECTIONS

Before connecting pipes to the piping package, remove the valve support shipping brackets in the end pocket. To complete piping connections, open the stop valves and attach the piping package to the coil, with any necessary accessories. Coil connection sizes are given in Tables 3 and 4. See Figures 18, 19 and 20 for coil connection locations. Refer to sales submittals for specific connection locations.

NOTE: *When special piping packages are furnished on Horizontal Cabinet Models D and E, knockouts may not match up with the piping connections.*

CAUTION: Failure to open the stop valves before brazing or soldering to the coil may result in damage to the valve seats.

NOTE: *The valve stem packing may require tightening.*

CAUTION: Remove the auxiliary drain pan from both horizontal and vertical 02 to 06 units before soldering. Failure to do so may result in damage to the plastic pan from dripping solder or from excessive temperature.

If desired, steam may be used in auxiliary water coils in horizontal and low vertical units of 02 to 06 size. To prevent water hammer, do not use a modulating steam supply with single-row coils. In order to obtain rated capacity, proper condensate removal, and to avoid freeze-up when using atmospheric pressure return, make sure that the following conditions are met:

1. Entering steam pressure to the coil should not be less than 2 psig.
2. Entering air temperature to the coil should be above 32 F.
3. Coil should be installed with the tubes level - not pitched.

CONDENSATE DRAIN CONNECTIONS

The neoprene drain connection will accept a 7/8-inch OD copper tube. Insert the tube into the drain connection for 2-7/8 inches. Attach a 5/8-inch OD copper tube to the safety drain, if provided. Hose clamps must be provided by the installer. The supply and return piping should not interfere with the auxiliary condensate drain pan. Auxiliary drain pan should be installed as shown in Figure 22.

TABLE 3 - Coil Connection Sizes for Vertical and Low Vertical Models (Inches)

UNIT SIZE	COIL TYPE	COIL DESCRIPTION	NO. ROWS	COIL* CONN.
		VERTICAL MODELS		
02-06	AO	12" Water	1	5/8 O.D.
08-12	AO	10½" Water	2	7/8 O.D.
02-06	DO	12" Water High Temp. Rise	2	5/8 O.D.
08-12	DO	12" Water High Temp. Rise	2	7/8 O.D.
02-06	L	9" Auxiliary Hot Water	1	½ O.D.
08-12	L	10" Auxiliary Hot Water	1	½ O.D.
		LOW VERTICAL MODELS		
02-06	AO	7½" Water	2	5/8 O.D.
02-06	L	3⅓" Auxiliary Hot Water	1	½ O.D.

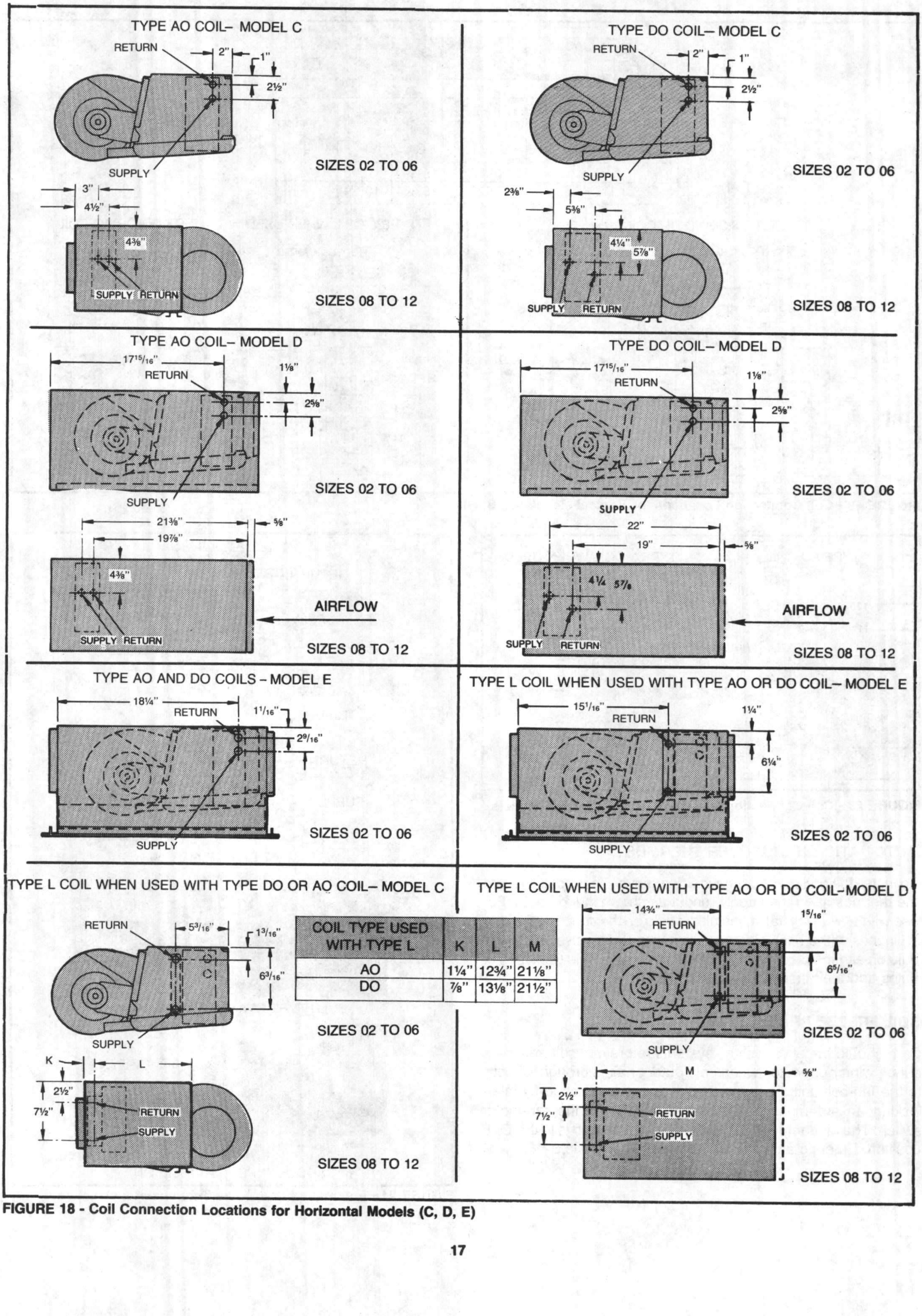
* O.D. dimension of tubes to be connected to UniTrane coil.

TABLE 4 - Coil Connection Sizes for Horizontal Models (Inches)

UNIT SIZE	COIL TYPE	COIL DESCRIPTION	NO. ROWS	COIL* CONN.
02-06	AO	7½" Water	2	5/8 O.D.
08-12	AO	9" Water	2	7/8 O.D.
02-06	DO	7½" Water High Temp. Rise	2	5/8 O.D.
08-12	DO	9" Water High Temp. Rise	3	7/8 O.D.
02-06	L	6⅔" Auxiliary Hot Water	1	½ O.D.
08-12	L	6⅔" Auxiliary Hot Water	1	½ O.D.

* O.D. dimension of tubes to be connected to UniTrane coil.

CAUTION: Insertion of a condensate line larger than specified above may result in damage to the drain connector. Insertion of a condensate line smaller than specified may result in leakage.



COIL TYPE USED WITH TYPE L	K	L	M
AO	1¼"	12¾"	21⅛"
DO	⅞"	13⅛"	21½"

FIGURE 18 - Coil Connection Locations for Horizontal Models (C, D, E)

COIL TYPE	B	C	D	E
AO	5¾"	23½"	22¾"	4⅜"
DO	6⅛"	22⅞"	22"	4⅞"

COIL TYPE USED WITH TYPE L	F	G	H	J
AO	20¹/₁₆"	18¾"	10"	9¼"
DO	20½"	19¼"	10½"	9¹³/₁₆"

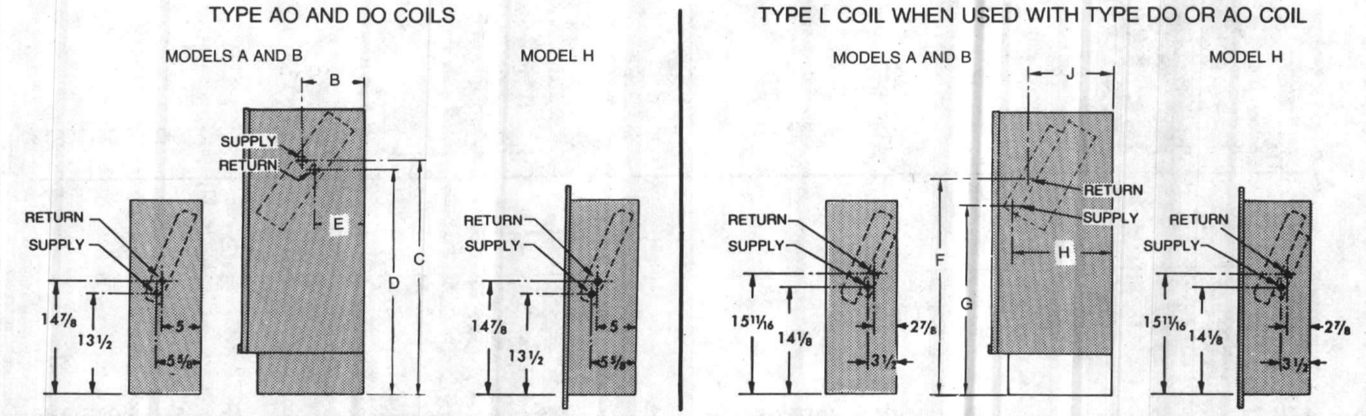


FIGURE 19 - Coil Connection Locations for Vertical Models (A, B, H)

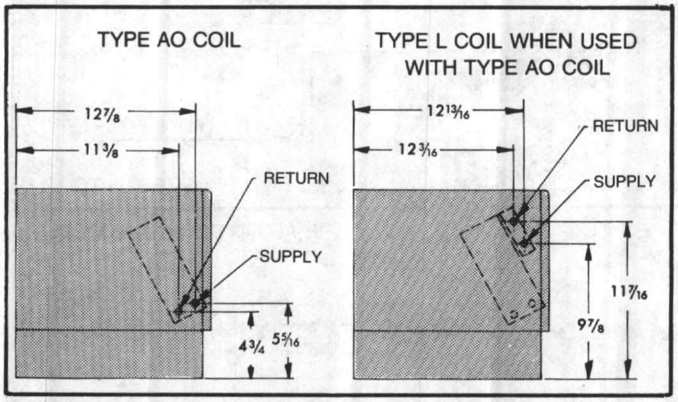


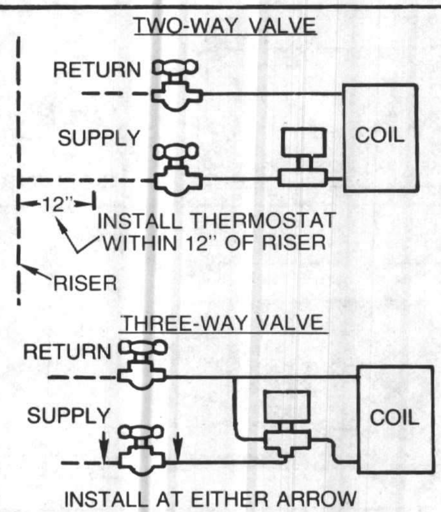
FIGURE 20 - Coil Connection Locations for Low Vertical Models (K,L)

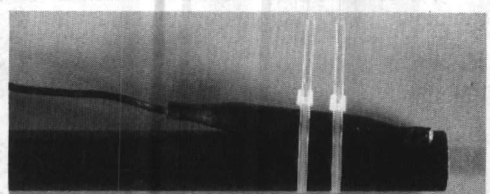
AUTOMATIC CHANGEOVER THERMOSTAT

To install the optional Automatic Changeover Thermostat, locate the thermostat on the supply runout as shown in Figure 21. For use with a two-way valve, install the bulb on the supply line within 12 inches of the riser. For use with a three-way valve, install the bulb on either side of the supply line stop valve. The two types of bulbs and their installations are shown in Figure 21.

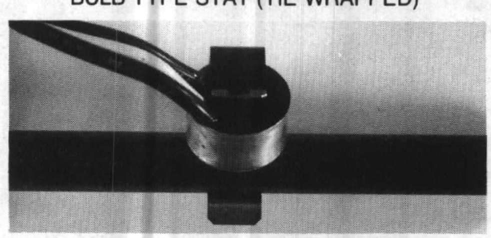
COIL FREEZE PROTECTION

Care should be taken with all systems to prevent coil freeze-up during winter operation when cold outdoor air is brought directly to the fan-coil unit. This can usually be accomplished by interlocking an automatic outdoor air damper with the fan-motor switch. The air damper must close when the switch is in the OFF position. Entering air temperature should be above 32 F.





BULB TYPE STAT (TIE WRAPPED)



SADDLE TYPE STAT (CLIP ON)

FIGURE 21 - Automatic Changeover Thermostat Installation

WIRING

WARNING: DISCONNECT ELECTRICAL POWER SOURCE AND SECURE IN THAT POSITION BEFORE SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH FROM ELECTRICAL SHOCK.

CAUTION: Use only copper conductors for wiring connections. Unit terminals are not designed to accept other types of wiring. Aluminum or other conductors may cause overheating and unit damage.

For wiring and installation, refer to the wiring diagrams supplied with the unit inside the control box cover for specific connections and connection requirements. Supply voltage connections are made at the junction box in the unit end pocket or in the combination motor control/junction box. (The bottom end pocket is open.) Wiring connections to a remote thermostat or fan motor switch must also be made at this box. All internal wiring is complete to this point. Refer to Table 5 for junction box location. See Table 6 for electric coil characteristics. Some electric coil units will require separate power leads for the coil and fan motor control circuits.

TABLE 5 - Junction Box Location for Electric Connections

UNIT SIZE	MODELS	MAIN COIL SIDE	SIDE OPPOSITE MAIN COIL
02-06	Vertical	X	
02-06	Horizontal W/O Electric Heat		
	- 2-Pipe Electric Piping Package	X	
	- 4-Pipe Electric Piping Package	X	
	- Pneumatic Piping Package		X
	- Without Piping Package	X	
02-06	Horizontal W/Electric Heat		X
02-06	Low Vertical W/Auxiliary Coil	X	
02-06	Low Vertical W/O Auxiliary Coil		X
08-12	Vertical		X
08-12	Horizontal		X

NOTE:
Electric junction box is furnished by Trane unless otherwise specified.

TABLE 6 - Electric Coil Data

UNIT SIZE	NO. OF ELEMENTS				HIGH SPEED OPERATION — AMPERES PER PHASE						
					ONE PHASE - TWO WIRE				THREE PHASE - THREE WIRE		
	HIGH SPEED	MEDIUM OR LOW SPEED	KW	MBH	120V	208V	240V	277V	208V	240V	480V
02	3	3	1.0	3.4	8.3	—	—	3.6	—	—	—
	6	3	2.5	8.6	—	12.0	10.4	9.0	7.0	6.0	3.0
03	3	3	1.5	5.1	12.5	—	—	5.4	—	—	—
	6	3	3.75	12.8	—	18.0	15.6	13.5	10.4	9.0	4.5
04	3	3	2.0	6.8	16.6	—	—	7.2	—	—	—
	6	3	5.0	17.1	—	24.0	20.8	18.0	13.9	12.0	6.0
06	3	3	2.4	8.2	20.0	—	—	—	—	—	—
	3	3	3.0	10.2	—	—	—	10.8	—	—	—
	6	3	7.5	25.6	—	36.0	31.2	27.0	20.8	18.0	9.0
08	3	3	4.0	13.7	—	—	16.7	14.4	11.1	9.7	4.8
10	3	3	5.0	17.1	—	—	20.8	18.1	13.9	12.0	6.0
12	3	3	6.0	20.4	—	—	—	21.7	16.7	—	7.2
	3	3	5.4	18.4	—	—	22.5	—	—	13.0	—

NOTE:
Electric Heating Coils are not available as standard with the following units:
- Low Vertical Units.
- 08 to 12 size Horizontal Cabinet units with quadrifuser grilles.
- 08 to 12 size units with type D coils.
- 02 to 06 size high KW units with type D coils.

INSTALLATION CHECKLIST

The following checklist is provided as an abbreviated guide to the detailed installation procedures given in this manual. This list should be used by the installing contractor to ensure that all necessary procedures have been completed. For more complete information, refer to the appropriate sections in this manual.

WARNING: DISCONNECT ELECTRICAL POWER AND ALLOW ROTATING EQUIPMENT TO STOP BEFORE SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH FROM ELECTRICAL SHOCK OR ENTANGLEMENT IN MOVING PARTS.

☐ 1. Units are checked for shipping damage.
☐ 2. Unit location is prepared for weight, level, service access and cutouts.
☐ 3. Unit is mounted securely to the floor and wall or ceiling support rods.
☐ 4. Unit casing is level.
☐ 5. Drain line has a drain line pitch of 1" drop per foot.
☐ 6. Ductwork connections are complete.
☐ 7. Valve shipping brackets are removed.
☐ 8. Coil connections are complete.
☐ 9. Condensate drain pan connections are complete.
☐ 10. Automatic Changeover Thermostat is installed (optional).
☐ 11. Coil freeze protection is provided.
☐ 12. Electrical supply power is connected according to wiring diagrams provided on the unit.

CAUTION: Use of conductors other than copper may result in overheating and damage to the unit.

☐ 13. Start-Up preparation is complete and unit is in the proper operating mode.
☐ 14. Owner-operator is instructed on unit operation.

RETAIN THIS INSTALLATION/MAINTENANCE MANUAL WITH THE UNIT FOR FUTURE REFERENCE.

START-UP

PREPARATION

Before starting the unit, complete the following checks:

☐ 1. Make sure the valve support shipping brackets are removed.
☐ 2. Check that the unit is level on the casing.
☐ 3. Ensure that the auxiliary drain pan pitches toward the drain lip from all directions. Piping must not touch the auxiliary drain pan or force it out of position.
☐ 4. On horizontal units of 02 to 06 size, check that the drain pan liner insulation fits into the 1/4-inch wide groove under the auxiliary drain pan lip. See Figure 22.
☐ 5. Secure all electrical connections at their terminals.
☐ 6. Ensure that all filters and unit panels are in place.

OPERATION

Fan-Coil UniTrane® operation is controlled by a motor speed switch, a thermostat, and a summer-winter switch (optional). Vertical units have unit or wall-mounted controls. Horizontal unit controls are wall-mounted.

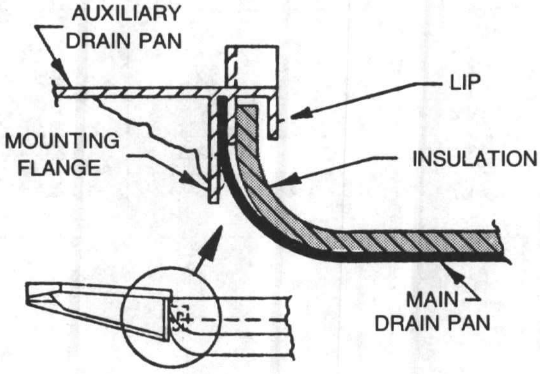


FIGURE 22 - Auxiliary Drain Pan on Horizontal Units of 02 to 06 Size

The motor speed switch controls the fan and is one of two types. The switch labeled OFF-HI-MED-LOW provides additional cooling by turning the switch to a higher speed. The switch type labeled MAN-OFF-AUTO provides continuous operation in the MANUAL position and operates only to meet the thermostat setpoint in the AUTO position.

Unit-mounted thermostats are labeled COOL-WARM and should be adjusted on the range according to the arrows on the knob. Wall-mounted thermostats usually have a dial to select an approximate temperature.

The optional summer-winter switch may be manual or automatic. The manual switch is labeled SUMMER-WINTER or HEAT-COOL. The automatic type of changeover switch is an integral part of the control circuit which reverses the thermostat action in accordance with water temperature changes.

On units with electric heat, the coil contactors are interlocked with the motor speed switch, so electric heat is possible only when the fan is in operation. The electric heat operating circuit includes a high temperature cut-out switch with automatic reset. When coil temperature exceeds the setpoint of the cut-out (210 F), the heating coil will de-energize and the fan will continue to run. The control circuit may also include a fan override thermostat to provide fan operation to cool the heating coil after manual shutoff.

Care should be taken with all systems to prevent coil freeze-up during winter operation, when cold outdoor air is brought directly to the fan-coil unit. On single-coil units, this can usually be accomplished by interlocking an automatic outdoor air damper with the fan-motor switch. The air damper should close when the switch is in the OFF position. On two-coil units, the heating coil should be in the preheat position and the automatic damper operator interlocked with the fan switch.

MAINTENANCE

PERIODIC MAINTENANCE CHECKLIST

The following checklist is provided as a recommended maintenance schedule. Detailed instructions for specific maintenance procedures are given after the checklist.

WARNING: DISCONNECT ELECTRICAL POWER AND ALLOW ALL ROTATING EQUIPMENT TO STOP BEFORE SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH FROM ELECTRICAL SHOCK OR ENTANGLEMENT IN MOVING PARTS.

EVERY MONTH

☐ 1. Inspect the unit air filters. Clean or replace clogged filter element.

☐ 2. Check the primary and auxiliary drain pans to be sure that they are clean and free to carry the flow of condensate through the drain line.

EVERY SIX MONTHS

☐ 1. Oil the fan motor.

EVERY YEAR

☐ 1. Inspect the unit casing for chips or corrosion. Clean or repair to protect unit protection.

☐ 2. Inspect the fan wheel and housing for damage. Rotate the fan wheel manually to be sure no obstructions block its movement.

☐ 3. Inspect the coil fins for excessive dirt or damage. Remove dirt and straighten fins.

☐ 4. Clean and tighten all electrical connections.

MAINTENANCE PROCEDURES

WARNING: DISCONNECT ELECTRICAL POWER AND ALLOW ALL ROTATING EQUIPMENT TO STOP BEFORE SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH FROM ELECTRICAL SHOCK OR ENTANGLEMENT IN MOVING PARTS.

FILTERS

Change or clean air filters at least twice a year. Filters will require more frequent care under high load conditions or dirty air. A clogged air filter reduces airflow, causing the high temperature cutout on electric heat units to shutoff the unit.

Table 7 lists filter sizes. Filters are available in 1/2-inch or 1-inch widths. Disposable, permanent (cleanable), or replaceable media filters are acceptable for all units. To replace disposable filters, remove filter from the unit and dispose of entire filter and frame. Replace with new filter in the proper direction. To replace filters with replaceable media, remove the filter and frame from the unit, replace media in the frame, and re-install the filter frame facing the proper direction.

To clean permanent filters, remove the filter and wash it in water to remove dust, dirt and lint. Then wash the filter with a mild alkali solution to remove the old filter oil. Rinse in clean, hot water and allow to dry. Recoat both sides of the filter with Air Maze Filter Kote W or an equivalent, using immersion or a spray gun. Allow to drain and dry thoroughly before re-installing the filter.

TABLE 7 - Filter Sizes (Inches)

UNIT SIZE	VERTICAL AND HORIZONTAL	LOW VERTICAL
02	19⅞ x 8¼	19½ x 8
03	27⅞ x 8¼	27½ x 8
04	31⅞ x 8¼	35½ x 8
06	43⅞ x 8¼	47½ x 8
08	45¾ x 11	—
10	57¾ x 11	—
12	69¾ x 11	—

DRAIN PANS

The primary and auxiliary drains should be cleaned to allow condensate flow. On 02 to 06 horizontal units, ensure that the drain pan liner insulation fits into the 1/4-inch groove provided for it under the auxiliary drain pan lip, as in Figure 22. To remove the auxiliary drain pan from vertical 02 to 06 units, first slide the pan up, then pull it away from the unit.

CAUTION: Failure to proceed with caution when removing the auxiliary drain pan may result in damage to the unit by breaking the pan's plastic mounting tabs.

MOTOR OIL

Bearing oilers are provided on the fan motor. It is recommended that motors be oiled twice a year with six to eight drops of SAE Number 10 non-detergent oil.

CAUTION: Do not operate the fan motor without the air filter or front panel in place. Excessive air handled by the fan may cause equipment damage due to motor overload.

REPAIR

FAN BOARD REMOVAL

When servicing fans or motor, follow these procedures to remove the fan board.

WARNING: DISCONNECT ELECTRICAL POWER AND ALLOW ALL ROTATING EQUIPMENT TO STOP BEFORE SERVICING THE UNIT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH FROM ELECTRICAL SHOCK OR ENTANGLEMENT IN MOVING PARTS.

VERTICAL MODELS

1. Remove the front access panel.
2. Disconnect the motor lead quick-connect plug at the junction box in the end pocket.
3. Pull the lower half of the red plastic drain tube from the upper half (02-06 only).
4. Remove the fan board mounting screws.
5. Lower the front edge of the fan board assembly about two inches and pull assembly out of the unit.

HORIZONTAL UNITS

☐ Open the bottom panel on recessed and cabinet models (Model 'E' sizes 02-06, Model 'D' — all sizes).

☐ **C32 Models**
1. Disconnect the motor wiring at the control box.
2. Remove fan board mounting screws.
3. Remove fan board assembly through the bottom of unit.

☐ **C34 Models**
1. Disconnect motor wiring at control box.
2. Remove bottom access panel.
3. Remove fan board mounting screws.
4. Remove fan board assembly through the bottom of access opening.

MOTOR REPLACEMENT

The special motor in the 02 to 06 size fan-coil units cannot be repaired or rewound. If the motor fails, order a replacement from The Trane Company. Use the unit serial number and unit size when ordering a new motor.

With the fan board assembly pulled out of the unit, motor replacement procedure will be evident upon inspection of the assembly. For most units, the clips which hold the fan housing together must be removed in order to get at the fan wheel-to-motor shaft allen screws. Fan housing-to-fan board mounting clips and screws should be removed. All clips may be reused for reassembly. Be careful not to spring them out of shape when removing.

When reassembling, make sure the fan wheel is centered in the fan housing and not rubbing on either side.

***NOTE:** Controls such as thermostats may be repaired locally; repair should be supervised by the control manufacturer's representative.*

TAB PLACEMENT HERE

DESCRIPTION:

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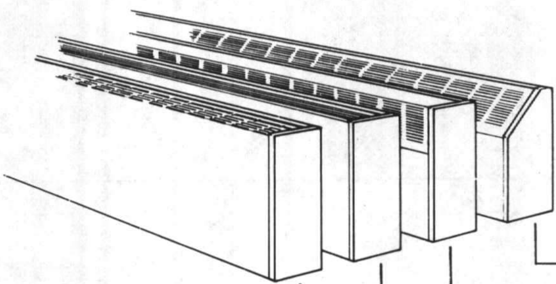
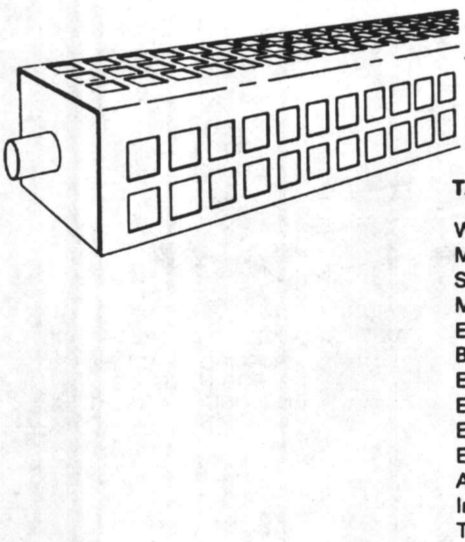
Installation WF-IN-3C

Library	**Service Literature**
Product Section	**Air Term Devices and Htg Prod**
Product	**Finned Tube Radiation**
Model	**WF**
Literature Type	**Installation**
Sequence	**3C**
Date	**December 1985**
File No.	**SV-TD-FIN-WF-IN-3C-1285**
Supersedes	**WF-IN-3B 384**

HYDRONIC ARCHITECTURAL WALL-FIN





NOTE: This installation manual covers the Trane Hydronic Architecural Wall-Fin models shown above.

TABLE OF CONTENTS

WALL-FIN COMPONENTS

For proper wall-fin installation, the components should be installed in the sequence outlined in this manual. Note that some items are optional and may not be required for each specific job.

Figures 1 and 2 identify the components used in a typical wall-fin installation. Detail drawings of mounting locations are shown on page 3.

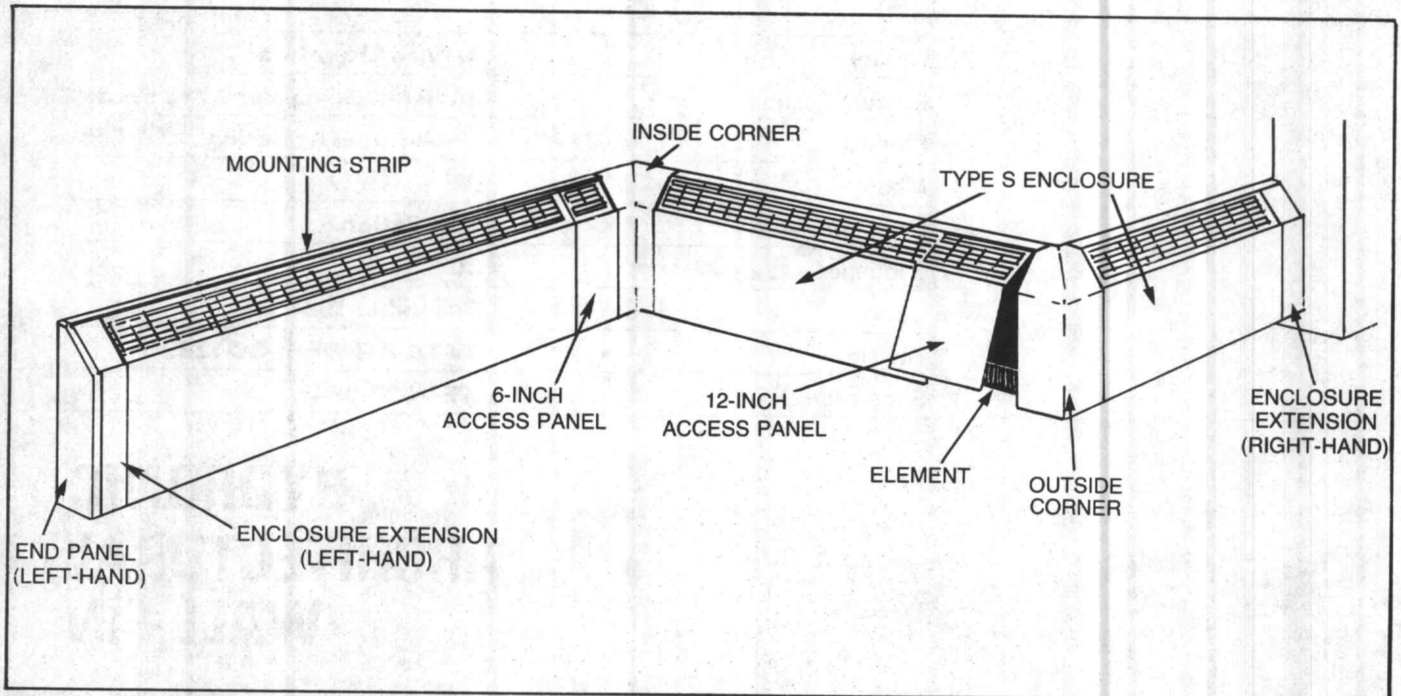


FIGURE 1 - Exterior Component Identification

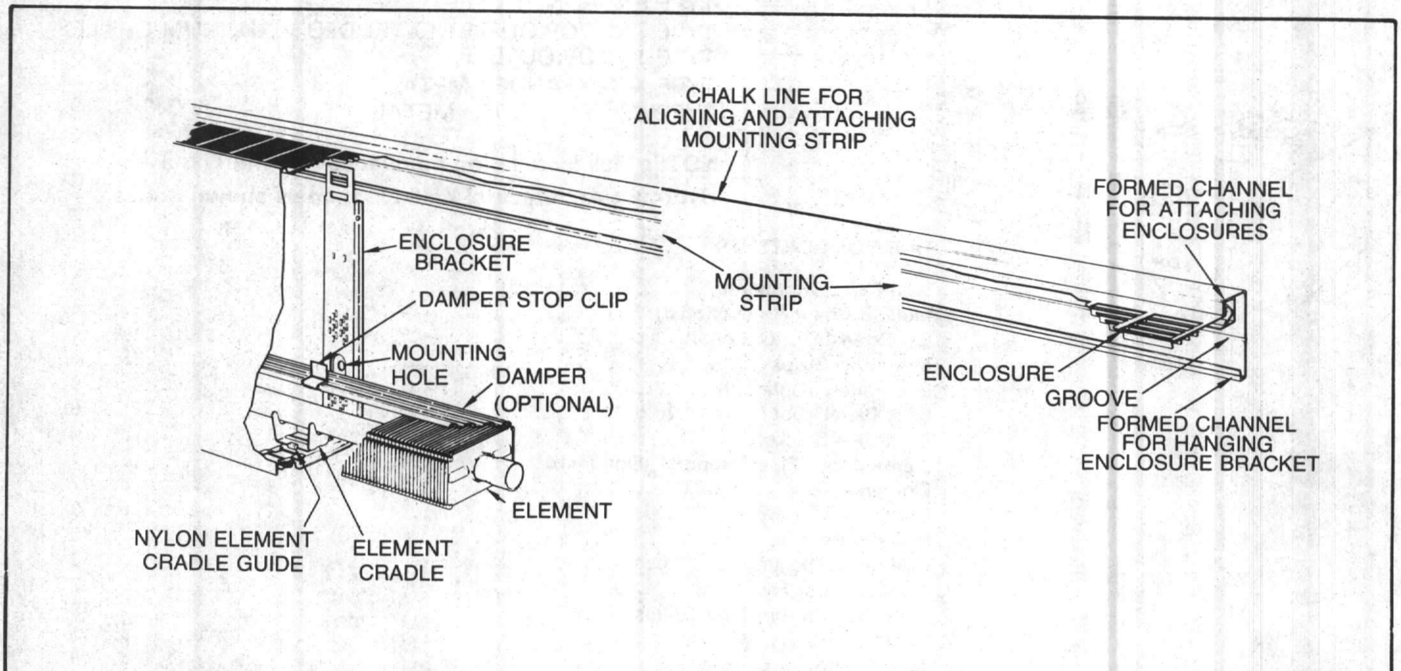
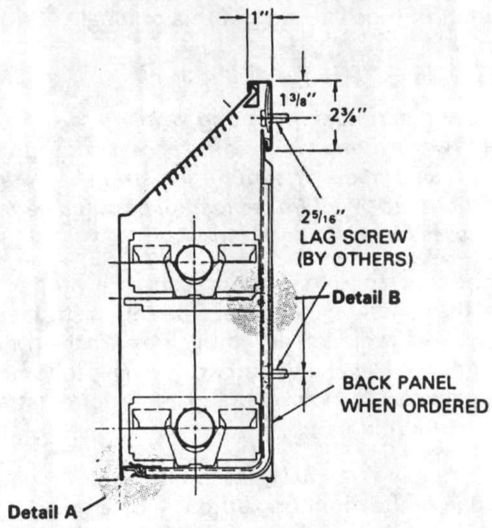
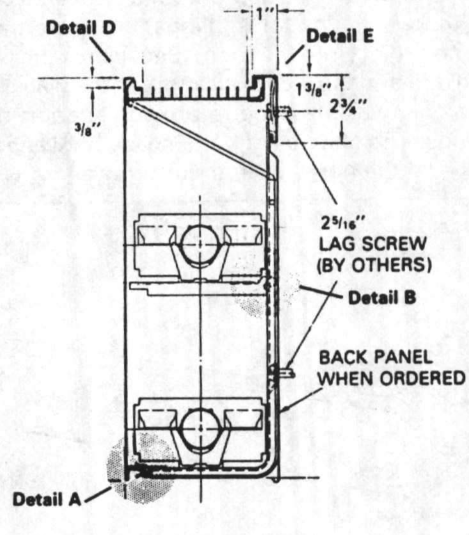


FIGURE 2 - Interior Component Identification

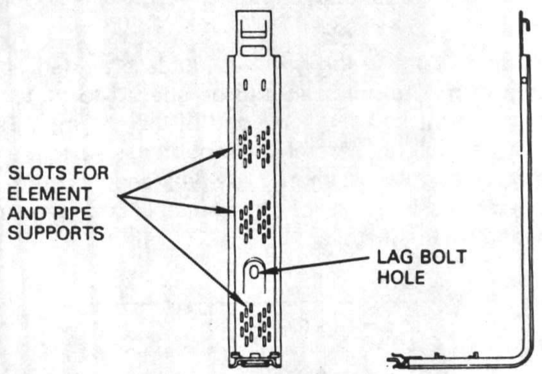
S-Enclosure



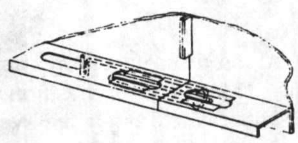
TA-Enclosure



Enclosure Bracket

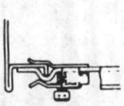


Detail C



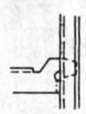
Panel to panel connection showing slide bolt.

Detail A



Front panel enclosure bracket connection.

Detail B



Element support to enclosure bracket mounting.

Detail D

TA - Front panel mounting to extruded aluminum grille.

Detail E

TA - Extruded aluminum grille and mounting strip connection.

MULLION CHANNELS

Mullion channels are used on panel walls or curtain walls where the wall studs (or mullions) are more than four feet apart and project into the room. Because of the weight of the wall-fin unit and the lack of strength in the wall construction, mullion channels are used to provide support between the wall studs. The channels fill the space between the wall-fin cabinet and the panel wall or curtain wall.

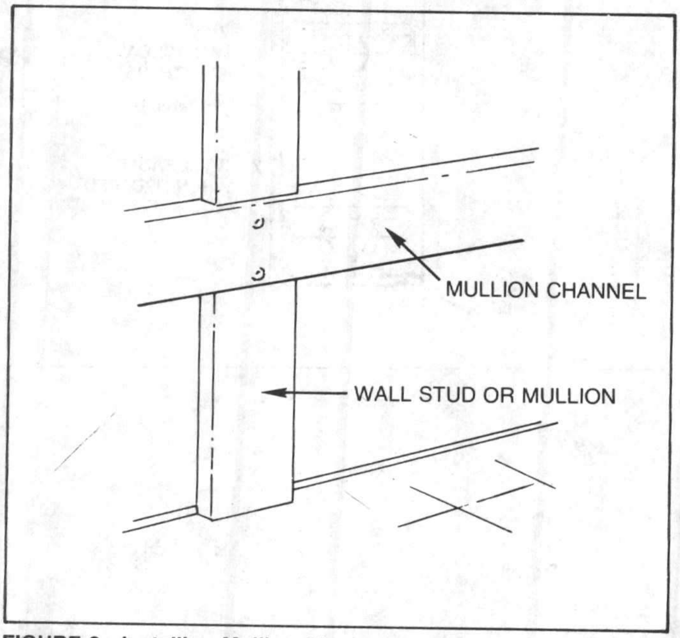


FIGURE 3 - Installing Mullion Channels

The top and bottom edges of the mullion channels should be notched to fit the wall studs or mullions. Attach the channels to the wall studs and fasten the wall-fin mounting strips to the channels. Suitable fasteners must be provided by the installer. See Figure 3.

Attach the bottom of the enclosure brackets to the mullions, to furring strips, or to additional mullion channels.

SILL EXTENSIONS

Sill extensions are used to extend the top of the cabinet back to the wall or window sill. They can add up to 14 inches of continuous surface to the top of the unit.

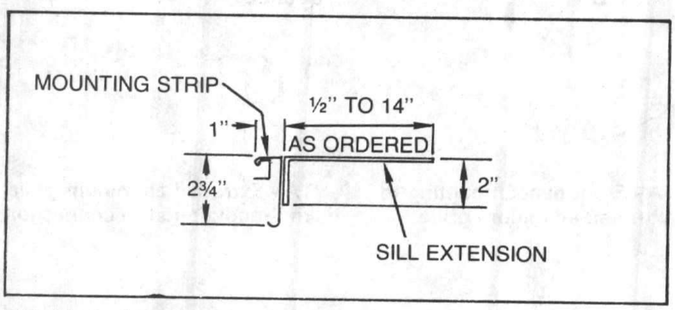


FIGURE 4 - Installing the Sill Extension

The sill extension is a separate angle piece and is to be installed at the same time as the mounting strip. The front 90-degree edge of the sill extension should be butted up to the back side of the mounting strip, as shown in Figure 4.

Both the sill extension and the mounting strip are secured at the same time, using the installation procedure outlined in the "Mounting Strips" section of this manual.

MOUNTING STRIPS

NOTE: *Before cutting the mounting strips for a specific job, make sure that the dimensions of the accessories have been taken into consideration. The mounting strip should be long enough to mount the wall-fin enclosure, plus end panels and any other accessories that are required.*

The straight-edge mounting strip assures a proper fit, regardless of the condition of the wall. Mounting strips support the entire wall-fin radiation assembly. Be sure the mounting strips are mounted level and butt up to each other properly. Enclosures, enclosure brackets, and accessories attach directly to the mounting strip.

Begin by "snapping" a chalk line on the wall to which the rear, top edge of the mounting strip will be aligned and fastened (see Figure 2). The distance from the chalk line to the floor should equal the height of the enclosure, plus an allowance of either four, five, or six inches, depending on the enclosure height. Mounting heights are shown in Figure 5. For example, with a 12-inch high enclosure the chalk line should be 18 inches above the floor line, and with a 16-inch high enclosure the chalk line should be 21 inches from the floor line.

Drill 5/16 inch holes in the grooved guide provided on the mounting strip. The holes should be spaced to match the wall studs. Align the rear, top edge of the mounting strip flush with the chalk line. Attach the mounting strip to the wall using the rectangular washers provided (see Figure 6) and 1/4-inch lag bolts. Lag bolts or other suitable fasteners are to be provided by the installer.

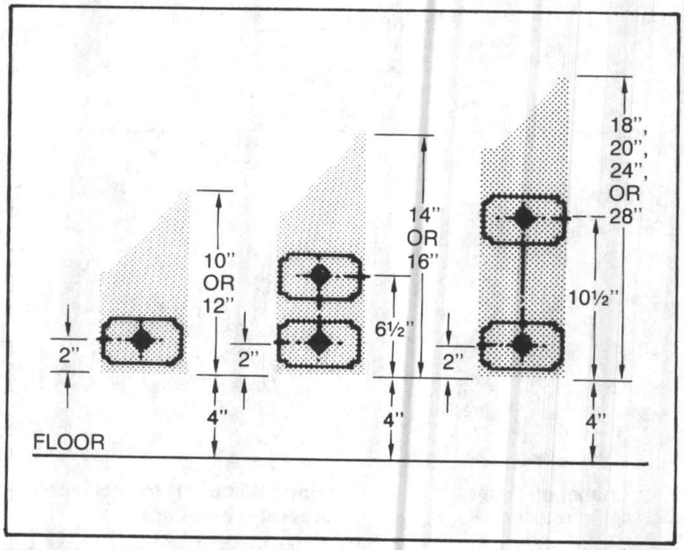


FIGURE 5 - Wall-Fin Mounting Heights

The rectangular washers must be used to provide a stiffening effect and help prevent any distortion of the strip should excessive weight be applied to the installed unit.

Mounting strips may be butted together or cut as necessary to provide the required length of run along the wall.

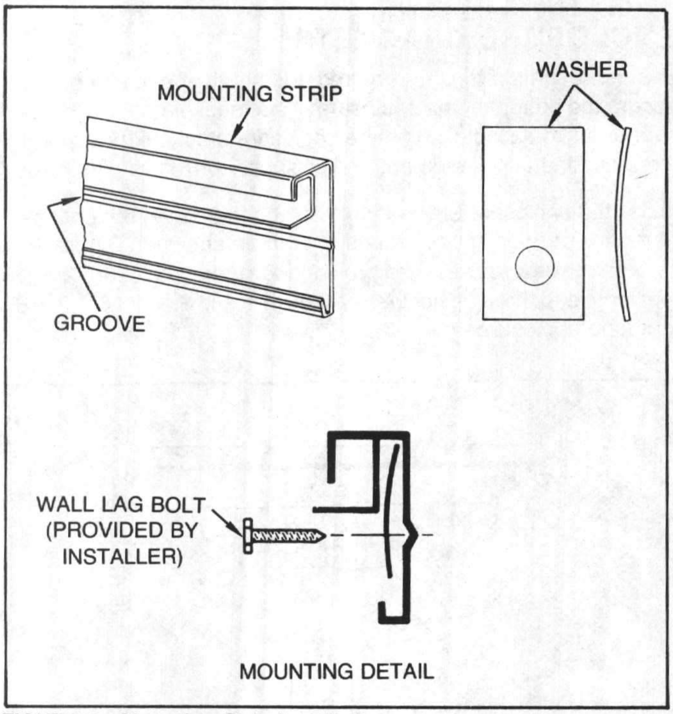


FIGURE 6 - Mounting Strip Installation

END PANELS

Install end panels at the same time as the mounting strip. Each end panel requires 3/4-inch on the mounting strip for proper mounting. Slide the formed tongue on the top back of the end panel (shown in Figure 8) into the space formed by the top and bottom channels of the mounting strip (shown in Figure 6).

Each end panel should be nailed to the wall through the nail holes provided in the rear flange. See Figure 8.

As shown in Figure 8, a hole is provided in the bottom flange for a sliding bolt. If the end panel is attached next to an enclosure or next to 6-inch or 12-inch access panels, engage the slide bolt into the end panel slide bolt hole for proper alignment.

WALL-TO-WALL INSTALLATION WITH END PANELS

End panels are one inch wide and take up 3/4-inch on the mounting strip. (See the "End Panels" section of this manual for proper mounting procedure.) Allow 1/4-inch clearance at the wall so there will be enough room to properly mount each end panel. Make sure the mounting strip is 1/2-inch shorter and the enclosure is two inches shorter than the wall-to-wall dimension. Refer to the example in Figure 7.

The mounting strip can be cut if necessary to provide the required length of run.

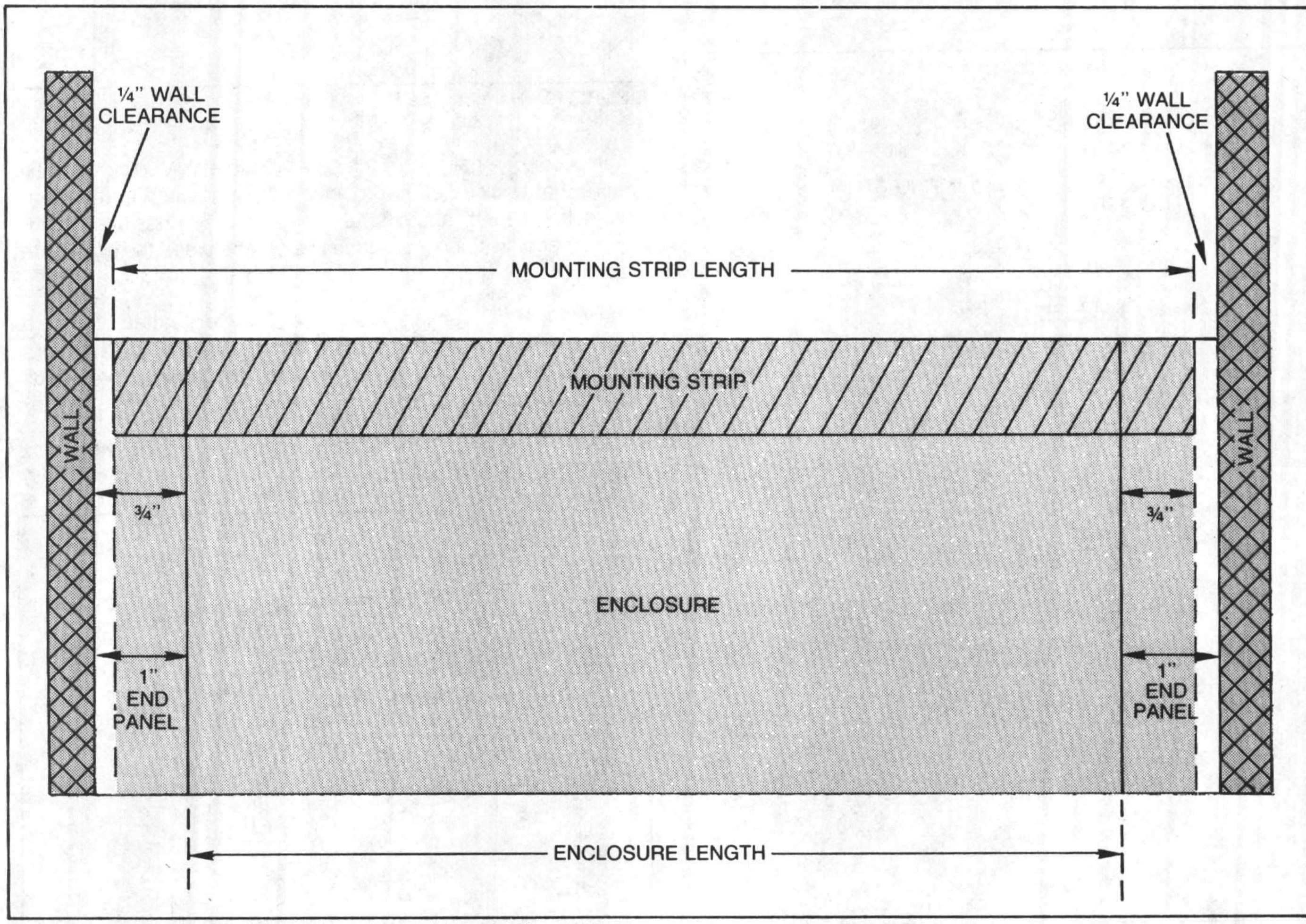


FIGURE 7 - Wall-to-Wall Installation with End Panels (Front View)

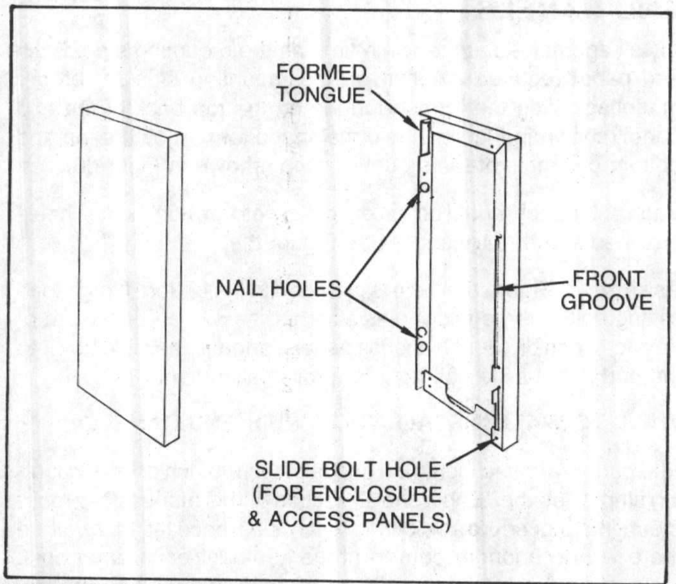


FIGURE 8 - End Panels

BACK PANEL

Install the back panel, if required, by hooking it over the channel at the lower edge of the mounting strip. See Figure 9.

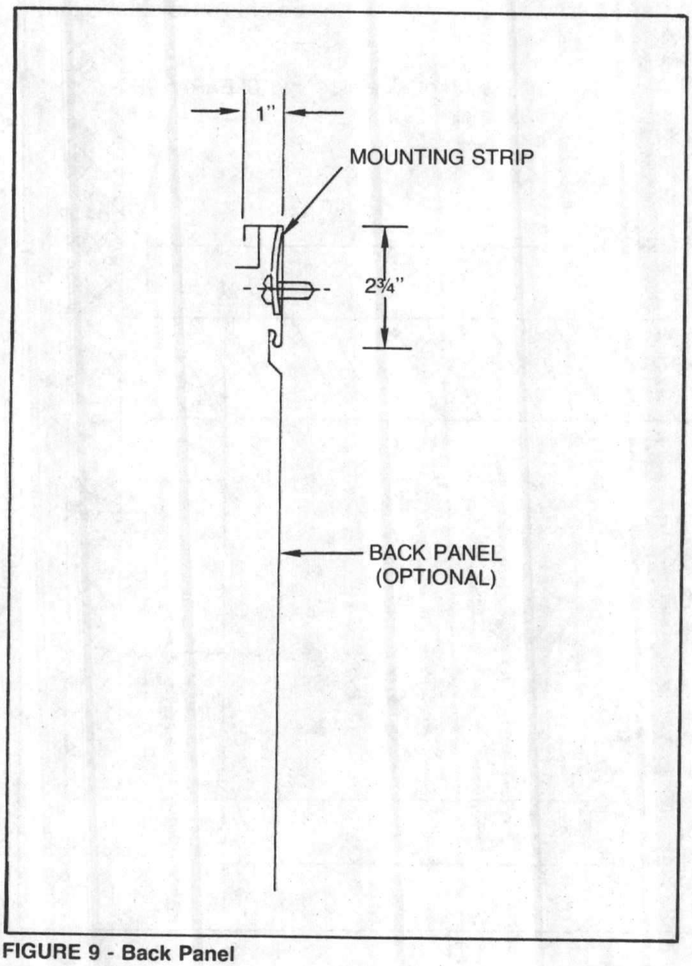


FIGURE 9 - Back Panel

ENCLOSURE BRACKETS

Enclosure brackets are required to mount the element and secure the bottom of the enclosure. Additional element and pipe supports can be installed on the enclosure brackets for supporting a second tier of element and/or supply or return piping.

Install the enclosure brackets by hooking them over the channel at the lower edge of the mounting strip as shown in Figure 10. Two enclosure brackets are provided for each enclosure 2 to 6 feet long, and three enclosure brackets are supplied for 6-1/2 to 8 foot long enclosures.

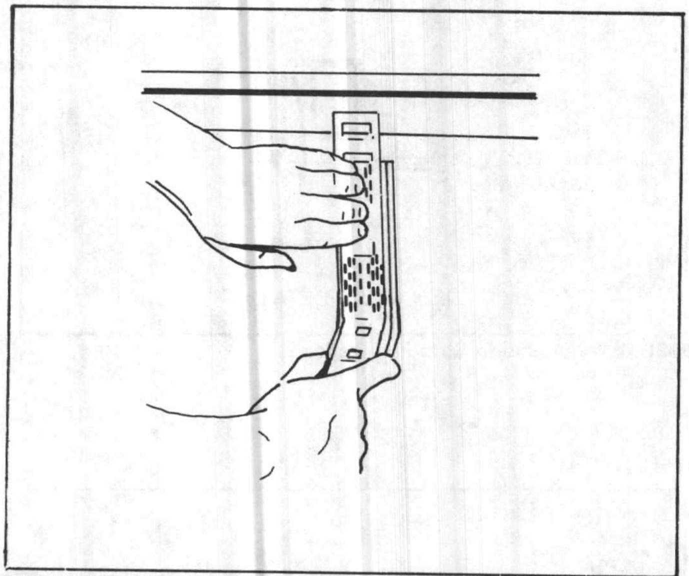


FIGURE 10 - Hanging the Enclosure Bracket

When possible, space the enclosure brackets on stud centers. To ensure that enclosures fit properly, it is suggested that the enclosure brackets be about three inches from the ends of each enclosure panel, with no more than five feet between the enclosure brackets.

If the enclosure brackets are on stud centers, attach them to the wall with 1/4-inch lag bolts or other suitable fasteners (supplied by the installer). Use the mounting hole provided, as shown in Figure 11.

Install element cradles in the nylon guides by sliding them into place. Refer to Figure 12.

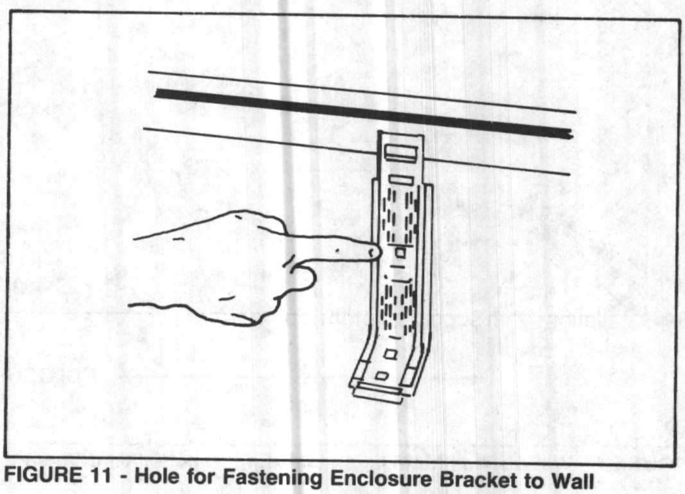


FIGURE 11 - Hole for Fastening Enclosure Bracket to Wall

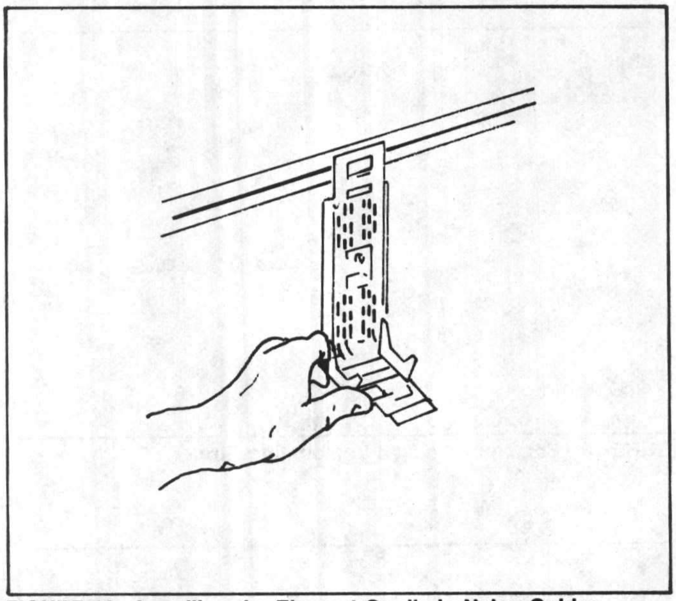


FIGURE 12 - Installing the Element Cradle in Nylon Guides

ELEMENT AND PIPE SUPPORTS

ELEMENT SUPPORTS

Element supports are used to pitch the heating element on steam installations, or to mount a second tier of element if required. The element supports provided will clip and lock into the graduated slots in the enclosure brackets. Refer to Figure 13. Install element cradles in the nylon guides by sliding them into place.

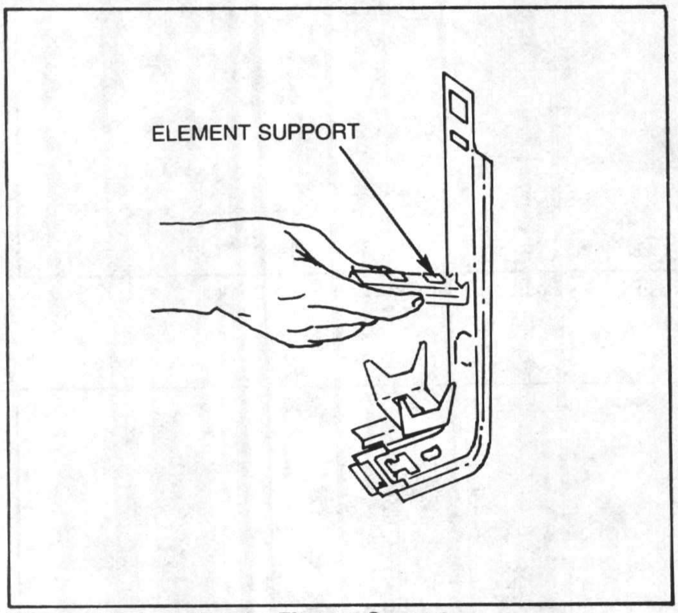


FIGURE 13 - Installing the Element Support

PIPE SUPPORTS

For installations with supply or return piping with one or two pipes, use the pipe supports provided. These pipe supports clip and lock into the graduated slots in the enclosure brackets. See Figure 14. Pipe supports do not have nylon guides and element cradles.

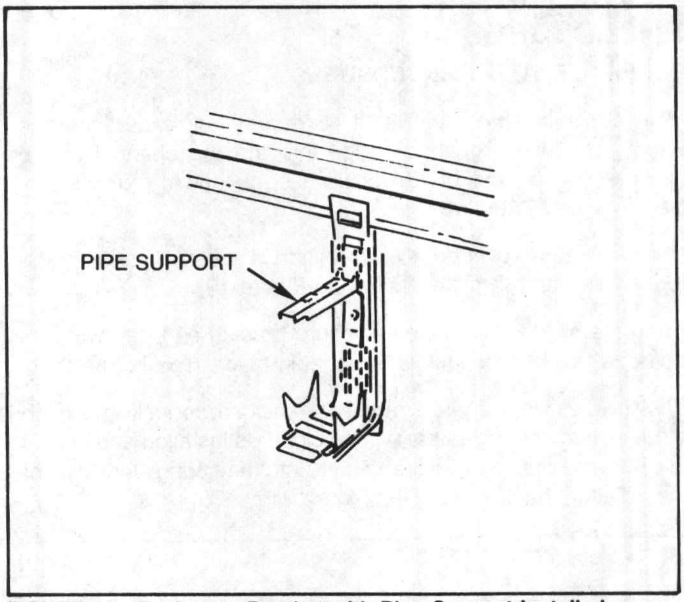


FIGURE 14 - Enclosure Bracket with Pipe Support Installed

ELEMENTS

Set the element in the cradles with the fin louvers facing downward (aluminum fins only). Refer to Figure 15.

NOTE: *If the elements include dampers, the elements should be level front-to-back to avoid damper hang-up during operation.*

On one row installations, the element should be mounted at the bottom of the enclosure on the enclosure bracket to obtain catalog capacity ratings.

Complete the installation of all elements and make the required piping connections. Nonferrous elements have one tube end belled for ease of sweat connection to the adjacent element. Steel element tube ends may be chamfered or threaded, as ordered, for welded or screwed connections.

With the elements in place, install the enclosures, enclosure extensions, access panels or access extensions. If the installation includes dampers, refer to the "Dampers" section of this manual before attaching the enclosures.

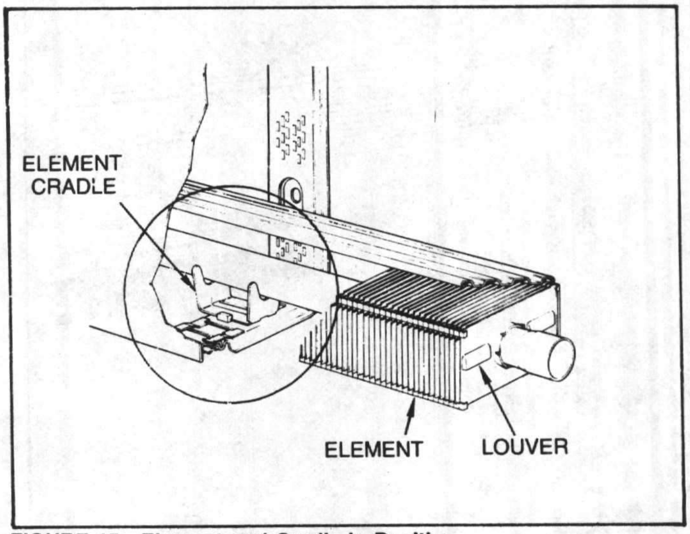


FIGURE 15 - Element and Cradle in Position

ENCLOSURES

TYPES S, F, AND T ENCLOSURES

Hold the enclosure panel at a 45 degree angle as shown in Figure 16. Insert the back edge into the top channel of the mounting strip, and bring the front edge down into position. See Figures 17 and 18.

Place the formed bottom edge of the enclosure panel in the formed lip of the bracket (shown in Figure 19).

Bring the slide lock on the enclosure bracket as far forward as possible to lock the enclosure panel in place. See Figure 20.

The lower, front edges of adjacent enclosures lock into each other with the sliding bolts. With enclosures installed and locked in enclosure brackets, slide the bolts into the spring steel clips of the adjacent enclosures. See Figure 21.

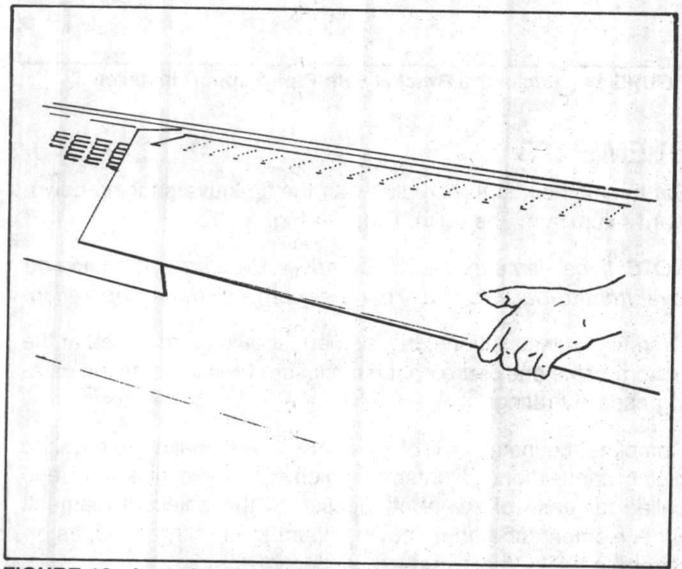


FIGURE 16 - Inserting the Enclosure Panel

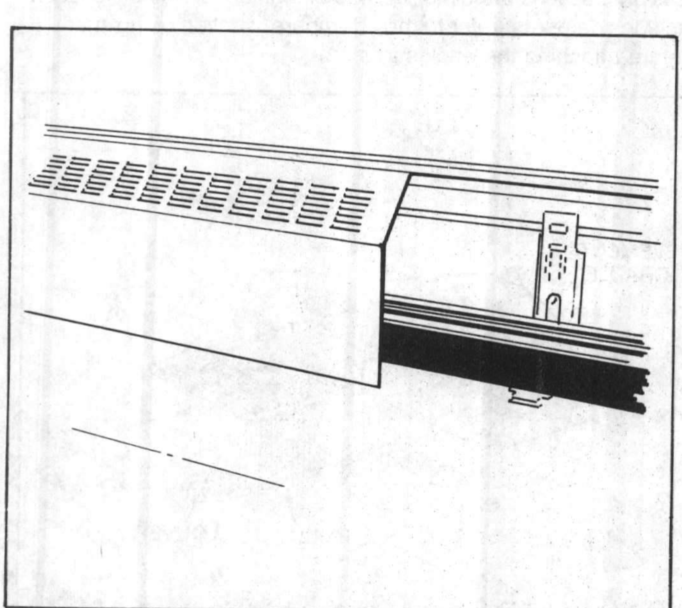


FIGURE 17 - Enclosure in Position

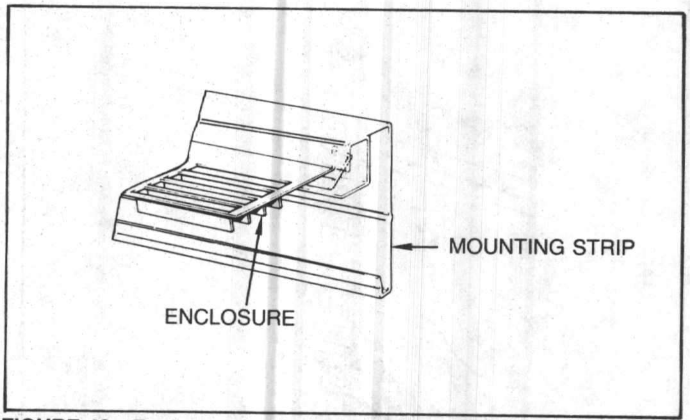


FIGURE 18 - Enclosure Locked to Mounting Strip

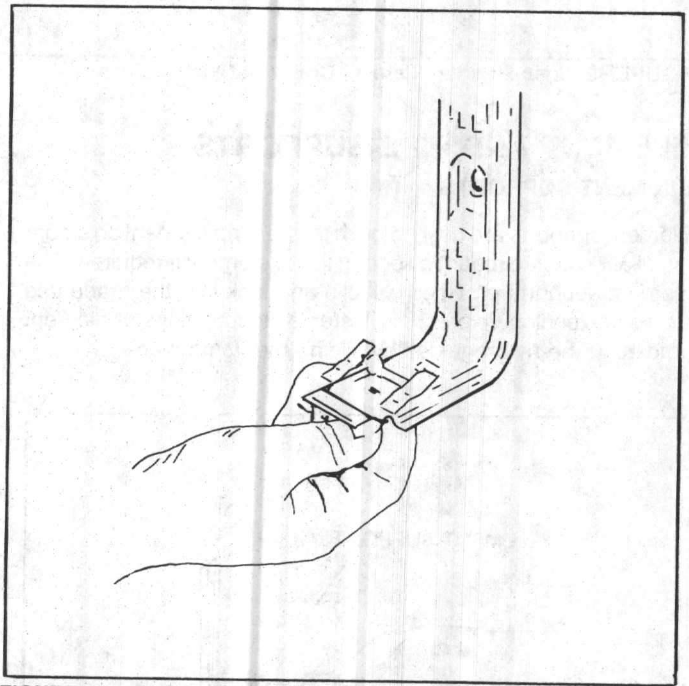


FIGURE 19 - Enclosure Bracket and Slide Lock

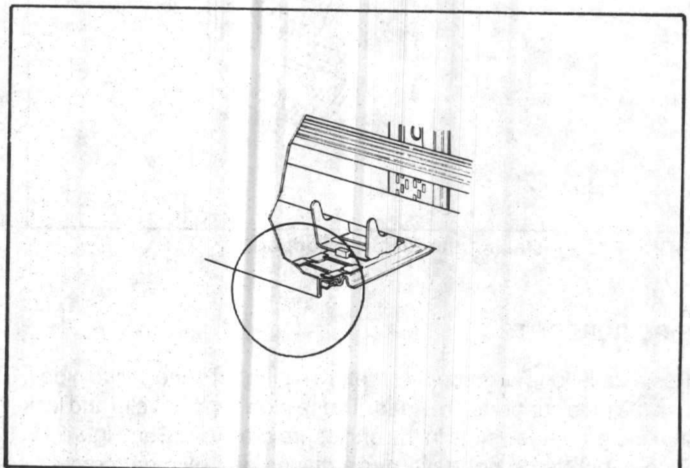


FIGURE 20 - Enclosure Locked to Bracket

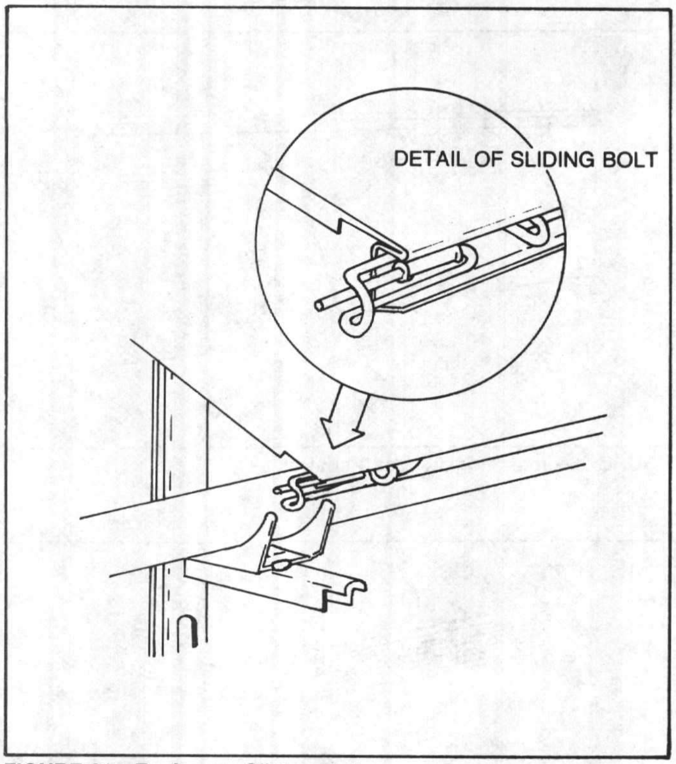


FIGURE 21 - Enclosure Sliding Bolt

TYPE TA ENCLOSURES

Type TA enclosures consist of an extruded aluminum grille and a separate front panel. In addition to the enclosure bracket, a rod loop is used to support the grille and front panel at the upper, front edge. See Figure 22.

Remove the enclosure bracket and insert the rod loop in the hole provided at the top of the bracket. Reinstall the bracket on the mounting strip as shown in Figure 23.

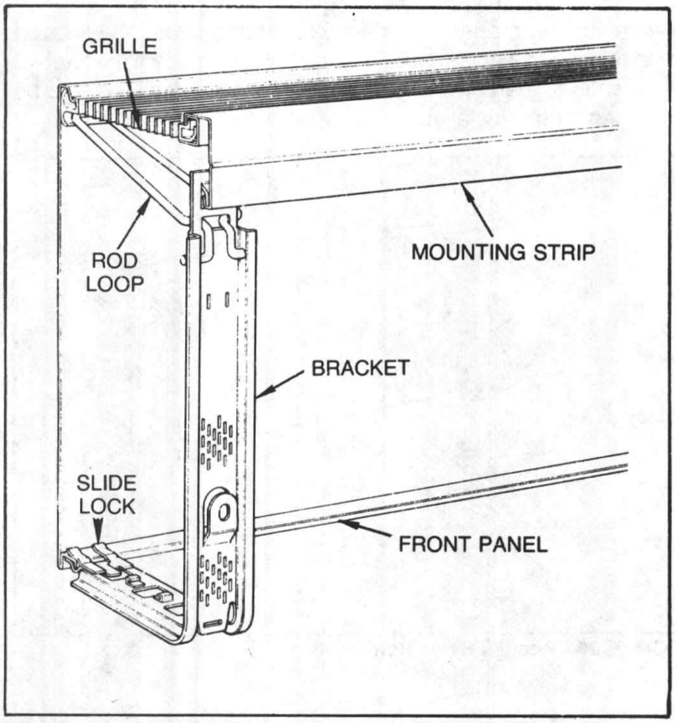


FIGURE 22 - Type TA Enclosure Mounting Detail (View from Rear)

Hold the grille in an upward position, 45 degrees from vertical, and insert the back edge of the grille into the top channel of the mounting strip. Bring the front edge of the grille downward and engage the rod loop. The front edge of the grille is formed to accept the rod loop.

If the installation includes dampers, attach the damper control mechanism at this time (see the "Dampers" section of this manual).

Insert the formed top edge of the front panel into the channel provided at the top, front edge of the grille. See Figure 24.

Bring the lower edge of the front panel down against the enclosure bracket and place the formed panel edge over the top of the bracket. Slide the slide lock as far forward as possible to lock the panel to the enclosure bracket.

Lock adjacent enclosures to each other with the sliding bolts as described for Type S, F, and T enclosures. Refer to Figure 21.

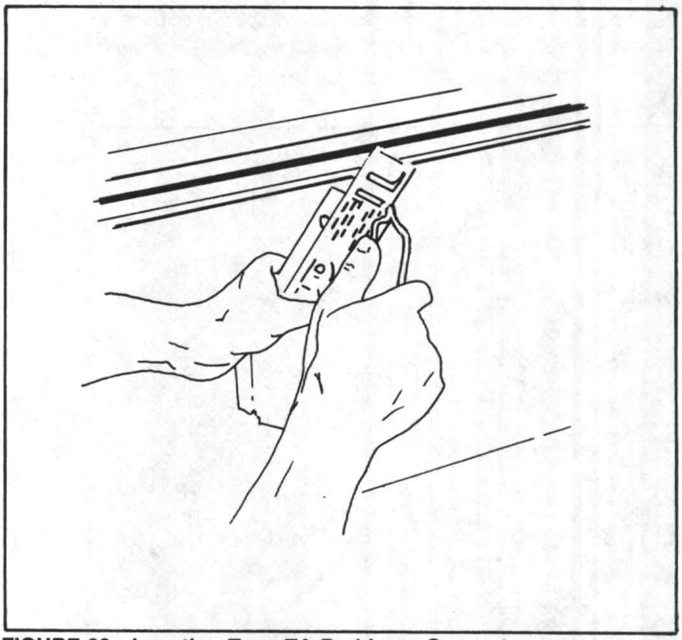


FIGURE 23 - Inserting Type TA Rod Loop Support

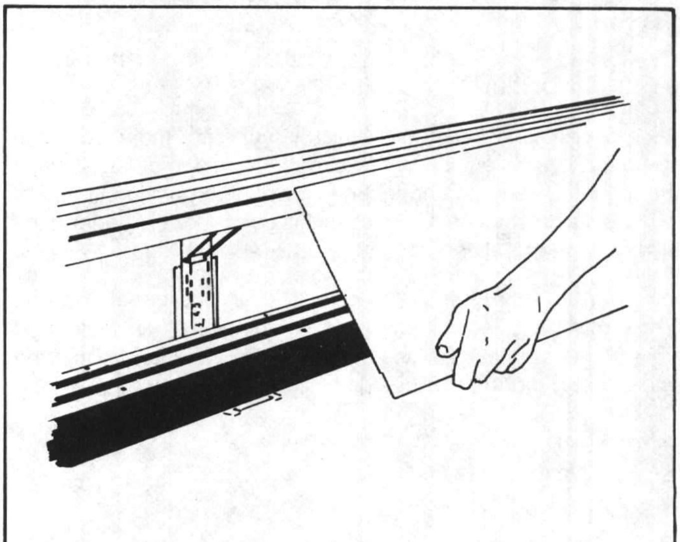


FIGURE 24 - Attaching Type TA Front Panel to the Grille

ACCESSORIES

ENCLOSURE EXTENSIONS

Enclosure extensions, shown in Figure 25, are designed to provide additional length to standard enclosures on wall-to-wall installations or when additional length is required to fully cover elements and piping.

The enclosure extension should lay over the top of the installed enclosure, with the flanged end positioned to butt up to the next enclosure, end cap, or corner piece.

Allow one inch overlap for a satisfactory joint. Remove the enclosure, place the enclosure extension over the edge of the enclosure, and snap the lower edge of the extension over the lower edge of the enclosure to form an assembly. Hold the assembly at an angle, insert it in the mounting strip, and bring the lower, front edge down into position. Lock the enclosure to the enclosure brackets (see Figure 20).

NOTE: *On Type TA enclosures the enclosure extension is to be inserted in the grille (in the same manner as enclosures are inserted) instead of in the mounting strip.*

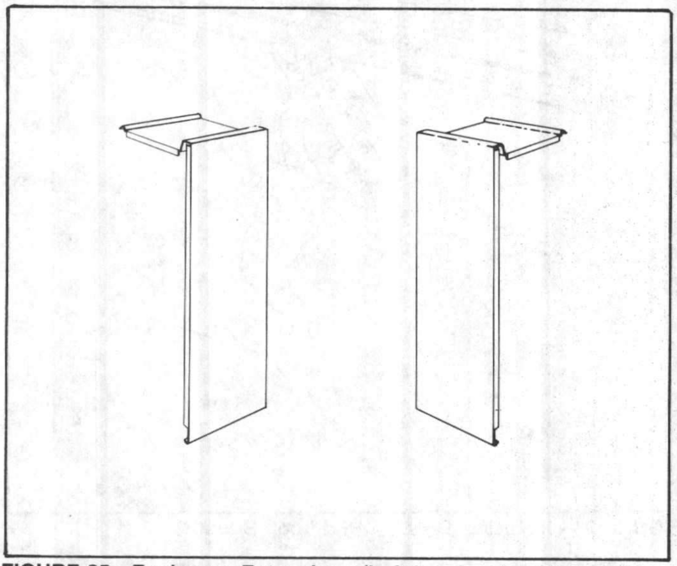


FIGURE 25 - Enclosure Extensions (Left-hand and Right-hand)

6-INCH AND 12-INCH ACCESS PANELS

Access panels in 6-inch or 12-inch lengths are mounted in the same manner as enclosures. Insert the top edge of the panel in the mounting strip and bring it downward into position. If an enclosure bracket has been placed at this point, lock the panel to the bracket with the slide lock on the bracket. See Figure 26.

When an access panel is used next to an end panel, the end panel must be nailed to the wall to provide rigidity. Slip the formed front edge of the access panel into the groove at the front of the end panel (Figure 8) or the corner piece (Figure 27).

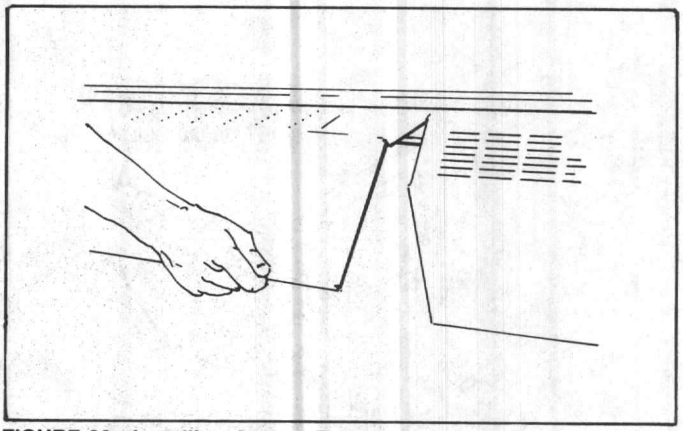


FIGURE 26 - Installing Access Panel

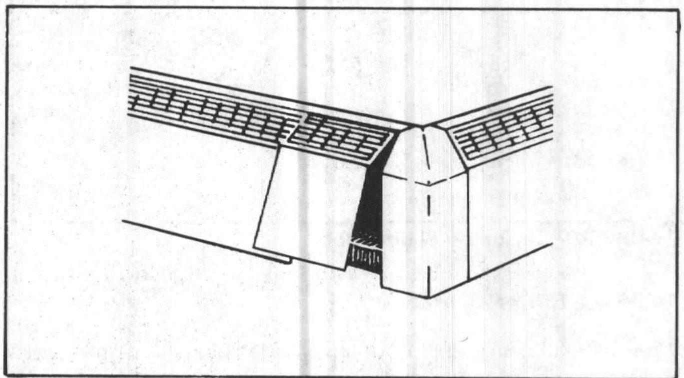


FIGURE 27 - Access Panel

ACCESS EXTENSIONS

The 12-inch access extension with a 4 x 6 inch access door is shown in Figure 28. A front support bracket is provided for mounting purposes when the extension is next to an adjacent wall.

Determine the proper mounting position and attach the support bracket to the adjacent wall. Set the bracket to accept the flanged front edge of the access extension. Mounting hardware is to be provided by the installer.

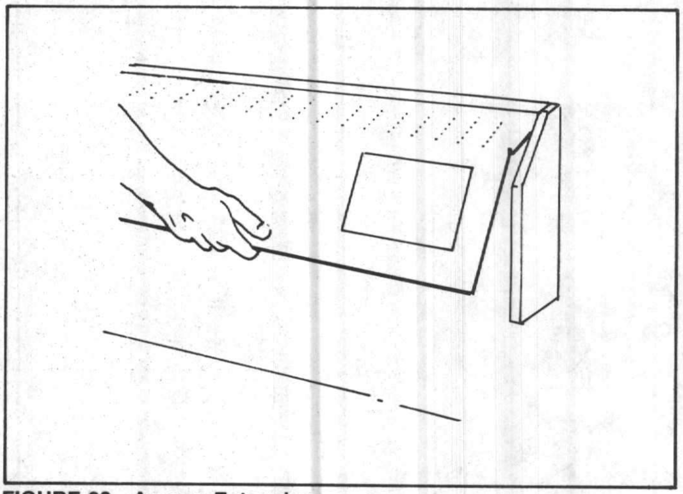


FIGURE 28 - Access Extension

Remove the adjacent enclosure and lay the extension over the edge of the enclosure. Snap the lower edge of the extension over the lower edge of the enclosure. Hold the access extension and enclosure assembly in an upward position 45 degrees from vertical and insert the formed top edge of the extension into the top channel of the mounting strip.

Allow at least one inch overlap on the adjoining enclosure to provide a satisfactory joint. The flanged front edge of the extension, however, must fit in the support bracket or an adjacent wall-fin end panel, inside corner, or outside corner.

Bring the lower front edge of the extension down into position and snap the formed lower edge over the bottom, front edge of the adjoining enclosure. See Figure 29.

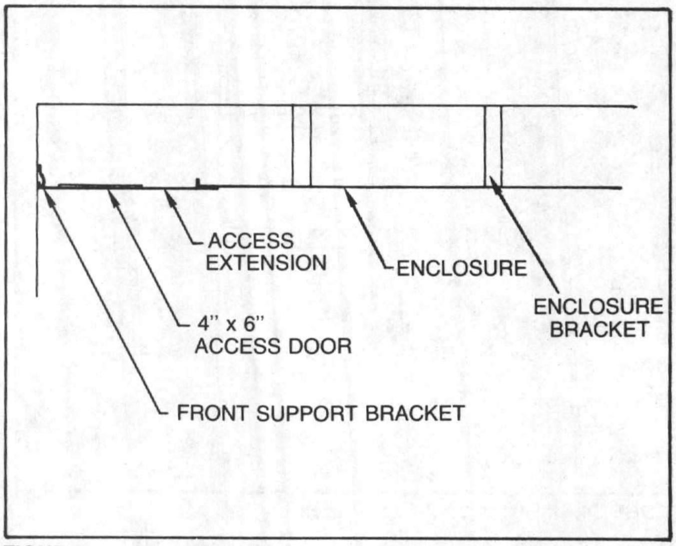


FIGURE 29 - Access Extension next to an Adjacent Wall

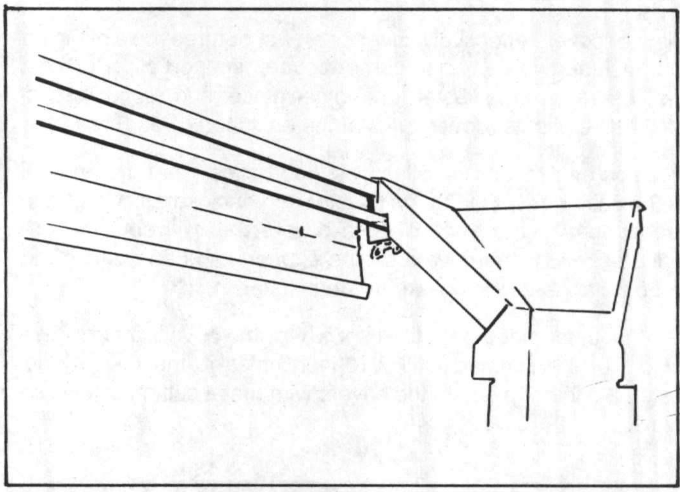


FIGURE 30 - Inside Corner, Mounting Strip, and Locking Clamp (Front View)

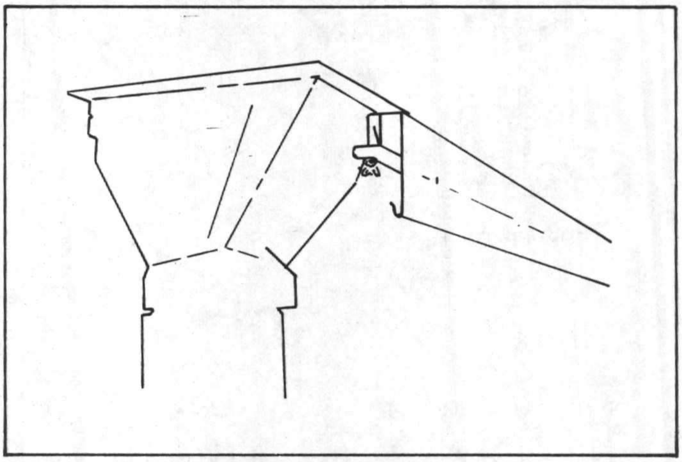


FIGURE 31 - Locking Clamp in Position (Rear View)

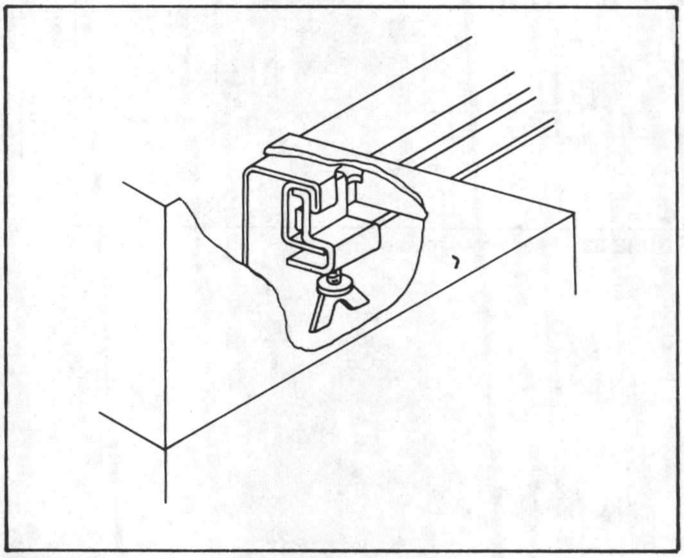


FIGURE 32 - Locking Clamp and Outside Corner

OUTSIDE AND INSIDE CORNERS

When an outside or inside corner is to be used, the mounting strip on both sides should be brought to within 1/2-inch of the corner. Place locking clamps (two provided with each corner piece) on both mounting strips at the corner. Set the corner piece on the mounting strip with the slots of the corner piece fitting into the mounting strip.

Slide the two locking clamps along the mounting strip until they are tight against the flange of the corner piece. Tighten the thumbscrews. Refer to Figures 30, 31, and 32.

Insert the formed flange on the edge of each adjacent enclosure into the grooves at either side of the corner piece. Install sliding bolts in the front, bottom edge of the adjacent enclosures and engage the bolt holes provided in the corner piece.

PILASTER COVERS

Pilaster covers effectively cover one, two, or three rows of piping and include two L-shaped corner covers, support clips to hang the covers on the pilaster, one joiner piece, and rubber trim to gasket the pilaster cover joints at the enclosure. See Figure 33.

Position and mount the pilaster support clips. Trim the ends of both pilaster covers to fit the pilaster and enclosures. Attach the rubber trim to the edge of both covers that will abut the enclosures. Hang the covers on the support clips and attach the bottom flange of the covers to the pilaster.

Lay the joiner piece over the joint where the covers meet at the middle of the pilaster. Drill 3/16-inch holes in the covers and fasten the joiner piece to the covers with metal cutting screws or rivets.

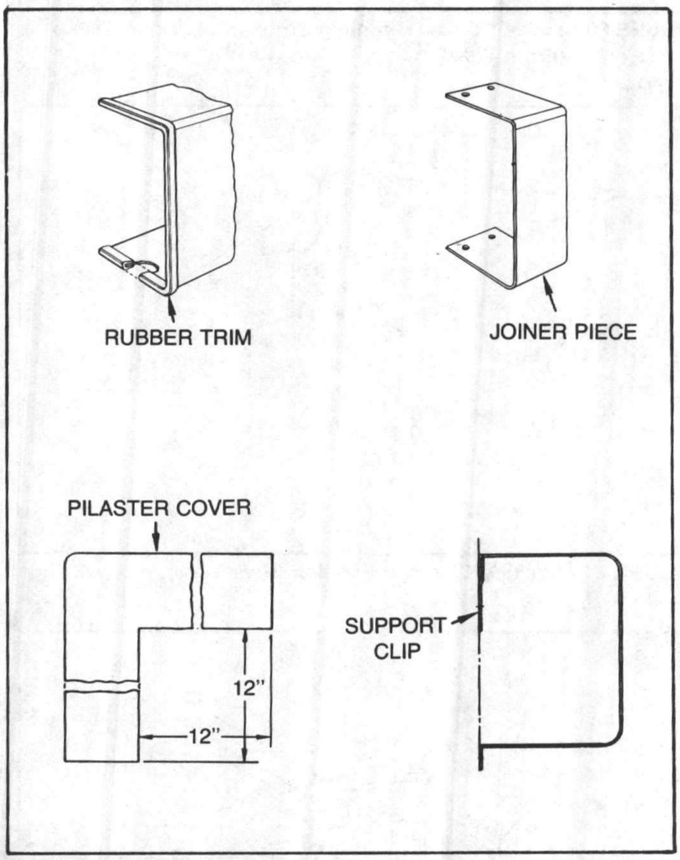


FIGURE 33 - Pilaster Assembly

INVERTED ENCLOSURES

Inverted enclosures are installed in a manner similar to the upright enclosures, except that the bottom of the inverted mounting strip is aligned to the chalk line. Since the inverted enclosure brackets cannot hang from the mounting strip, fasten them to the wall with lag bolts.

Tamper-proof fasteners are provided to secure and lock enclosures to the enclosure brackets. Use element supports to mount the element cradles and elements as shown in Figure 34.

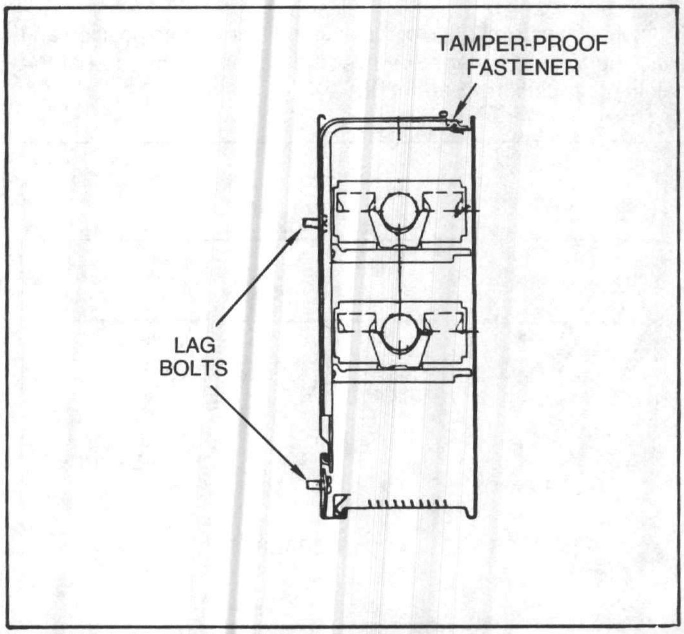


FIGURE 34 - Inverted Enclosure Assembly

TAMPER-PROOF FASTENERS

Tamper-proof fasteners are supplied to fasten the enclosures to the enclosure brackets for tamper-proof and inverted enclosure installations. Slide the lock forward as far as possible and tighten the socket head screw. See Figure 35.

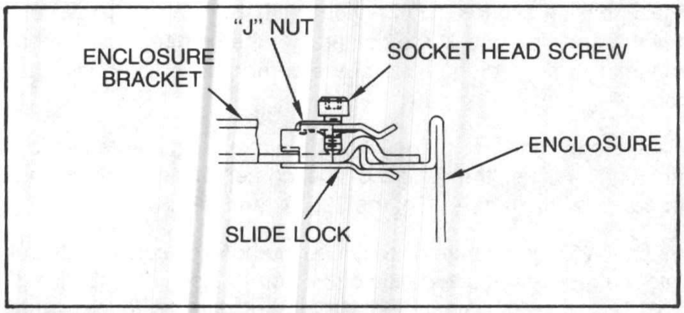


FIGURE 35 - Tamper-proof Fastener

FRONT AND BOTTOM INLET GRILLES

FRONT INLET GRILLES

Figures 36 and 37 illustrate two suggested methods of installing enclosures with front inlet grilles.

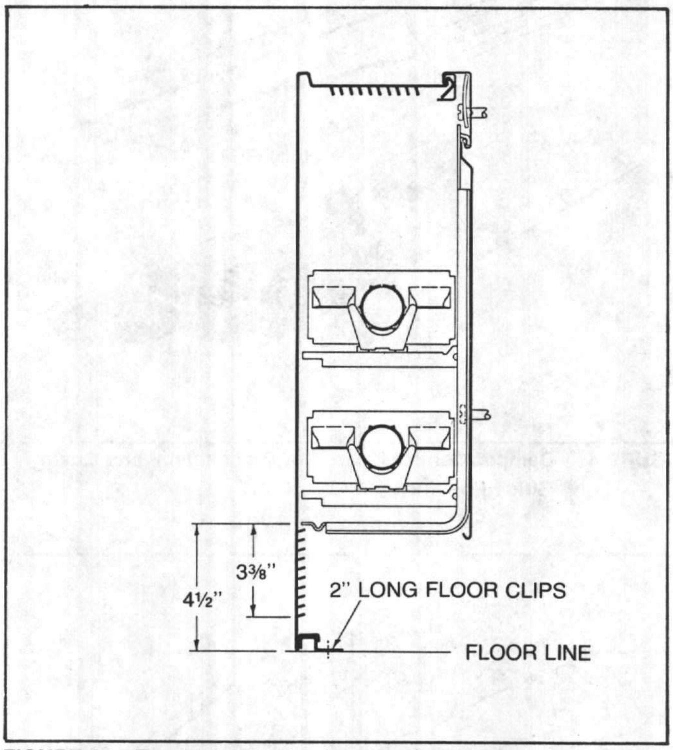


FIGURE 36 - Front Inlet Enclosure with Floor Clips

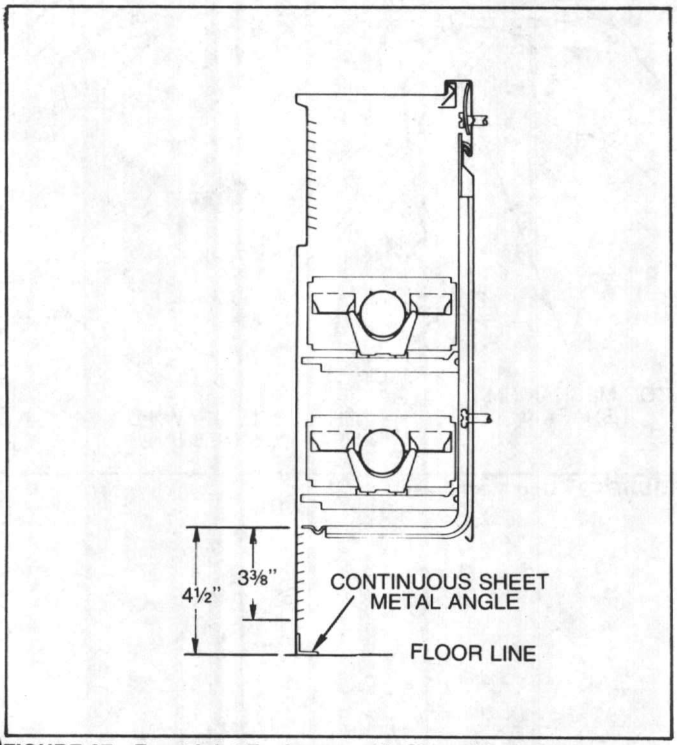


FIGURE 37 - Front Inlet Enclosure with Sheet Metal Angle

In the first method, two inch long metal clips are attached to the floor, and the enclosure formed edge slips over the clips. In the second method, a continuous sheet metal angle is used at the floor line and the enclosure is attached to the angle with sheet metal screws.

BOTTOM INLET GRILLES

Bottom inlet grilles are separate pieces that attach to the wall and the enclosure bracket. As shown in Figure 38, the "J" Nut (A) is factory installed and contains threads for the screw (B). To install, attach the front edge of the grille to the bracket with the bolts and washers provided and secure the back of the grille to the wall.

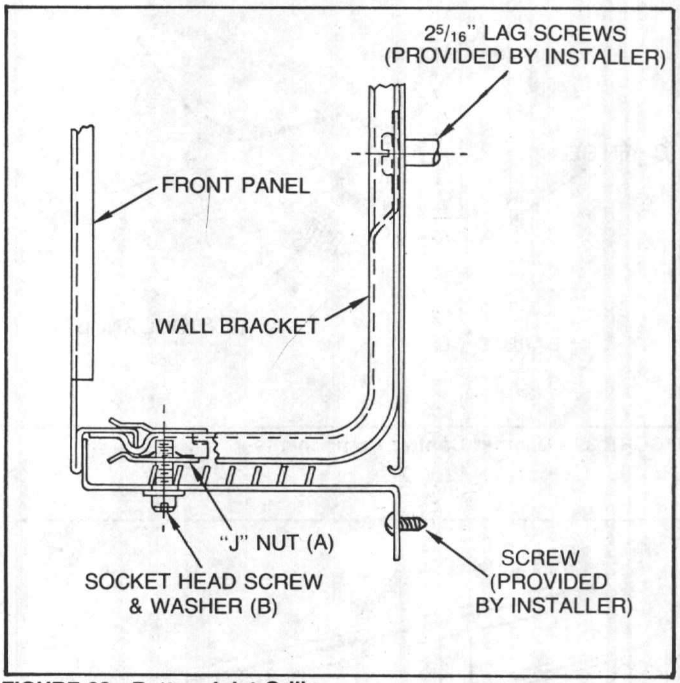


FIGURE 38 - Bottom Inlet Grille

DAMPERS

Dampers are shipped attached to the elements, except for the 3/4-inch Copper/Aluminum Series 60 element. The damper for a 3/4-inch element must be field installed. (See Figures 54 and 55 for installing the field mounted damper.) The damper control assembly is shipped separately in a cloth bag. Refer to Figure 39.

DAMPER INSTALLATION WITH TYPE S, F, AND T ENCLOSURES

Place the enclosure ahead of and below the element, as shown in Figure 40.

NOTE: *Before installing the damper control knob cog mechanism on the enclosure, make sure there will be 24 inches between the cog mechanism and the chain guide, which is secured to the mounting strip. (See Figure 41.) This distance is necessary to provide a proper angle for the chain for damper operation.*

Set the metal retainer of the cog mechanism so that it will not obstruct the four slots, two at the top and two at the bottom of the plastic part. Be sure the enclosure is face downward with the top toward the installer. Position the cog mechanism so that the shaft is pointed toward the grille. See Figure 42.

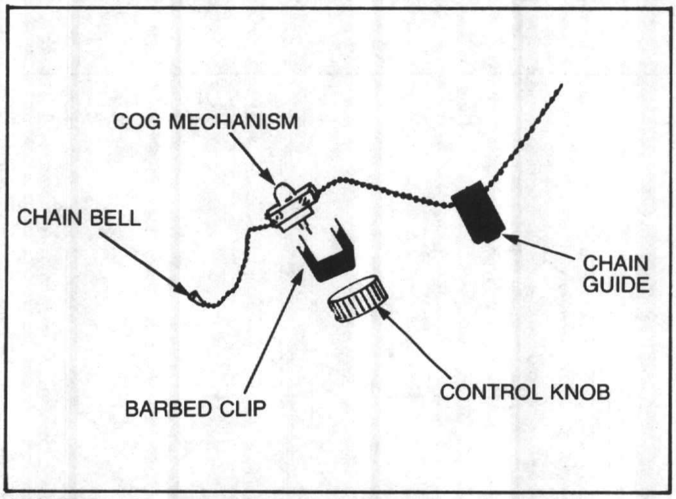


FIGURE 39 - Damper Control Components

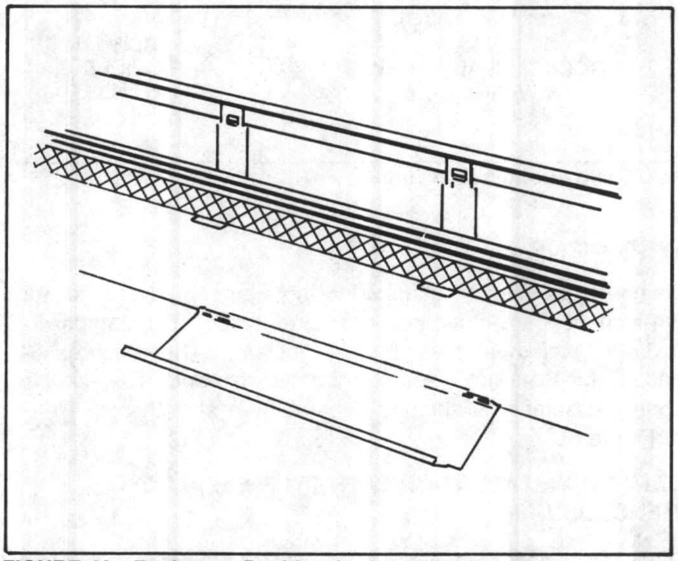


FIGURE 40 - Enclosure Position for Installing Damper

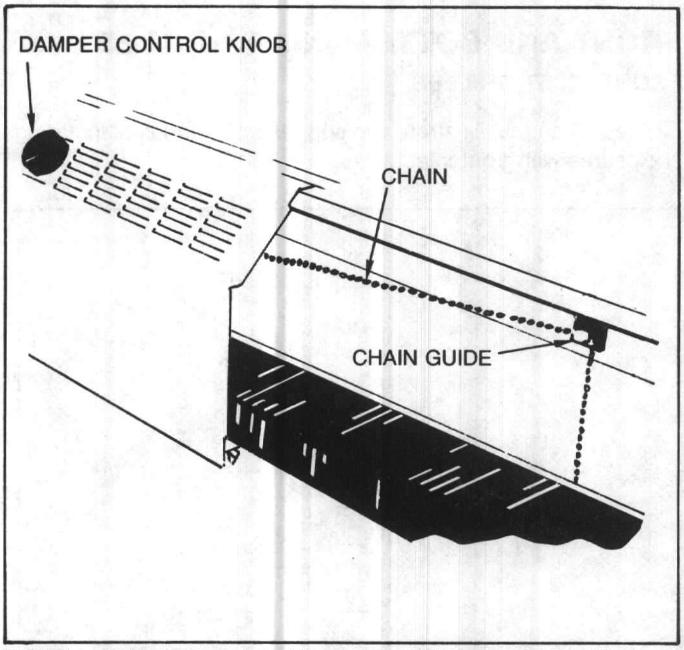


FIGURE 41 - Damper Control Knob, Cog Mechanism, and Chain Guide Position

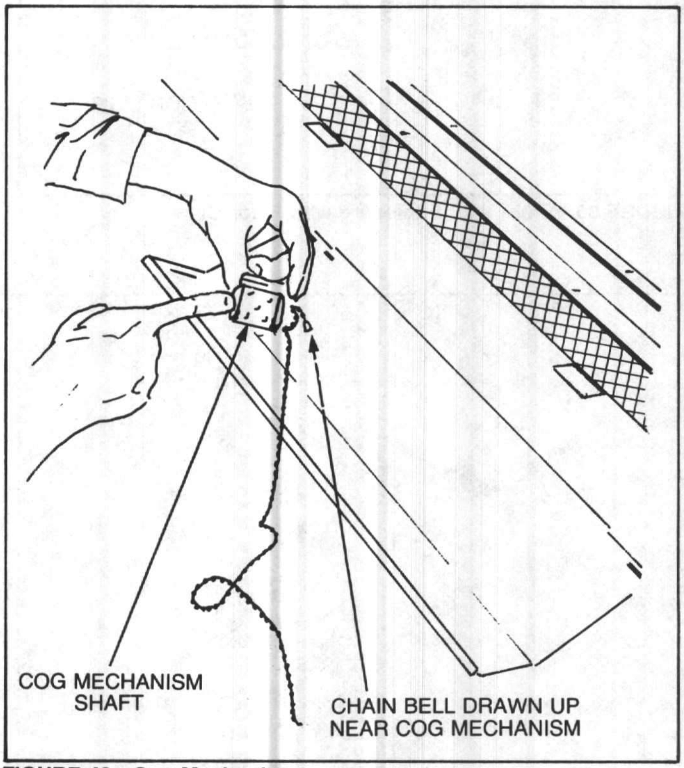


FIGURE 42 - Cog Mechanism

With the shaft of the cog mechanism pointed toward the enclosure grille, insert the shaft between the center segments of the grille. See Figure 43.

Hold the cog mechanism in place and insert the barbed clip through the grille from the outside of the enclosure. Place it over the shaft and into the four slots of the plastic part. The barbed clip usually slips into the slots easily, locking the cog mechanism into position. On the stamped grille, the second set of barbs from the end should be engaged. See Figure 44.

If the barbed clip will not slip into place easily, spring it open slightly. If difficulty is still encountered, insert the barbed clip through the grille and guide the slots of the cog mechanism over the prongs of the clip. See Figure 45.

Figure 46 shows the cog mechanism and barbed clip properly mounted on the enclosure grille.

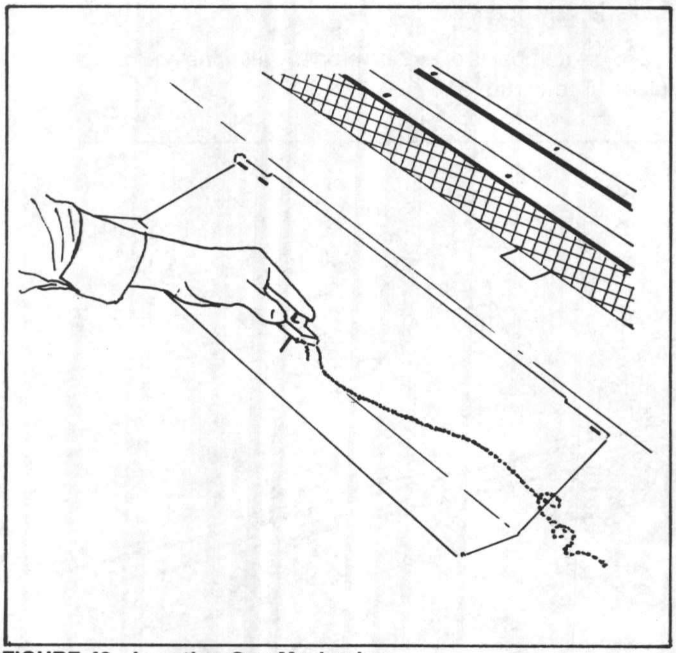


FIGURE 43 - Inserting Cog Mechanism

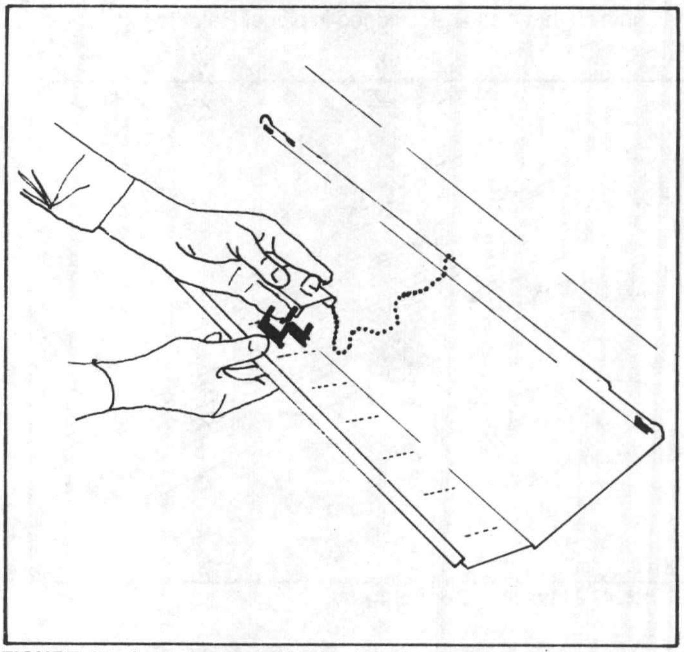


FIGURE 45 - Inserting Cog Mechanism into Barbed Clip

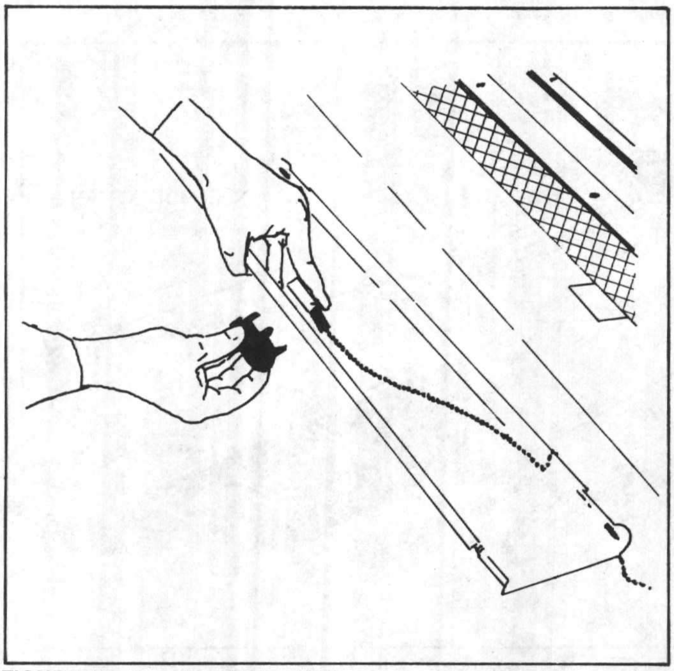


FIGURE 44 - Inserting Barbed Clip

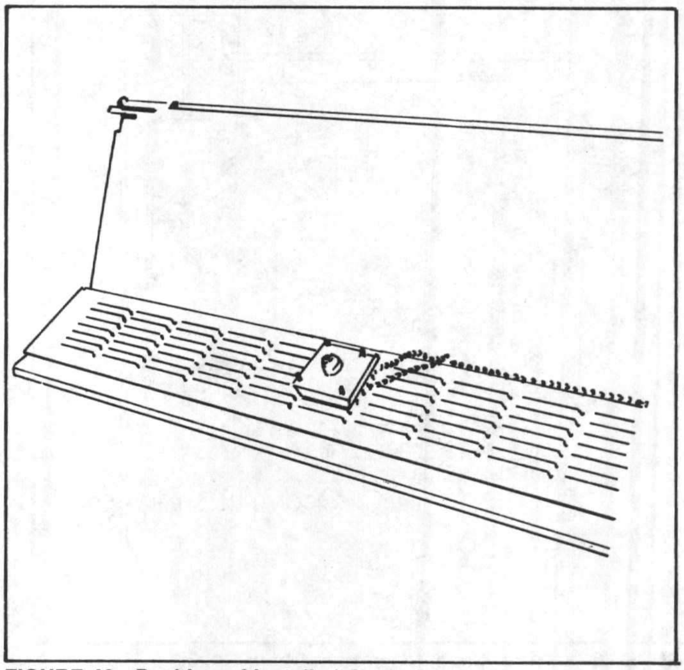


FIGURE 46 - Position of Installed Control

Install the control knob on the shaft now projecting through the grille, as shown in Figure 47. Tighten the set screw to secure the control knob to the shaft.

Extend the chain, without crossing the cog mechanism, either to the right or left for at least two feet. Be sure the chain guide is correctly placed on the chain. It may be necessary to remove the bell, slip the chain guide off, reverse it, return it to the chain, and refasten the bell. Remove the bell from the long end of the chain. Insert the end of the chain through the nearest hole on the outside edge of the damper and reinstall the bell. Allow sufficient slack in the chain so that it can be fastened in place. Refer to Figure 48.

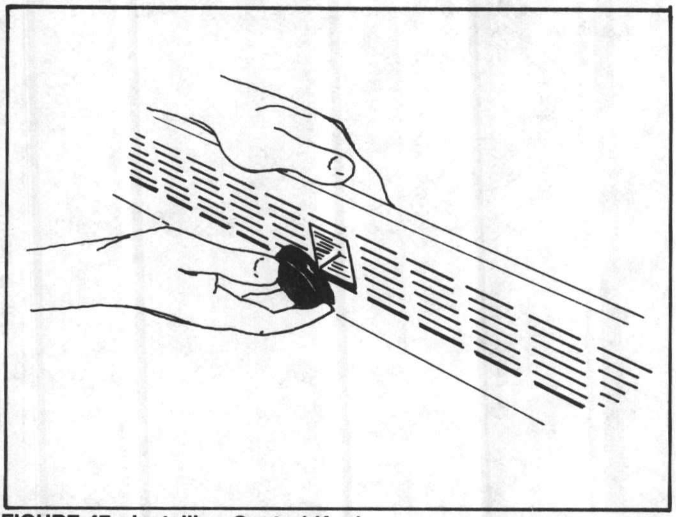


FIGURE 47 - Installing Control Knob

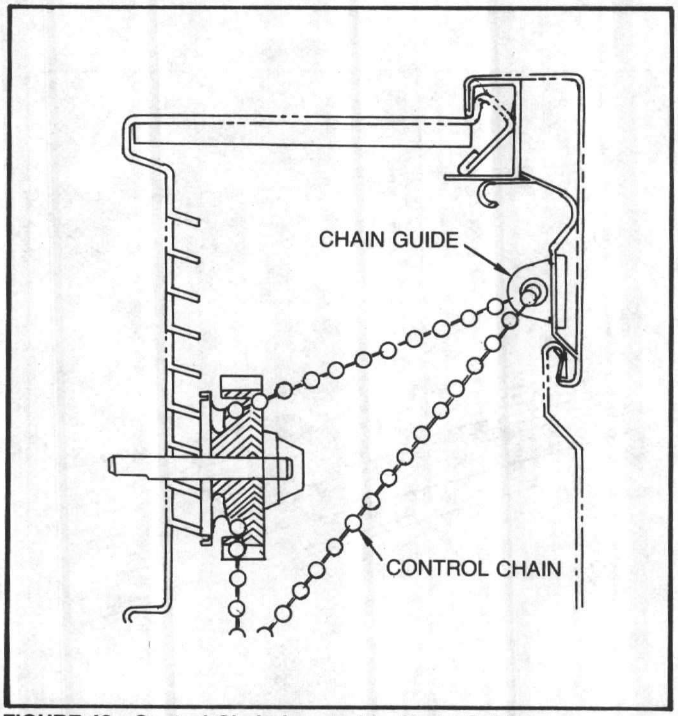


FIGURE 48 - Control Chain Inserted in Chain Guide

Position the chain guide with the plastic guide down and outward, and snap it into place on the mounting strip. See Figure 49.

The chain guide should be located between the cog mechanism and the point where the chain is attached to the damper. **The location must be no more than two inches from the point where the chain is attached to the damper.** See Figure 50.

Place the damper stop clip over the front edge of the damper, exactly in front of one of the enclosure brackets. In operation, the stop clip should rest against the enclosure bracket when the damper is fully open.

Be sure the damper is operating properly after the enclosures are in place. See Figure 51.

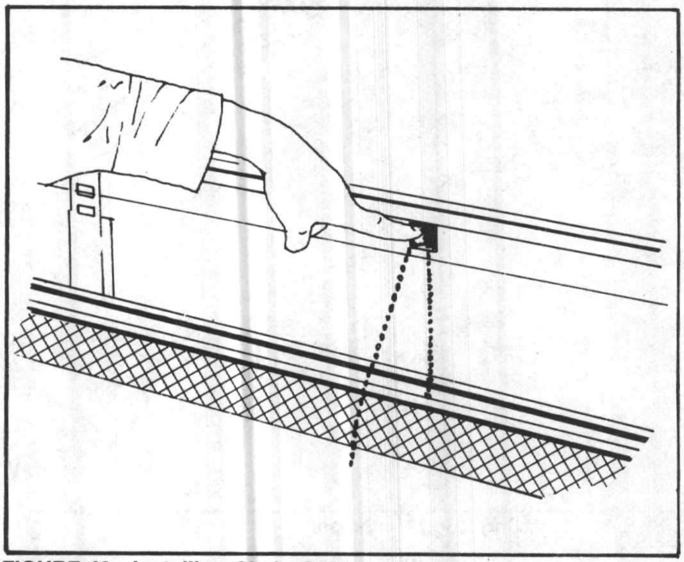


FIGURE 49 - Installing Chain Guide

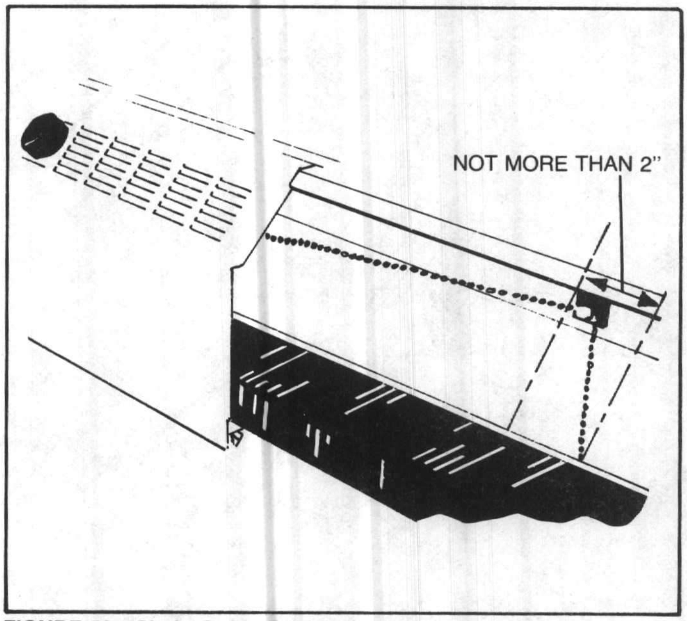


FIGURE 50 - Chain Guide Position

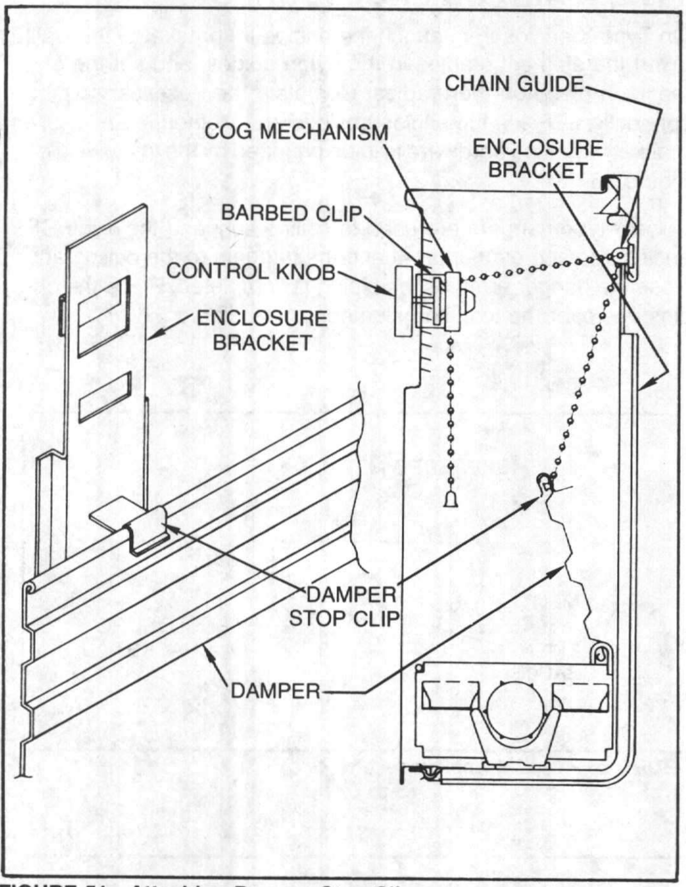


FIGURE 51 - Attaching Damper Stop Clip

DAMPER INSTALLATION WITH TYPE TA ENCLOSURES

For Type TA enclosures, install the damper control mechanism as described for Type S, F, and T enclosures, except with the extruded aluminum grille in place on the mounting strip. Only the first set of barbs on the barbed clip should be engaged in the cog mechanism. See Figure 52.

Position the chain guide with the plastic guide down and outward, and snap it into place on the mounting strip. The chain guide should be located between the cog mechanism and the point where the chain is attached to the damper. The location must be no more than two inches from the point where the chain is attached to the damper. See Figure 53.

FIELD-MOUNTED DAMPERS

To field install the damper blade, a simple utility hook with a threaded end will be needed. The utility hook is to be furnished by the installing contractor.

First install the mounting strip, the enclosure brackets, and the heating element according to the instructions in this manual.

The damper blade is furnished with pre-punched holes. Lay the damper blade on top of the heating element. Drill a small hole in the wall, in the same location as each damper blade hole, for the installation of the utility hooks. Remove the damper from the top of the heating element. Install the utility hooks just above the heating element. Make sure the open ends of the utility hooks are in the upright position. Position the damper blade on each utility hook and close the open end of the hook to keep the damper blade secure when it is in operation. See Figures 54 and 55.

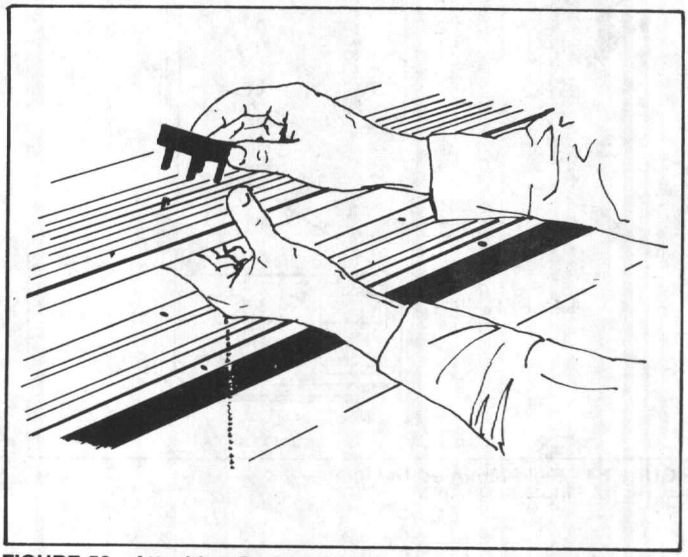


FIGURE 52 - Attaching Barbed Clip (Type TA Enclosures)

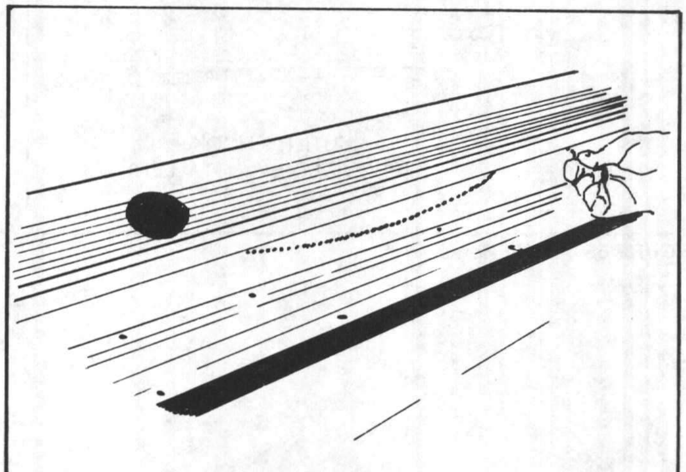


FIGURE 53 - Installing Chain Guide (Type TA Enclosures)

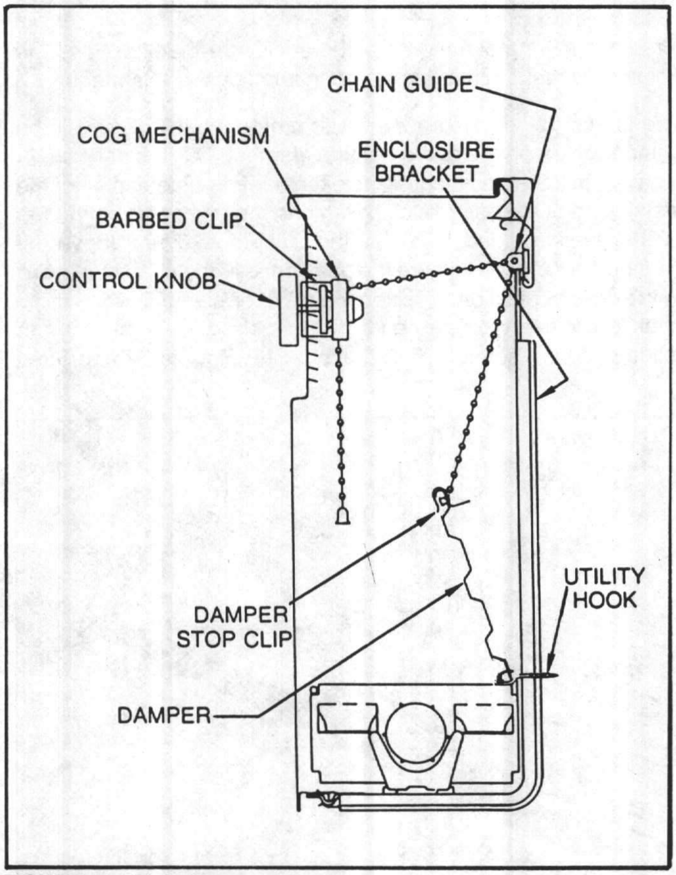


FIGURE 54 - Field-Mounted Damper

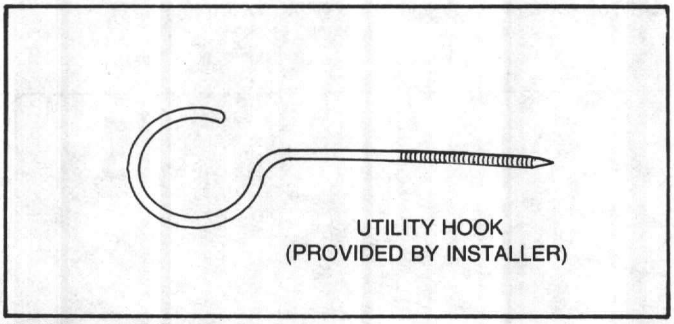


FIGURE 55 - Utility Hook

TYPE X AND CS ENCLOSURES

On Type X enclosures, attach the enclosure bracket to the wall, insert the element cradles in the nylon guides, and set the elements in place on the cradles. Complete the necessary piping connections. Place the enclosures over the elements. Enclosure bracket mounting hardware is to be provided by the installer. See Figure 56.

Scissor-type hangers are used to ceiling suspend the Type CS enclosures and elements. Attach the hangers to the ceiling and close the hanger arms as the piping is completed. Place the enclosures over the installed elements. See Figure 57.

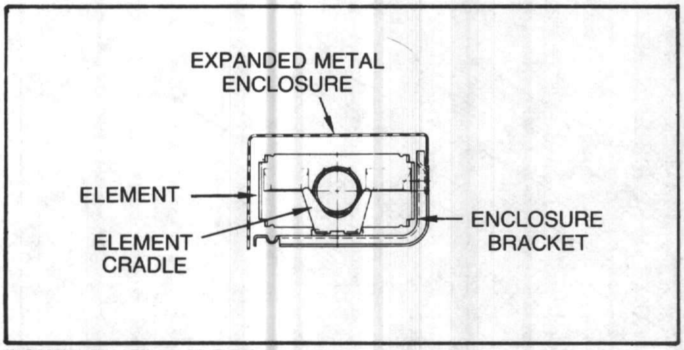


FIGURE 56 - Type X Enclosure

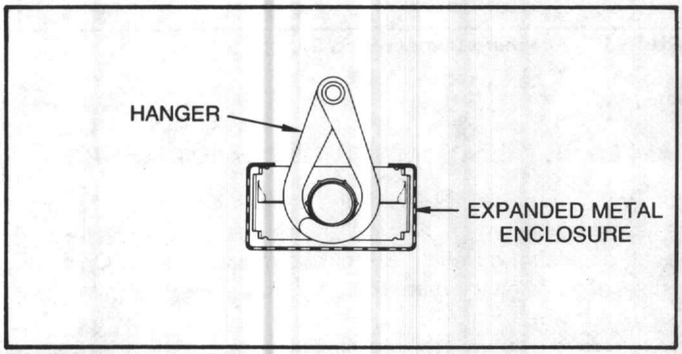


FIGURE 57 - Type CS Enclosure

FIELD PAINTING

Special surface preparation may be required when field painting the unit. The surface should be free of oil, grease, and dirt and should be scuff sanded prior to painting. This surface preparation is sufficient when alkyd enamels are used.

If Latex paints are used, an intermediate alkyd primer must be applied after proper surface preparation to improve adhesion. In lieu of the intermediate alkyd primer coat, such surface preparation methods as liquid sandpaper or hand sanding will provide good adhesion in some cases. However, this is true only when a high grade Latex paint is used.

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Taco Instruction Sheet

202-001

Heat Exchangers

INSTALLATION

1. Allow sufficient clearance for removal of tube bundle.
2. After initial start and run at operating temperatures and pressures, shut down and tighten head bolts.
3. Make certain that tubing is full of water before introducing steam or hot water into shell, otherwise flashing or noise may occur.

CLEANING

Shell and tube bundle should be flushed out periodically. If cleaning is necessary, remove head and bundle to clean inside of shell and outside of tubes. Replace gaskets if necessary.

If unit is installed in a hard water area, inside of tubing can be cleaned as follows: –

1. Break water connections and plug bottom opening.
2. Fill the tubes with a solution of 1 part muriatic acid to 10 parts of water and allow to stand for 2 hours:
   CAUTION: A longer period may cause damage to the copper tubing.
3. Drain off and flush **thoroughly** with clean water.
4. Re-assemble unit.

NOTE

Commercially available cleaners may also be used.

REPLACEMENT PARTS

When ordering replacement parts specify

1) Complete Model Number
2) Date of Manufacture
3) Special Materials if Required

Normally, the only replacement parts required would be:

1 — Tube Bundle
1 — Set of Gaskets

NOTE: When ordering replacement tube bundles care must be take to insure correct construction and proper materials. **Units** manufactured prior to 1974 should have the prefix RUX.

Example: A replacement bundle for a B10212-L built in 1970 would be a RUX10212-L.

Replacement heads are also available if required.

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5

INSTALLATION AND OPERATION MANUAL

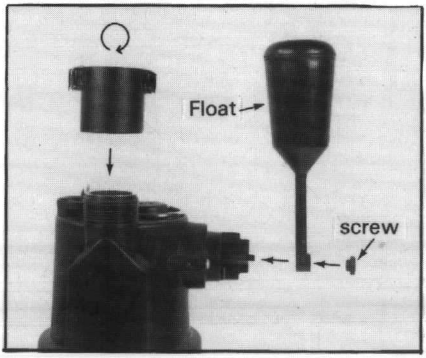
SUBMERSIBLE SUMP PUMP

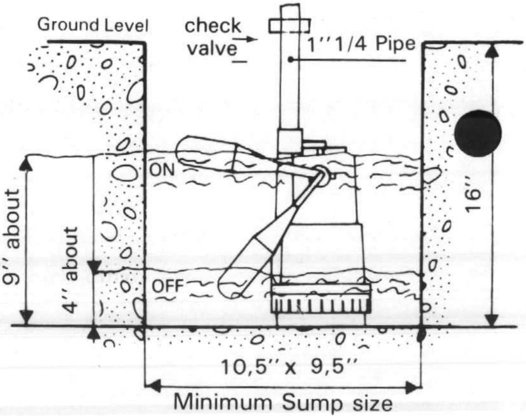
MODEL : CPS 33

Peabody Barnes

651 North Main Street. Mansfield, Ohio 44902
Phone : 419/522-1511

FORM N° 79570-286





GENERAL INFORMATION

A CPS submersible sump-pump is designed to pump basement drainage water, washing machine water or wastewater from a softner. Any model may be used to drain a tank or a basin, for example. The pump can be operated fully or partially submerged. All components are made of non-corrosive materials, pump is equipped with a patented automatic switch which activates a built-in contactor.

INSTALLATION

1. A model CPS pump can be installed in an open or closed sump with a minimum diameter of 11 inches. Where possible, a 12'' × 18'' diameter basin is recommended.

2. The discharge system for a sump application should be 1-1/4'' plastic, PVC or steel pipe. If desired a swing check valve should be installed in line to prevent water from running back into the basin.

NOTE : If required, a 1-1/2'' discharge coupling is available. Consult factory for P/N 79565.

3. The model CPS sump is rated 115 volt, single phase, 60 cycle electric service. The motor is a permanent split capacitor type designed to pump water in domestic application.

OPERATION

1. The float must be assembled in the upward, vertical position as indicated in the illustration above. Make sure that the float moves freely in the sump basin without touching the basin wall. Adjust the position of the pump in the basin as required. Do not overtighten the threaded nut that holds the float in place. The float should move freely on the float axis switch. Do not overtighten the supplied coupling.

2. The motor is equipped with thermal overload protection. The motor will temporarily stop if overloaded or overheated. If this occurs, the pump must be allowed to cool before attempting a restart.

3. The motor in your CPS pump is factory sealed and cannot be serviced in the field. In the event of a motor failure, contact your nearest dealer or authorized Peabody Barnes Service Station.

4. Run water into the sump basin until pump is activated - about 9'' of water. Continue to fill the sump, allowing pump to operate several times (on-off) to insure a satisfactory installation. If unit does not operate properly, see ''Trouble Shooting'' information.

TROUBLE SHOOTING

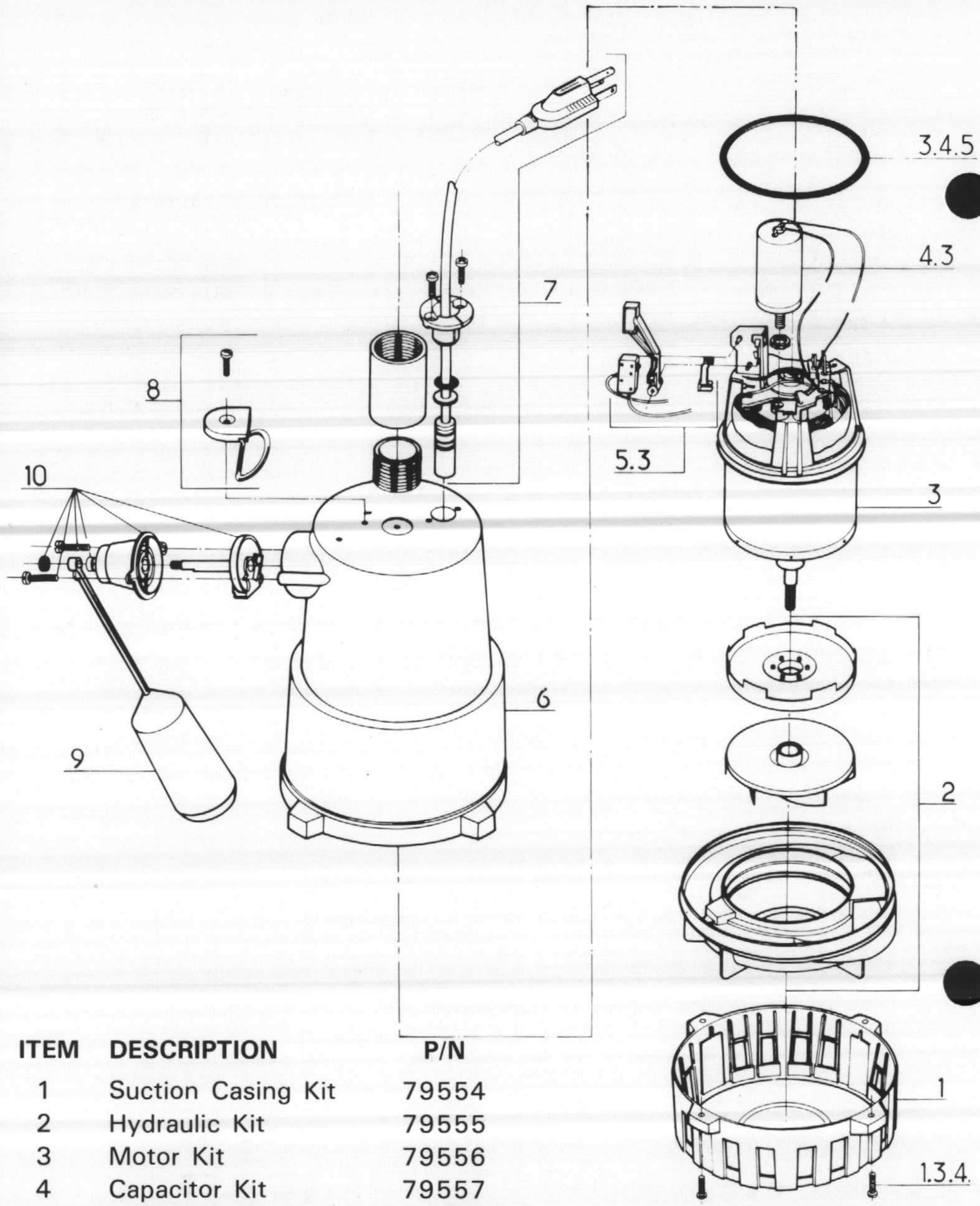
Trouble	Possible Cause	Remedy
1) Pump does not run.	No power at receptacle.	Pull plug and check with a tester to be sure that current is available at receptacle. Correct as required.
	Poor connection at receptacle.	Check the prongs of the plug.
	Level control defective.	Disconnect pump from power and remove from service. Place pump on work bench-plug into receptacle and gently lift the float until switch, either clicks or pump starts. If the pump does not start when the switch clicks the switch is defective and must be replaced.
2) Pump runs but does not empty basin.	Suction screen or impeller clogged.	Clean out suction screen. Impeller may be cleaned by removing screen.
	Discharge line clogged.	Clean out discharge line.
	Discharge head too high.	Move pump closer to discharge outlet. Pump will not discharge water if the head, vertical distance from the pump to discharge outlet is more than 25 feet.

WARNING

TO REDUCE RISK OF ELECTRIC SHOCK, DISCONNECT THE PUMP FROM THE POWER SOURCE BEFORE HANDLING OR SERVICING THIS PUMP.

TO REDUCE RISK OF ELECTRIC SHOCK OR DEATH, THIS PUMP MUST BE PROPERLY GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE AND ALL APPLICABLE LOCAL CODES AND ORDINANCES.

THIS PUMP HAS NOT BEEN INVESTIGATED FOR USE IN SWIMMING POOL AREA.



ITEM	DESCRIPTION	P/N
1	Suction Casing Kit	79554
2	Hydraulic Kit	79555
3	Motor Kit	79556
4	Capacitor Kit	79557
5	Micro Switch Kit	79558
6	Delivery Casing Kit	79559
7	Cable Kit	79560
8	Handle Kit	79561
9	Float Kit	79562
10	External Float Switch	79563

OPTIONAL ITEMS

1-1/4'' Coupling	P/N	79564
1-1/2'' Coupling	P/N	79565
25' Cord Kit	P/N	79566

SUMP PUMP LIMITED WARRANTY

Peabody Barnes Inc., warrants each sump pump, when used in a domestic application (i.e. not continuous duty) against defective workmanship and materials for a period of one (1) year after date of installation or thirty-six (36) months from the date of manufacture, whichever date occurs first. The last three or four digits of the serial number which appear on your pump determines your manufacturing date. The Company's obligation under this Warranty is limited to furnishing or replacing any product returned at the expense of the user in order to establish the claim.

The cost of labor, such as for the removal and reinstallation of the product, are not covered under this warranty.

The Company assumes no liability for incidental and consequential damages which may result from the use or misuse of its products. Some states do not allow the exclusion or limitation of incidental or consequential damages, however, so this limitation or exclusion may not apply to you.

Peabody Barnes
PEABODY BARNES INC.
651 N. MAIN ST.
MANSFIELD, OH 44902

AFFIX
STAMP
HERE

PEABODY BARNES INC.
651 N. MAIN STREET
MANSFIELD, OHIO 44902

WARRANTY REGISTRATION NO. ______________________

Your pump is warranted to the effect of the guarantee shown on the reverse side of this page. This guarantee becomes effective only upon receipt by Peabody Barnes Inc., of the warranty registration below.

FOR YOUR RECORDS

Model Purchased : ______________________

Date of Purchase : ______________________

Purchased From : ______________________

Address : ______________________

____

CUT HERE

WARRANTY REGISTRATION NO. ______________________

To validate your warranty, supply all information requested on this card and return it to the address on the reverse side within 15 days after the purchase date.

Owner's Name : ______________ Date Purchased : ______________

Address : ______________________

City : ____________ State : ____________ Zip : ____________

Dealer's Name : ______________________

City : ____________ State : ____________ Zip : ____________

Pump Model : ______________ Code Date : ______________

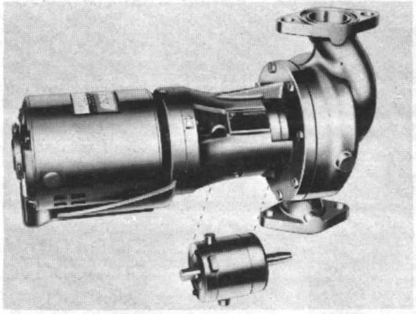
Taco **Instruction Sheet**

302-001

2½", 3" & 1600 Series Pumps

Plant I.D. No. 001-329

APPLICATION



All pumps covered by this instruction sheet are designed for pumping water.

Working Pressure:	175 PSIG with cold water and 125 PSIG at rated temperature.
Temperature:	250°F Standard 300°F with Hi-Temp Seal

INSTALLATION:

Install horizontally only and with the two bracket ribs pointing to the ceiling. Do not support, suspend or brace motor and/or bracket. Support provided by casing is sufficient for structural integrity of the pump.

The casing can be rotated relative to the bracket for installation in vertical or horizontal pipe.

The pump must be installed far enough away from ceiling and walls to permit lubrication of bracket and motor.

"CAUTION": UNDER NO CIRCUMSTANCES SHOULD ANY PART OF BRACKET OR MOTOR BE COVERED WITH INSULATION.

START UP:

Before operating the pump for the first time check the following:

1. Is motor correctly wired for voltage in use?
   Warranty is void if motor is damaged due to improper electrical hook-up.
2. If a magnetic starter is used, see that the heater element is sized for the Service Factor load of the motor; otherwise, nusiance tripouts may occur.
3. Motor and pump are properly oiled at the factory. However, as a matter of precaution it is recommended that the oil level in the pump bracket be checked as specified on pump nameplate. An oil level slightly above the "full" mark on the dip stick can be tolerated.
4. Motors are properly aligned with pump at the factory and normally require no attention. If due to rough handling, the moter base becomes bent, realign by shimming between cast iron and steel section of motor base.
5. Before starting motor, ascertain that pump is filled with water to lubricate the seal. Do not operate pump dry for motor checkout.

LUBRICATION:

Pump must never be operated with oil level in bracket below low limit on dip stick. For replenishing, use premium grade SAE No. 30 oil only (see pump nameplate). Lubricate motor per instruction label attached to motor.

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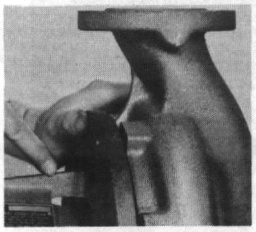


FIGURE 1

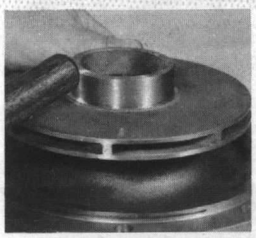


FIGURE 2

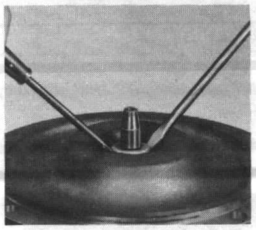


FIGURE 3


FIGURE 4

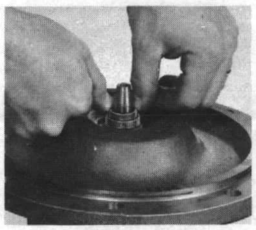


FIGURE 5

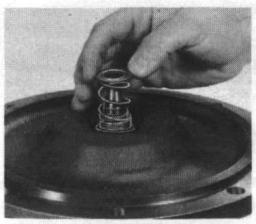


FIGURE 6

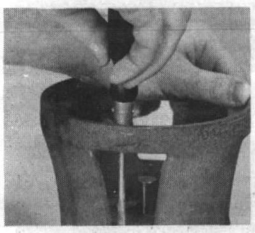


FIGURE 7

SEAL REPLACEMENT:

To replace the water seal, the following steps must be observed:

1. Disconnect electrical connections. Relieve system pressure and drain water from body.
2. Remove motor assembly from bracket and bracket from pump body.
3. Place bracket in vertical position, impeller up and loosen screw at center of impeller two turns. (7/16 Hex Head) This screw has a left-hand thread. Tap impeller at its outside diameter with handle of hammer to free tapered fit between shaft and impeller and completely remove screw, washer, and impeller. (see Figure 2)
4. Remove carbon assembly and ceramic seal by prying them loose with a screw-driver. (see Figure 3)
5. Thoroughly clean shaft and seat cavity.
6. Insert new seal seat. For easy assembly coat OD of seal rubber (either a cup or an O-ring) with special grease provided in small container. Do not use any other oil or grease. Push seat all the way down into cavity. Seat must not be cocked relative to shaft. Be sure face of seal stays absolutely clean – wipe surface with soft, clean cloth if necessary. (see Figure 4)
7. Install new carbon assembly. Coat inside of rubber bellows with special grease provided (do not use any other oil or grease) and slide assembly (carbon first) over shaft until carbon meets seat. Push on rubber insert on very end of assembly and not on outside diameter of carbon retainer. Be sure carbon face stays absolutely clean. (see Figure 5)
8. Install spring and spring retainer with raised face inside spring. (see Figure 6)
9. Replace impeller using new impeller screw and washer provided. Make sure cones of both impeller and shaft are clean.
10. Reassemble bracket into pump casing new gasket provided. Clean gasket surface of both casing and bracket if necessary. Be sure that the longer of the two outside bracket ribs is on top. (see Figure 1)
11. Reinstall coupler and motor.
12. Follow procedure outlined under section Start Up where required.

IMPELLER REPLACEMENT:

Follow steps 1 through 3 and 8 through 12 outlined under section Seal Replacement.

BEARING (CARTRIDGE) REPLACEMENT:

If for some reason the bracket bearings should fail, it is not necessary to replace the entire bracket.

A pre-lubricated cartridge containing bearings and shaft is available. To change the cartridge, follow this procedure:

—Follow steps 1 through 4 as outlined under section SealReplacement.

—Flip bracket around so that motor end is on top.

—Remove the two outermost socket head screws. (see Figure 7)

—Pull out old cartridge. If necessary tap cone end of shaft with a hammer to accomplish this.

—Insert new cartridge and refasten with socket head screws. Make sure shaft sleeve is in place with cone on sleeve resting against cone of shaft.

—Follow steps 5 through 12 outlined under section Seal Replacement.

Note: It is recommended that when changing the cartridge the water seal be replaced also. However, if you plan to re-use the water seal it is not necessary to remove the seal seat. The carbon assembly may be lubricated with water to make reinstallation easy.

Taco	INSTALLATION AND OPERATION INSTRUCTIONS
NUMBER IS 300-2.2	Effective: September 1, 1982 Supersedes: IS300-4 dated 3/31/68

TACO BASE MOUNTED PUMPS (SLEEVE AND BALL BEARING)

Plant ID No. 001-922

A—INSTALLATION

A1-LOCATION

Locate pump in an easily accessible place with sufficient space around it for maintenance and servicing. On larger pumps allow head room for the use of hoists or overhead cranes. Locate pump on a dry and clean place so that motor will be protected from moisture and dust.

On closed heating systems place compression tank at the suction side of the pump. When pump head is less than 20 feet, it is permissible to connect compression tank to discharge side of pump.

On open systems, install pump close to liquid supply and make suction piping as short and as straight as possible.

A2-FOUNDATION

The foundation serves to carry the pump weight and to absorb vibration. Normally, the foundation is made of concrete block, preferably tied in with the floor or ground. Make the foundation block about 4" longer and 4" wider than the base of the frame. Height of the block may vary from 2/3 to 1 times the *width* of the foundation (Fig. 1). When foundation is poured, provide a hole near each of the four (4) corners. To simplify installation and maintenance use lead Anchors. Place the front Anchor about 2" from the edge of the foundation to clear overhanging casings (Fig. 2).

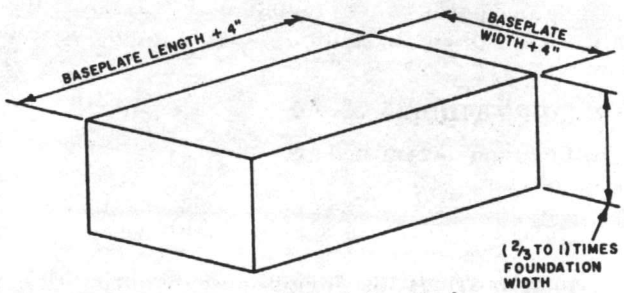


Fig. 1—Foundation Block

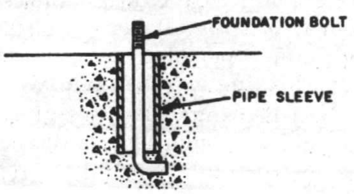


Fig. 2—Foundation Bolt

A3-PIPING

Correct piping is of prime importance for the proper operation and long life of the pump. Stresses induced by piping will cause excessive wear of seals, bearings, and couplings that could ultimately destroy these elements.

Both suction and discharge piping should be suspended close to the pump connections, so that no pipe weight rests on the pump. Pipe flanges and pump flanges should align perfectly before connections are made, piping should never be drawn by force into place.

Thermal expansion of piping requires special attention on heating installations. If no room is provided for pipe expansion, stresses are induced in the piping that will exert a load on the pump. Forces created by pipe stresses can exceed by far the load exerted through pipe and water weight. Stress forces can distort pump, bend shafts, wear out seals, and impeller wear rings, and ultimately burn out bearings. To protect pump from thermal pipe stresses, provide spring hangers and flexible connectors that are suitable to compensate for pipe expansion. (See Fig. 3).

Install gate valves on both suction and discharge side of the pump to allow servicing without draining the system. Also provide a flanged nipple (spool) between gate valve and suction end of the pump to enable you to take the pump apart without disturbing piping (Fig. 3). In order to have them easily accessible, the pump and flange nipples should not be covered with insulation.

On open pumping systems drawing water from a level below the pump (suction lift) install a foot valve with strainer. On open systems where the pump is located below the suction water level (suction head) install a check valve in the discharge line close to the pump.

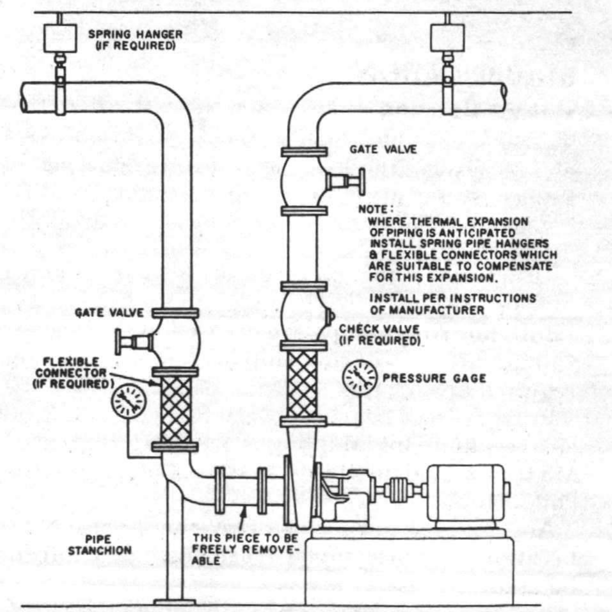


Fig. 3—Typical Installation—Vertical Piping

A—INSTALLATION-Continued

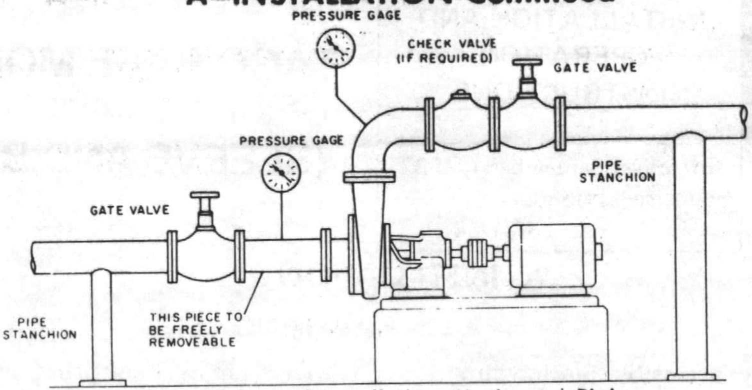


Fig. 3—Typical Installation—Horizontal Piping

A4-PUMP SETTING

When pump is set on its foundation, make sure to have it properly levelled. Place baseplate over foundation bolts provided for it, place shims at corners of baseplate when required and level with a spirit gauge. Tighten baseplate firmly to its foundations. Check also level of suction and discharge flanges.

A5-COUPLING ALIGNMENT

Proper alignment of pump and driver will assure trouble-free operation and long life of the pump. Misalignment will cause rapid wear of seals, couplings, and bearings. All pumps are carefully aligned before leaving the factory. However, experience indicates that alignment invariably changes in shipping and handling. Therefore, it is of utmost importance that alignment be checked at various steps of the installation process. i. e., **after leveling, after piping, and after first few weeks of operation.**

Check alignment by placing a slotted straight edge across the coupling halves at top, bottom, and at the sides. If any light is seen between the straight edge and one of the coupling flanges, it means the unit is out of alignment. (Fig. 4)

If light is seen at top and bottom position of the straight edge, alignment is out of height. Usually shims are placed under the motor feet. Loosen the four motor bolts, remove or add shims as required to correct proper height. Tighten the motor bolts and check to make sure alignment was corrected properly.

If alignment is out on the sides of the coupling, loosen the four motor bolts and lightly tap the motor in the direction required. Tighten the four motor bolts and check to make sure alignment was corrected properly.

As alignment in one direction may alter the alignment in another, be sure to check all alignments made.

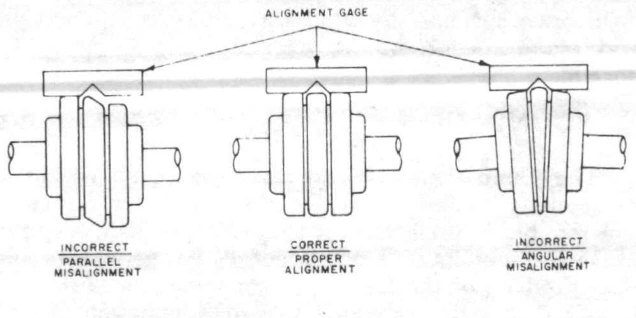


Fig. 4—Coupling Alignment

A6-CONNECTING PIPING

Piping may now be connected to pump. Make sure that pump and pipe flanges are strictly parallel and properly spaced for the gasket that will be used. Also check that pipes are supported properly and do not rest on pump flanges. Never draw pipes by force to pump flanges. Recheck alignment after piping connections are made. If misalignment was caused by piping, it is a sign that pipe stresses distorted the pump. Correct piping to relieve stresses.

B—PUMP START-UP & OPERATION

Before starting up pump for the first time several items are to be checked to avoid damaging pump.

B1-LUBRICATION

Sleeve Bearing pumps are filled with oil at the factory but some oil might be lost during shipment. As a matter of precaution, check oil level before starting up pump. Proper level is at the center of the sight glass. If oil level is too low, remove top cover (Fig. 5) and refill.

Drain and refill oil well once a year. Initial filling is Socony Mobil DTE Heavy Medium Oil, but any premium SAE Grade 20 Non-Detergent Motor Oil can be used.

Motor bearings also might loose oil during shipment. Check oil level as indicated on motor instruction. Electric motors have either an oil cup or a pipe plug for filling. An overflow is located at the side of the bearing area. Before starting unit, fill motor bearing with an oil can until oil flows out of overflow.

Ball Bearing pumps are greased at the factory. Grease will not flow out during shipment, so no checking will be required at startup.

Regrease ball bearings every two years or 3,000 hours of operation. Initial filling is LUBRIKO-grease, Density M31, manufactured by Master Lubricants Company, Philadelphia.

Any general purpose ball bearing grease No. 3 NLGI (National Lubricating Grease Institute) hardness may be used.

To grease bearings open side covers (Fig. 5), slide them about 1/2" to the side and introduce grease thru the opening with a putty knife. Fill grease chamber 2/3 high. Excessive grease causes unnecessary friction and will overheat bearing. If bearings run hot after regreasing, stop pump, open side cover, and wipe out excessive grease. Overheating will then cease.

Motor ball bearings also are greased at the factory. Grease should be replaced as indicated by motor manufacturer's instruction. Normally greasing is required every two years. On electric motors grease is usually introduced through a grease fitting with a grease gun.

B—PUMP START-UP & OPERATION-Continued

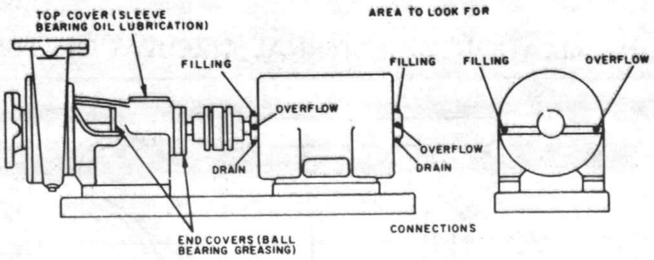


Fig. 5—Lubrication Points

B2-MOTOR WIRING & SENSE OF ROTATION

Check wiring of motor before starting to make sure that connections are wired properly for the voltage in use. Overvoltage can burn out motor windings. Check heater element in magnetic starter to see that it is rated the same as the motor.

AMP RATING FOR 3 PHASE SQUIRREL CAGE INDUCTION MOTORS

Motor HP	220 Volt 1750 RPM	220 Volt 3450 RPM	440 Volt 1750 RPM	440 Volt 3450 RPM
1/4	1.0	–	.5	–
1/3	1.4	–	.7	–
1/2	1.8	–	.9	–
3/4	2.4	2.2	1.2	1.1
1	3.6	3.4	1.8	1.7
1 1/2	4.8	4.6	2.4	2.3
2	6.2	5.6	3.1	2.8
3	9.0	8.0	4.5	4.0
5	14.4	13.4	7.2	6.7
7 1/2	20.0	19.2	10.0	9.6
10	26.4	25.6	13.2	12.8
15	39.0	38.0	19.5	19.0
20	51.0	50.0	25.5	25.0
25	62.0	60.0	31.0	30.0
30	74.0	72.0	37.0	36.0
40	96.0	–	48.0	–
50	120.0	–	60.0	–

Before attempting to check out sense of rotation of pump, fill pump with water to provide lubrication of the seal. Do not operate pump dry for motor checkout.

Next throw the switch and see if direction of rotation corresponds with arrows on frame of pump. The direction of rotation is counterclockwise facing the suction end of pump. Direction of rotation of three phase motors can be easily reversed by interchanging two of the three wires at the terminal board of the motor. Reversing of single phase motors is done by interchanging some internal wires or clamps. Instructions for reversing are found either on the motor nameplate or inside the motor terminal cover.

B3-PUMP START-UP

After you have checked lubrication and wiring you are ready to start the pump.

Open the gate valve in the suction side and close the valve on the discharge side. Start motor, wait until unit has come to full speed and then open discharge valve slowly. Do not run pump for more than a few minutes with completely shut valves. If system conditions call for part-time operation against shut valves, install a bypass line from discharge to suction.

B4-MECHANICAL SEAL AND STUFFING BOX CARE

Mechanical Seal (See caution below)*

Mechanical seals are the most delicate component of the pump. Special care has to be given to them to assure trouble-free operation.

The sealing element of a mechanical seal consists of a carbon washer rotating against a stationary ceramic ring.

Surfaces of both are highly lapped to assure sealing.

Any dirt that penetrates between the two mating parts will cause a rapid wear of the seal faces and will ultimately result in seal leakage.

New heating systems are usually contaminated by various materials such as construction debris, welding slugs, pipe joint compound, mill scale, etc. It is of utmost importance that such systems be cleaned out thoroughly before putting pump into continuous operation.

Cleaning of a heating system is simple and easy. First flush out system with cold water at city pressure to remove all loose foreign matter that penetrated into the system. Afterwards boil out system with chemicals to remove dirt adhering to pipes.

Chemicals most commonly used for this procedure are sodium triphosphate, sodium carbonate, or caustic soda, but any nonfoaming detergents as used in dishwashers can be applied.

Fill system with clean water, add cleaning chemicals (1) lb. for every 40 to 50 gallons of water, (or Mfrs. Instruction) start pump and heat up system. Let system run for a few hours, then drain and refill with fresh water. Your pumps are now ready for continuous duty. (See caution below).*

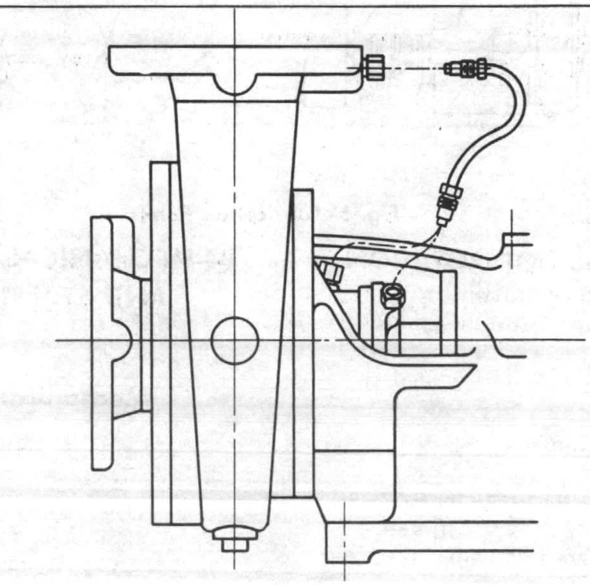
Stuffing boxes are less delicate in operation than mechanical seals. No chemical cleaning is necessary as on mechanical seal pumps, but flushing out with cold water is beneficial on this type of pump too.

After pump is started up adjust gland of stuffing box evenly so that it drips from one to three drops of water per minute. This drip is absolutely essential to prevent damage to packing and shaft sleeve. It also prevents overloading of motor. Excessive dripping may cause air to enter pump under certain conditions.

Sump of pump should be piped to any convenient sewer or drain. A pipe tapping is provided for this purpose at the side of the sump. Never plug this drain tapping.

*CAUTION: The addition of certain chemical additives to systems utilizing TACO Equipment, voids the warranty.

INSTALLATION OF EXTERNAL CIRCULATION TUBE

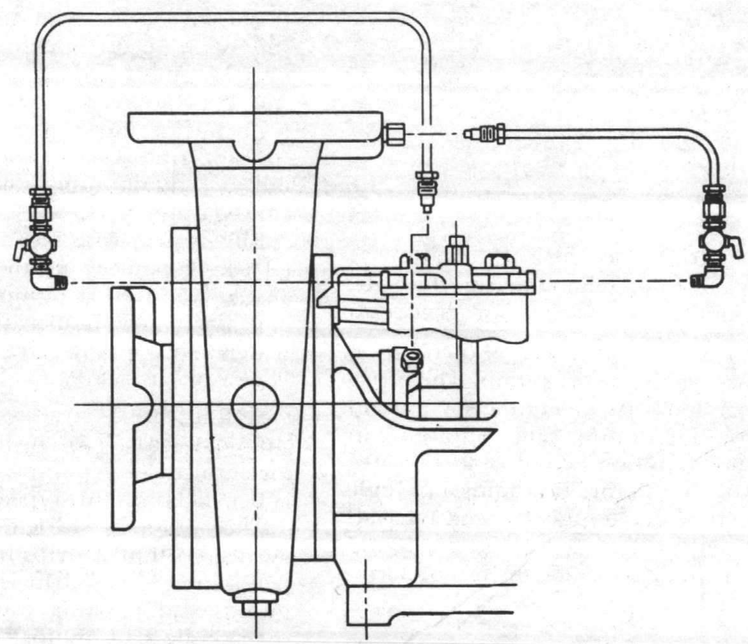


IMPORTANT

Before filling system with water, assemble external circulation tube to pump casing as follows:

1. Screw nut into body until hand tight.
2. With a wrench continue tightening for about one and one-half full additional turns. (It is not necessary to tighten nut all the way down)

INSTALLATION OF PUROCELL FILTER



IMPORTANT

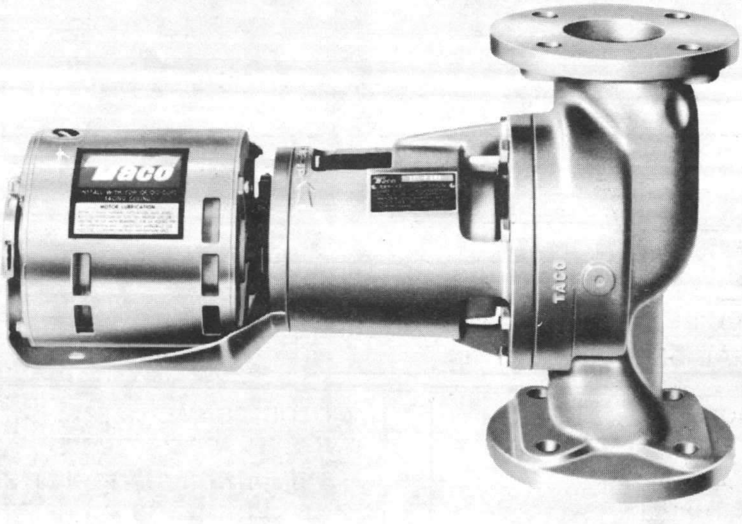
1. Attach Filter to the pump by loosening the top bolt on the frame and casing and slip bracket under bolt and tighten.
2. If Recirculating line is installed — remove from frame and insert this end into inlet of Filter.
3. Attach line from outlet of the filter to seal retainer cap.

Taco	REPLACEMENT PARTS
NUMBER **304-001**	Effective: December 1, 1985 Supersedes: PL300-1 dated: 12/1/84

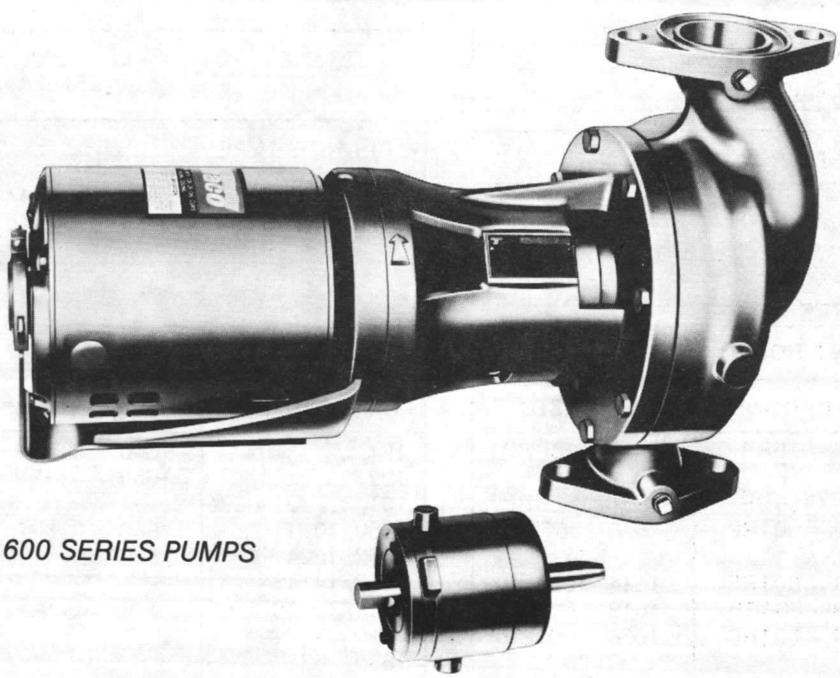
121 THRU 138 PUMPS
1600 SERIES PUMPS

IMPORTANT: When ordering, always specify part number, part name, and complete model number of pump.

CARTRIDGE DESIGN PUMPS



121 – 138 SERIES PUMPS



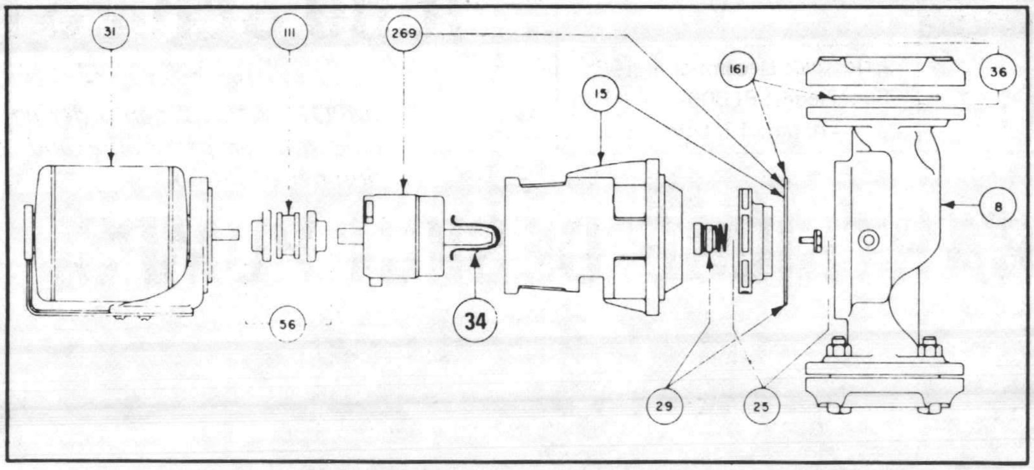
1600 SERIES PUMPS

Taco, Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone: (401) 942-8000 Telex: 92-7627

Litho in U.S.A.

Form No. F304-001 Taco (Canada) Limited 1310 Aimco Blvd., Mississauga, Ontario L4W 1B2 Telephone: 416-625-2160 Telex: 06-961179

REPLACEMENT PARTS FOR (–9) AND SERIAL NUMBER CARTRIDGE DESIGN PUMPS



SERIAL NUMBER CODE

1600 - 4.25 C 1 N 1 N

- N — FLANGE TYPE
- 1 — MOTOR FRAME SIZE
- N — WATER SEAL
- 1 — BRACKET DESIGN
- C — MATERIAL OF CONSTRUCTION

MATERIAL OF CONSTRUCTION

X O O O O

A CAST IRON PUMP AND IMPELLER (3)
B ALL BRONZE PUMP AND IMPELLER
C CAST IRON PUMP AND BRONZE IMPELLER

MOTOR FRAME SIZE*

O O O X O

1 48 FRAME (1/4, 1/3, 1/2 HP)
2 56 FRAME (3/4, 1 HP)
3 56 FRAME (1 1/2, & 2 HP)
4 56 FRAME (3 HP)

* Refer to standard motors only. See nameplate for other motors.

BRACKET DESIGN

O X O O O

1 ALL CURRENT STYLE PUMPS

WATER SEAL TYPE, ITEM #29

O O X O O

N 1600 – 170RP NI – RESIST
H 1600 – 170HRP TUNGSTEN CARBIDE
E 1600 – 170ERP CERAMIC

FLANGE TYPE

O O O O X

N NPT (STANDARD)
D DIN (EXPORT)

ITEM #8 REPLACEMENT BODY

PUMP MOD. NO.	CAST IRON	BRONZE
121	121 – 018RP	121 – 018BRP
122	"	"
131, 32, 33 & 38[1]	133 – 150RP	133 – 150BRP
1600, 10, 11[1]	1610 – 001RP	1610– 001BRP
1602, 1604[2]	N/A	N/A
1612, 14, 15	1614 – 001RP	1614 – 001BRP
1616, 18, 19	1618 – 004RP	1618 – 004BRP
1620, 22, 24	1634 – 001RP	1634 – 001BRP
1630. 1632	"	"
1634, 1635	"	"
1636, 1638	1640 –002RP	1640 – 002BRP
1640, 1641	"	"

ITEM #36 REPLACEMENT FLANGE SET

PUMP MOD. NO.	CAST IRON	BRONZE
121	1600 – 033RP	1600 – 033BRP
122	1600 – 034RP	1600 – 034BRP
131, 32, 33, & 38[1]	"	"
1600, 10, 11[1]	1600 – 031RP	1600 – 031BRP
1602, 1604[2]	"	"
1612, 14, 15	"	"
1616, 18, 19	1600 –032RP	1600 – 032BRP
1620, 22, 24	"	"
1630, 1632	"	"
1634, 1635	"	"
1636, 1638	1600 – 174RP	1600 – 174BRP
1640, 1641	"	"

Note (1) When replacing Item #8 body on 131, 132, 133, 138 and 1600C – 1& –9, you must also order current style impeller.
Note (2) Body for the 1602 & 1604 are no longer available. Consult factory.
Note (3) 121 thru 138 only.

ITEM # 15 REPLACEMENT BRACKET					ITEM # 161 GASKET KIT
PUMP MOD. NO.	MOTOR FRAME SIZE (48)		MOTOR FRAME SIZE (56)		
	CAST IRON	BRONZE	CAST IRON	BRONZE	
121, 122	1600 – 155RP	1600 – 156RP	NA	NA	1600 –050RP
1600, 10, 11	"	"	"	"	"
1602, 1604	1600 – 175RP	1600 – 176BRP	"	"	"
1612, 20, 30	"	"	"	"	"
131, 132	"	"	"	"	"
1615*	–	–	–	–	"
133, 138	NA	N/A	1604 – 023RP	1604 – 024RP	"
1614, 22, 24	"	"	1604 – 023RP	1604 – 024RP	"
1632, 34	"	"	1604 – 023RP	1604 – 024RP	"
1635*	–	–	–	–	1600 – 050RP
1616, 36	"	"	1604 – 025RP	1604 – 026RP	1618 – 006RP
1619*	–	–	–	–	
1638, 40, 41	"	"	1604 – 025RP	1604 – 026RP	"

* Select bracket, per motor frame size code in serial number.

ITEM #25 REPLACEMENT IMPELLER ASSEMBLY

PUMP NO.	(-9) PUMPS	CURRENT	DIA. -9	DIA. CUR.	PUMP NO.	(-9) PUMPS	CURRENT	DIA. -9 CUR.
121, 122	121 – 142BRP	121 – 142BRP	4.30	4.30	1618	1618 – 001BRP	N/A	7.900
131	131 – 075BRP	1630 – 023BRP	4.80	4.40	1619*	N/A	1619 – 001BRP	
132	132 – 063BRP	1630 – 022BRP	5.20	4.90	1620	1620 – 022BRP	N/A	5.100
133	133 – 075BRP	1632 – 022BRP	5.75	5.65	1622	1622 – 020BRP	N/A	5.850
138	138 – 037BRP	1634 – 023BRP	6.25	6.15	1624	1624 – 040BRP	N/A	6.500
1600	1600 – 179BRP	1610 – 020BRP	4.75	4.50	1630	1630 – 022BRP	1630 – 022BRP	4.900
1602	1602 – 025BRP	N/A	5.500		1632	1632 – 022BRP	1632 – 022BRP	5.650
1604	1604 – 028BRP	N/A	6.200		1634	1634 – 023BRP	1634 – 023BRP	6.150
1610	1610 – 019BRP	1610 – 019BRP	4.750		1635*	N/A	1635 – 001BRP	–
1611*	N/A	1611 – 001BRP	–		1636	1636 – 001BRP	1636 – 001BRP	6.400
1612	1612 – 019BRP	1612 – 019BRP	5.750		1638	1638 – 001BRP	1638 – 001BRP	6.900
1614	1614 – 018BRP	1614 – 018BRP	6.350		1640*	1640 – 001BRP	N/A	7.900
1615*	N/A	1615 – 001BRP	–		1641*	N/A	1641 – 001BRP	–
1616	1616 – 002BRP	1616 – 002BRP	7.100					

*When ordering, please advise diameter of impeller.

ITEM # 31 REPLACEMENT MOTOR ASSEMBLY*

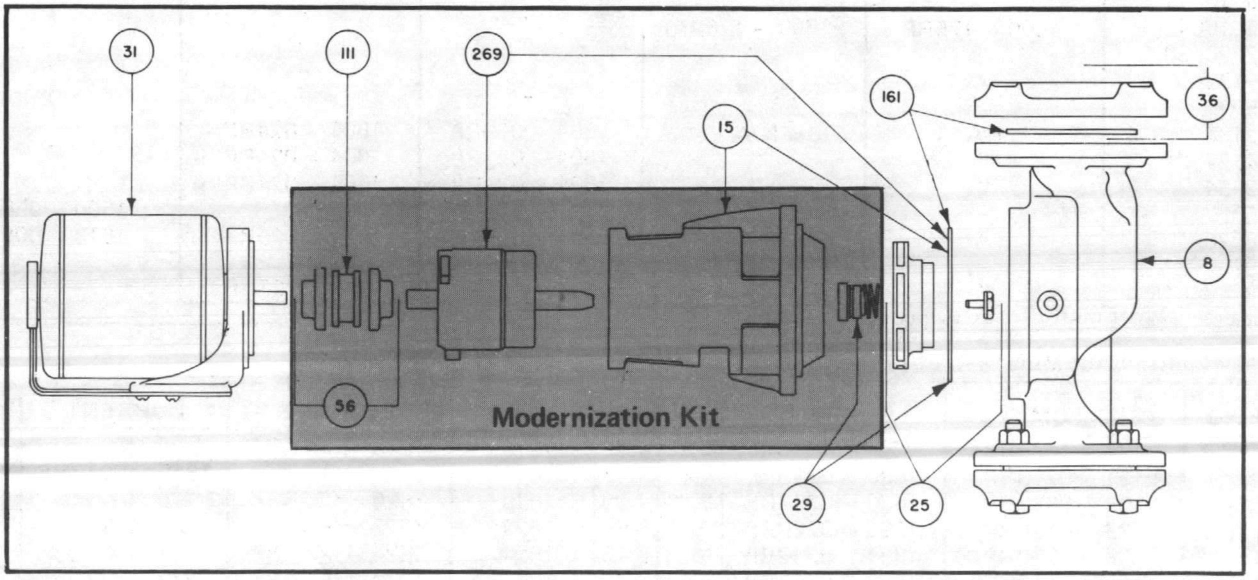
HP	115/60/1	115/230/60/1	200/60/3	230/460/60/3
1/4	121 – 151RP	N/A	121 – 148RP	121 – 137RP
1/3	131 – 143RP	N/A	131 – 115RP	131 – 137RP
1/2	N/A	132 – 096RP	132 – 066RP	132 – 097RP
3/4	N/A	133 – 119RP	133 – 140RP	133 – 134RP
1	N/A	138 – 119RP	138 – 148RP	138 – 142RP
1½	N/A	1636 – 013RP	1636 – 019RP	1636 – 010RP
2	N/A	1638 – 012RP	1638 – 015RP	1638 – 010RP
3	N/A	N/A	1640 – 013RP	1640 – 010RP

* When ordering other than standard, refer to nameplate, then consult factory.

ITEM # 34 SHAFT SLEEVE	1600 – 205	All –9 and Serial Number Pumps.
ITEM # 56 COUPLER	1624 – 053RP	All Inline Pumps ¼ thru 2 HP.
ITEM # 56 COUPLER	1624 – 041RP	All Inline Pumps 3 HP.
ITEM # 111 RUBBER INSERT	1624 – 004RP	All 4J Couplers.
ITEM # 111 RUBBER INSERT	1624 – 020RP	All 3J Couplers.
ITEM # 111 RUBBER INSERT	900 – 512	All 5J Couplers.
ITEM # 269 CARTRIDGE ASSY.	1600 – 160RP	All -9 and Serial Number Pumps.

REPLACEMENT PARTS FOR OLD STYLE PUMPS AND CIRCULATORS*

*121+122-3-7; 131, 132+133-3-6; 138-1+2; 1600, 1602, 1604, 1610, 1612, 1614, 1620, 1622, 1624, 1630, 1632, 1634-1+-C1.



ITEM # 8	BODY	Same as –9 and Serial Number Pumps.
ITEM # 25	IMPELLER AND SHAFT ASSEMBLY	No longer available . Must purchase Item #74 Modernization Kit listed below, Plus –9 IMPELLER
ITEM # 29	SEAL KIT	Part No. 1600 – 055RP
ITEM # 31	MOTOR ASSEMBLY [1]	Same as –9 and Serial Number Pumps.
ITEM # 36	FLANGE SET	Same as –9 and Serial Number Pumps.
ITEM # 56	COUPLER	Same as –9 and Serial Number Pumps.
ITEM # 111	RUBBER INSERT	Same as –9 and Serial Number Pumps.
ITEM # 161	GASKET KIT	Same as –9 and Serial Number Pumps.

ITEM # 74 MODERNIZATION KIT*

PUMP NO.	MOTOR FRAME SIZE (48)		MOTOR FRAME SIZE (56)		
	CAST IRON	BRONZE	CAST IRON	BRONZE	
121, 122	121 – 154RP	122 – 002RP	N/A	N/A	
131, 132[2]	131 – 144RP	132 – 145RP	133 – 147RP	138 – 153RP	
133, 138	N/A	N/A	"	"	
1600, 1610	121 – 154RP	122 – 022RP	N/A	N/A	
1602, 1604[2]	131 – 144RP	132 – 145RP	133 – 147RP	133 – 147RP	
1612, 1620[2]	"	"	133 – 147RP	138 – 153RP	
1630[2]	"	"	"	"	
1614, 1622	N/A	N/A	"	"	
1624, 1632	N/A	N/A	"	"	
1634	N/A	N/A	"	"	

Note (1) When replacing 1/3 or 1/2 HP 56 Frame (old) motor with a new 48 Frame motor, adapter kit # 1600 – 194RP must be ordered.

Note (2) Select modernization kit per motor frame size. Select impellers per selection chart on previous page, under –9 column

*Change

Taco

INSTRUCTION SHEET

NUMBER
IS-100-1.3

Effective: May 1, 1981
Supersedes: IS 300-1-1 dated 11/25/68

PUMP SERVICING INSTRUCTIONS – NOS.

121-7	1600-1	1620-1
122-7	1602-1	1622-1
131-6	1604-1	1624-1
132-6	1610-1	1630-1
133-6	1612-1	1632-1
138-2	1614-1	1634-1

Plant ID. No. 001-322

ITEMS TO CHECK BEFORE STARTING

1. Motor and bracket have been properly lubricated at the factory and should not require additional lubricant. Before starting, check oil level in bracket thru sight oil gauge. Level should be between top and center of window. If, for some reason, level is below center of window, see instructions on oil well cover.
2. Check motor and power supply for proper wiring connections and voltage. If motor is damaged due to improper wiring hook-up, guarantee is void.
3. The casing is rotatable and may be installed in a vertical or horizontal pipe. The motor and bracket must be horizontal in all cases with oil well cover facing the ceiling.

LUBRICATION

Motor– Motor is well oiled before shipment in accordance with manufacturer's recommendation and should not require any oil upon arrival. When oil is required, follow instructions attached to the motor end shield plates.

Pump– (For best results TACO-LUBE #12 is recommended. Maintain oil level at all times within limits specified on oil well cover.

MOTOR ALIGNMENT

All circulator motors are aligned within required tolerances when shipped. They normally do not require any attention. If due to rough handling the motor base becomes bent, loosen screws connecting cast iron and steel sections of the motor base and place shims between the two sections until the motor shaft is properly aligned with the pump shaft.

TO REPLACE WATER SEAL AND/OR IMPELLER

1. Stop pump and close suction and discharge valves.
2. Drain water from casing.
3. Remove pipe plug on opposite side of oil gauge and drain oil (water may have gotten into oil reservoir).
4. Remove motor assembly from bracket.
5. Remove bracket from pump body. Loosen set screw and pull out pump end of drive coupling. DO NOT BEND SHAFT.
6. Remove oil well cover, loosen set screw in inside Thrust Collar and while holding Thrust Collar, remove Impeller and Shaft, Thrust Washers and Thrust Collar.
7. Clean bearings and bracket and inspect for possible damage. Clean sight oil gauge.
8. Remove stationary seal from bracket, clean recess and apply a film of light oil to OD of new stationary seat rubber cup, press firmly in place with thumbs. Be certain it is "bottomed" equally, otherwise it might leak.
9. Gently remove old seal parts from shaft with a rotating motion and clean entire shaft with soft clean cloth (Do not use much pressure). Drop new spring and holder onto the shaft.
10. Apply a good film of oil, from the very end of the shaft right down to, and slightly beyond the end of the spring. With the seal in the palm of the hand (seat facing the hand) and with an oscillating motion, press seal over end of shaft then down to free length of the spring. Line up seal, spring and spring holder.
11. Thoroughly clean both seal faces with a soft clean cloth.
12. Remove set screw from Thrust Collar. Apply a film of oil to each side of Thrust Collar, then place a Thrust Collar Washer on each side of the Thrust Collar with the LIGHT COLORED (Cadmium Plated) SIDES facing the Thrust Collar. While holding this 3 Part Assembly (Thrust Collar and two Washers) in the oil reservoir with grooves on OD of Collar facing the Impeller, slide Impeller and Shaft into bracket so that hole in Shaft is directly in line with screw hole in Thrust Collar. Insert and tighten set screw until it bottoms in the hole in the shaft, then turn back 1/16 of a turn. This automatically adjusts the spring tension on seal. THIS LAST OPERATION MUST BE ACCOMPLISHED IMMEDIATELY AFTER OPERATIONS 10 AND 11. IF TOO MUCH TIME ELAPSES, THE OIL MAY BE SQUEEZED OUT FROM UNDER SHAFT SEAL, PREVENTING THE RUBBER PART OF SEAL FROM SLIDING ON SHAFT WHICH IS NECESSARY WHEN PERFORMING OPERATION 12.
13. Re-assemble motor and coupling assembly to bracket and bracket to casing, making certain that casing gasket is in good condition and properly located. Engage teeth of rubber coupling insert with those in the metal ends. Bring all three parts together, then back off one end about 1/32" and tighten. Do not squeeze rubber insert, some pump sizes use A "FIGURE-8" shaped one piece coupler. Install without stretching or compressing.
14. Open valves in suction and discharge lines and vent air thru vent holes, if provided. Start motor for TWO SECONDS, then stop and inspect for water leaks. If any leaks occur, one or more previous operations must be repeated.
15. If no leaks occur, re-fill oil reservoir as previously indicated under LUBRICATION-PUMP and replace oil well cover.
16. Start pump and again check for leaks. (Note: If pump is operated longer than 30 SECONDS without being primed, the mechanical seal could be damaged).

Taco	MAINTENANCE AND SERVICING INSTRUCTIONS
NUMBER **IS300-2.3**	Effective: October 1, 1982 Supersedes: IS300-2.3 dated 4/1/81

Plant ID, No. 001-359

TACO "LP" SERIES

BALL & SLEEVE BEARING BASEMOUNTED AND CLOSE COUPLED

MAINTENANCE AND SERVICING

GENERAL

Before starting any service work on the pump, read these instructions carefully.

A step by step procedure of the most common service jobs is given to assist you in performing the service required. Follow each step on the exploded views on the replacement parts list. Item numbers, part numbers and quantities required for any replacement part is provided on the replacement parts list.

Be certain to stop pump and close suction and discharge valves before starting any service work.

To gain access to internal parts of pump, remove flanged nipples (spool piece) or flex connectors that have been provided on suction and discharge sides of pump.

If no freely removeable piece is provided on suction side of pump, you can service the pump by disconnecting both suction and discharge flanges and remove the frame hold-down bolts. The pump end can now be moved for convenient servicing. On close coupled pumps with anchor blocks, the above applies. For close coupled pumps not using anchor block an alternate method will have to be used.

1. REPLACING IMPELLER

Required Replacement Parts
Item No. 6 Impeller
Item No. 3 Suction Cover O Ring,
Pipe Flange Gaskets

DISASSEMBLY

Remove suction cover bolts and remove suction cover from pump. Loosen impeller bolt (right hand thread) with socket or offset box wrench. Remove impeller bolt, belleville washer and impeller washer. Remove impeller and impeller key.

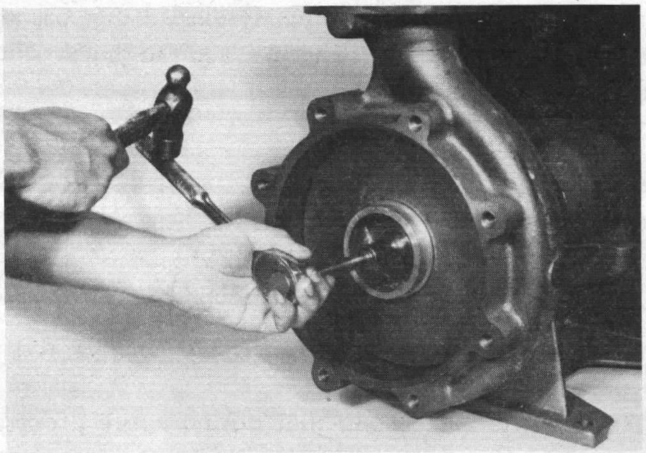
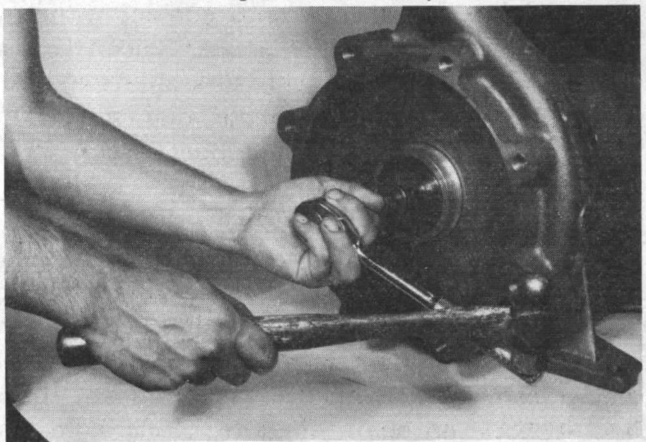


Fig. 1 – Disassembly



Reassembly
Fig. 2 – Removing and Replacing Impeller Bolt

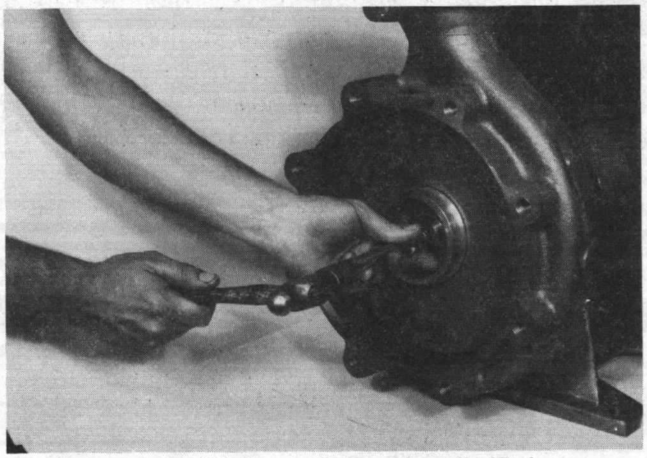


Fig. 3 – Hitting on Drift – Impeller Bolt

MAINTENANCE AND SERVICING

REASSEMBLY

Be certain that shaft and key way are clean and free of burrs. If grease is applied to shaft end, key way and impeller bolt, use only silicon grease.

Replace impeller key and slide impeller on shaft end. Reassemble belleville washer and impeller washer on impeller bolt and then tighten down firmly.

Replace suction cover o ring and reassemble suction cover to pump. Be certain that boss for gauge on suction cover flange be up. Replace flange gasket and reconnect flange. Tighten suction cover and flange bolts evenly.

2. REPLACING SEAL

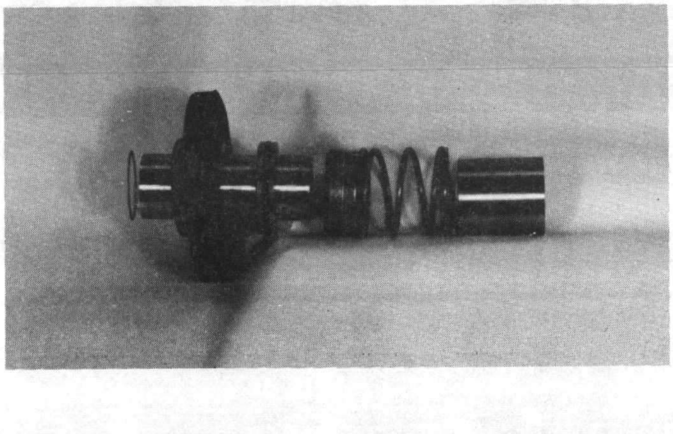
Required Replacement Parts

- Item No. 3 Suction Cover O Ring
- Item No. 9 Impeller Spacer (If badly worn)
- Item No. 91 Seal Kit (Includes Items No. 28, 29, 35 & 67)

CAUTION: Be certain that during entire process of replacing seals, its rubber parts do not come into contact with any regular oil or grease. Silicon Grease is provided with all seal kits and this is the only grease that should be used to lubricate rubber parts.

DISASSEMBLY

Follow disassembly steps for impeller replacement, however you must also disconnect the discharge flange. Remove external re-circulation line if one is provided. Remove seal retainer cap bolts. Tap the seal retainer cap lightly with hammer to loosen it and slide it back on shaft. Remove casing bolts and remove casing from frame. Slide impeller spacer, sleeve with water seal on it, seal retainer cap and sleeve gasket off shaft. Remove stationary seal seat from seal retainer cap. Clean if necessary, with fine emery cloth, shaft, impeller spacer, seal retainer cap and casing which mates with seal retainer cap.



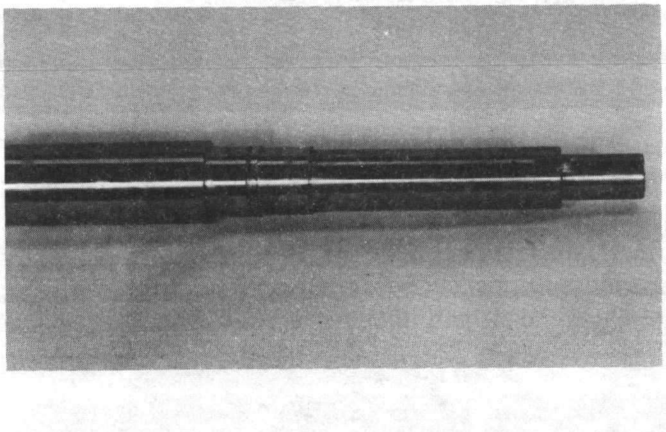
REASSEMBLY

For ease of assembly lubricate o.d. of o ring of seal seat with light film of silicon grease. Place the seal retainer cap on a horizontal surface and place new seal seat in retainer cap. Be certain that your fingers or thumbs do not come into contact with seal seat face. Use a clean rag for protection of seat face when pressing seat into seal retainer cap. After seat is pressed into the cap, check on back side of cap to be sure that seat is properly seated against the cap shoulder.

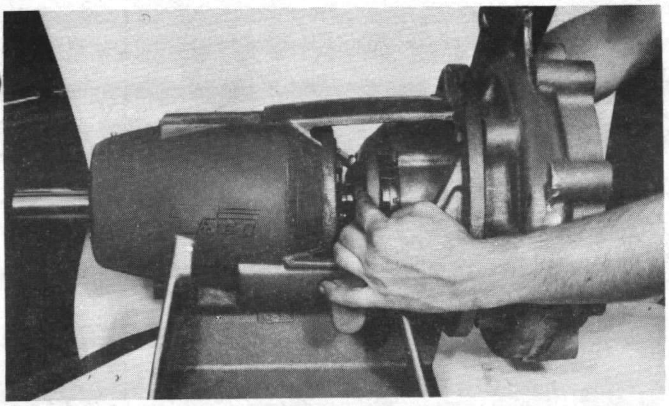
Apply a light film of silicon grease to shaft. Slide sleeve gasket on shaft and butt shoulder, slide sleeve on shaft and butt to sleeve gasket. Chamfered end of sleeve should point toward impeller end of shaft. Slide seal retainer cap with seat pressed into cap on shaft as far back as it will go. Place cap gasket on seal retainer cap.

Lubricate i.d. of rubber on rotating seal with silicon grease and slide on shaft sleeve, carbon washer facing seal seat. Push seal all the way back until it gently touches the seal seat. Slide the seal spring over the sleeve followed by the spring retainer with raised portion toward the spring. Place impeller spacer on shaft so it butts the seal sleeve. Assemble casing to frame and firmly tighten casing bolts alternately.

Reassemble impeller, after impeller bolt has been firmly tightened, insert the two side bolts through the seal retainer cap and cap gasket and slide seal retainer toward casing. Start the two side bolts and take bolts up evenly. When seal retainer comes into contact with casing insert top & bottom bolts and tighten all four bolts alternately. Replace external recirculation line if one is provided. Reassemble suction cover with new O ring. Connect suction and discharge flange. Firmly tighten all flange and suction cover bolts.



MAINTENANCE AND SERVICING



3. REPLACING PACKING

Replacement Parts Required
Packing Set

Remove packing gland nuts and slide gland back as far as it will go. Remove old packing rings.

Pump numbers, quantity of packing ring and packing ring sizes are as follows:

Pump Number	Quantity of Ring	Ring Size I.D. O.D. Thickness
1205 (1-1/4-5), 1206 (1-1/4-6), 1505 (1-1/2-5), 1506 (1-1/2-6),	4	1-1/4 x 1-3/4 x 3/8
1508 (1-1/2-8), 2006 (2-6)	4	1-1/4 x 1-3/4 x 3/8
2505 (2-1/2-5), 2506 (2-1/2-6), 3005 (3-5) 3006 (3-6)	4	1-1/4 x 1-3/4 x 3/8
2008 (2-8), 2508 (2-1/2-8), 2510 (2-1/2-10)	5	1-1/4 x 2 x 3/8
3008 (3-8), 4006 (4-6)	5	1-1/4 x 2 x 3/8
3010 (3-10), 4008 (4-8), 4010 (4-10)	6	1-1/2 x 2-1/4 x 3/8
4012 (4-12), 5008 (5-8), 5010 (5-10)	6	1-1/2 x 2-1/4 x 3/8
5012 (5-12), 6010 (6-10)	6	1-1/2 x 2-1/4 x 3/8
6012 (6-12)	5	2 x 3 x 1/2

If a solid ring or a length of packing is used be certain that all rings be cut diagonally. You are now ready to start reassembling packing rings.

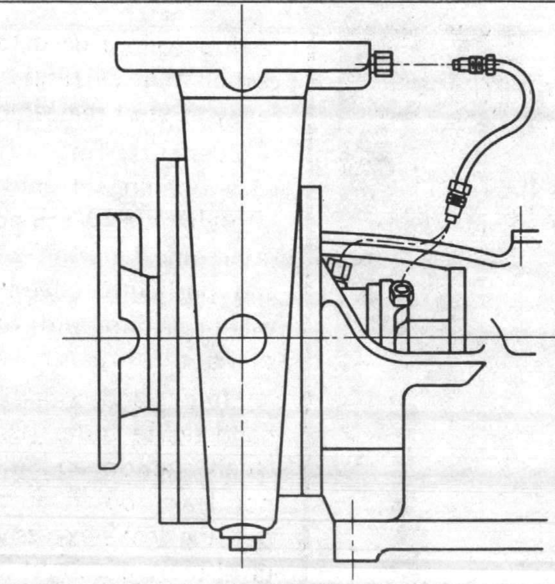
Open first ring sufficiently to place around shaft with opening at the top of packing chamber. Push into chamber with packing gland. Pull gland back and insert another ring with opening on right hand side and push into chamber with packing gland. Repeat this procedure with opening at bottom and left hand side until all rings have been installed.

Slide gland squarely up to last packing ring and hand tighten nuts. (Do not use a wrench at this time). Open suction and discharge valves. If packing does not leak, loosen nuts until there is a slight leak. If packing leaks excessively tighten nuts with a wrench until there is a slight leak, pump may now be started.

Normal leakage for packed pumps is three (3) to seven (7) drops per minute.

During running in period of approximately 30 to 60 minutes take up on nuts one half (1/2) turn every 5 minutes, or until at the end of the running in period you are getting normal leakage of three (3) to seven (7) drops per minute. While tightening nuts make certain that gland is being pulled up evenly.

INSTALLATION OF EXTERNAL CIRCULATION TUBE

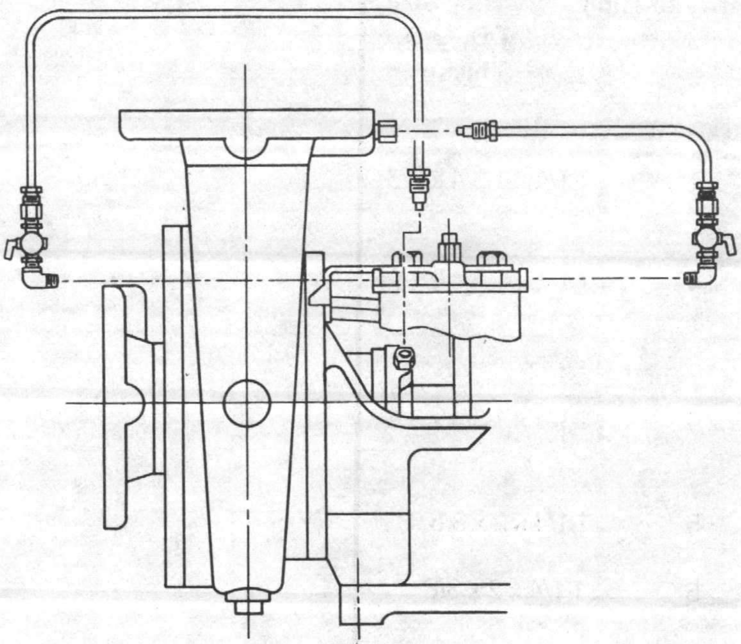


IMPORTANT

Before filling system with water, assemble external circulation tube to pump casing as follows:

1. Screw nut into body until hand tight.
2. With a wrench continue tightening for about one and one-half full additional turns. (It is not necessary to tighten nut all the way down)

INSTALLATION OF PUROCELL FILTER



IMPORTANT

1. Attach Filter to the pump by loosening the top bolt on the frame and casing and slip bracket under bolt and tighten.
2. If Recirculating line is installed — remove from frame and insert this end into inlet of Filter.
3. Attach line from outlet of the filter to seal retainer cap.

NUMBER **PL300-2.3**	**REPLACEMENT PARTS LIST** Effective: June 1, 1983 Supersedes: PL300-2.3 dated 2/1/81

FOR FOLLOWING MODEL NUMBERS:

BM or CC: 2-8 2½-8 2½-10 3-8 & 4-6
BM or CC: 2008 2010 2012 2508 2510 3008 & 4006
SB or BB: 2008 2010 2012 2508 2510 3008 & 4006

WHEN SELECTING AND ORDERING PARTS, ALWAYS REFER TO SERIAL NUMBER ON NAME PLATE
—Example—

FLANGE SIZE — **FRAME SIZE & STYLE**

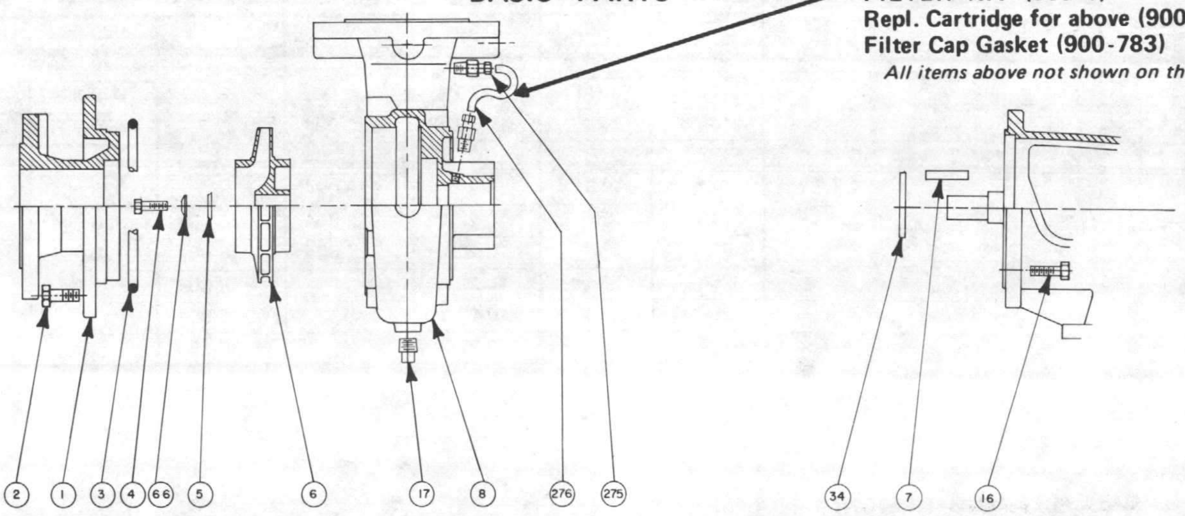
2008 – 7.9 B5B2

NOMINAL IMPELLER DIAMETER — **MATERIAL OF CONSTRUCTION**

ACTUAL IMPELLER DIAMETER — **SEAL OR PACKING DESIGN**

BASIC PARTS

FILTER KIT (900-1)
Repl. Cartridge for above (900-439)
Filter Cap Gasket (900-783)
All items above not shown on this sheet.



Item No.	No. Reqd.	DESCRIPTION	PART NO. PER PUMP SIZE 2-8 2008	2-12 2012	2½-8 2508	2½-10 2510	3-8 3008	4-6 4006	REMARKS
1	1	Suction Cover	920-003	884-003	928-003	922-003	934-003	938-003	Add 'B' for Brz.
2	8	Suction Cover Bolts	10-216	10-211	10-216	10-211	10-216	10-230	
3	1	Suction Cover 'O' Ring	912-005	868-004	912-005	862-005	912-005	918-005	
4	1	Impeller Bolt (SS)	10-257	10-259	10-257	10-257	10-257	10-257	3/8-16x11/2 SS
5	1	Impeller Washer	926-004	926-004	926-004	926-004	926-004	926-004	
6	1	Impeller	920-002	884-002	928-002	922-002	934-005	938-002	Add 'B' for Brz.
7	1	Impeller Key (SS)	13-104A	13-105A	13-104A	13-104A	13-104A	13-104A	
8	1	Casing	920-001	884-001	928-001	922-001	934-001	938-001	Add 'B' for Brz.
16	4	Casing Bolt	10-201	10-201	10-201	10-201	10-201	10-201	3/8-16x1-1/8
17	1	Drain Plug	16-102	16-104	16-102	16-102	16-102	16-102	3/8 NPT
34	1	Slinger Ring	900-044	900-044	900-044	900-044	900-044	900-044	
66	1	Belleville Washer	900-053	900-053	900-053	900-053	900-053	900-053	
222	1	Fitting	900-566	900-566	900-566	900-566	900-566	900-566	
275	2	Fitting	900-798	900-798	900-798	900-798	900-798	900-798	
276	1	Tube	900-728	900-728	900-728	900-728	900-728	900-728	

(1) Throttle Bushing (Item 10), found in Seal Section, must be ordered with each casing.

FRAME SIZE & STYLE – 0000-00-XX00

B1 BALL BEARING DESIGN: Update pump with 840-124RP Complete Frame Assembly. Please furnish all nameplate data to insure proper updated nameplate.

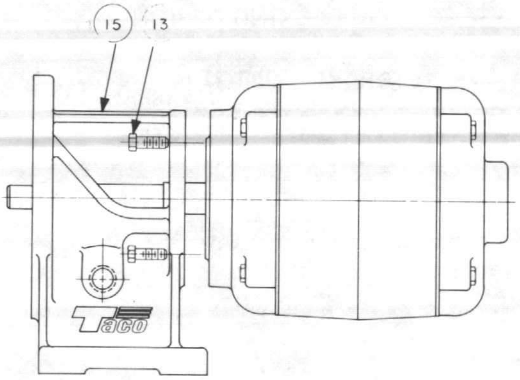
B2 SLEEVE BEARING DESIGN: Update pump with 840-124RP Complete Frame Assembly. Please furnish all nameplate data to insure proper updated nameplate.

B3 SLEEVE BEARING DESIGN: Update pump with 840-124RP Complete Frame Assembly. Please furnish all nameplate data to insure proper updated nameplate.

B6 SLEEVE BEARING DESIGN: Update pump with 840-124RP Complete Frame Assembly. Please furnish all nameplate data to insure proper updated nameplate.

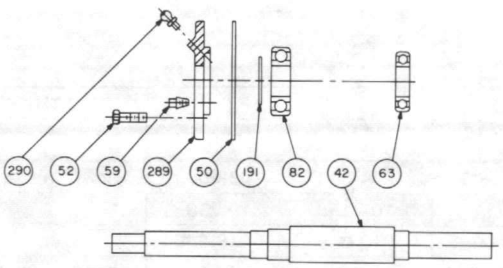
B4

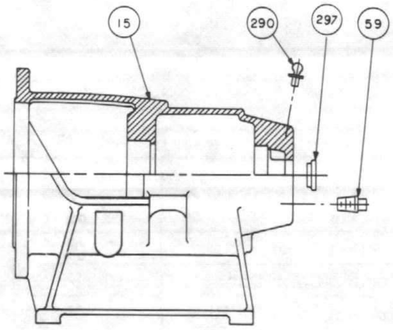
CLOSE COUPLED (CC)



NEMA FRAME Size "T"	NEMA FRAME Size "U"	ITEM 13 FR. BOLT Part No.	ITEM 15 PUMP FR. 1750 "T"	ITEM 15 PUMP FR. 3450 "T"	ITEM 15 PUMP FR. 1750 "U"	ITEM 15 PUMP FR. 3450 "U"
	48	10-201			920-004	920-004
	56	10-201			920-004	920-004
143	182	10-201			920-004	920-004
145	184	10-201	920-004		920-004	920-004
182	213	10-223	928-004		928-004	928-004
184	215	10-223	928-004		928-004	928-004
213	254	10-223	928-004	928-004	928-004	928-004
215	256	10-223	928-004	928-004	928-004	928-004
254	285	10-223		928-004		900-126
256	286	10-223		928-004		900-126
284		10-223		900-126		

B5 BALL BEARING DESIGN:

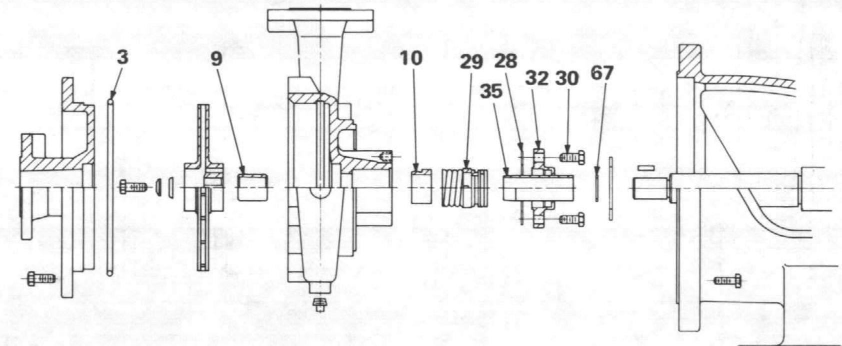




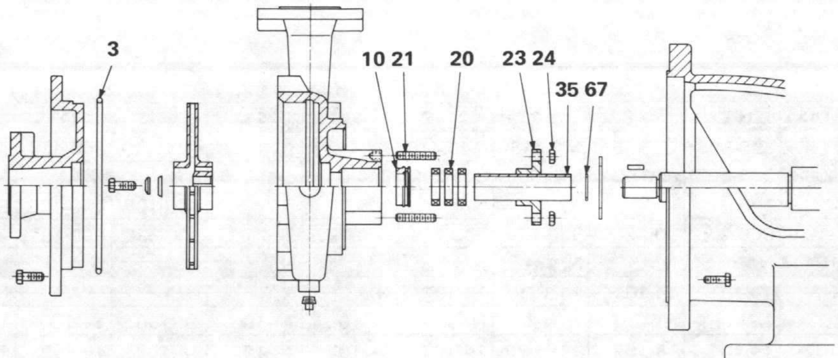
Item No.	No. Req.	DESCRIPTION	PART NO.	REMARKS REMARKS
74	1	Frame Assembly (complete)	840-124RP	
15	1	Frame	840-111	
42	1	Shaft	840-113	Add SS for Stainless Steel
50	1	Bearing Plate Gasket	840-123	
52	4	Bearing Plate Bolt	10-230	3/8 - 16 x 1
59	2	Drain Plug	16-111C	1/8 NPT Brass
63	1	Ball Bearing	840-114	
82	1	Ball Bearing	840-071	
191	1	Retainer Ring	15-105	
289	1	Bearing Cover Plate Assembly	840-120	
290	2	Lubrication Fitting	15-200	
297	1	End Cap	820-368	

SEAL OR PACKING DESIGN – 0000-00-00X0

MECHANICAL SEAL



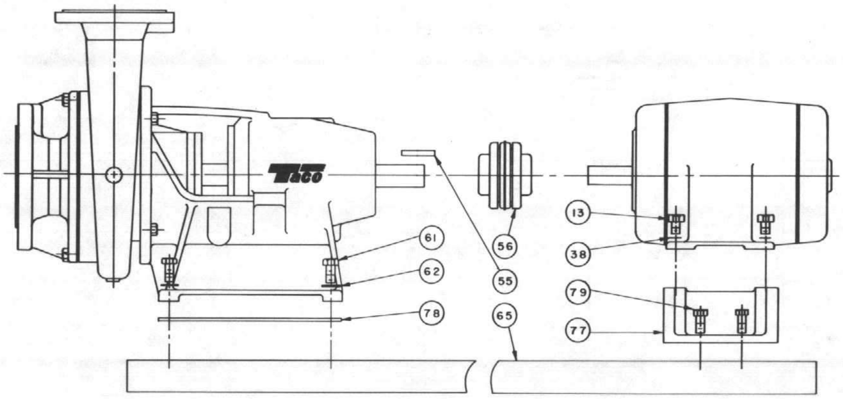
PACKING



TYPE B STANDARD. TYPE D HI-TEMP. TYPE P PACKED. TYPE E CERAMIC.

Item No.	No. Reqd.	DESCRIPTION	SEAL OR PACKING DESIGN				REMARKS
			Type 'B'	Type 'D'	Type 'P'	Type 'E'	
3	1	'O' Ring	*See Page 1*				
9	1	Impeller Spacer	900-026RP	900-026RP	Not Used	900-026RP	
10	1	Throttle Bushing	920-016	920-016	920-008	920-016	
20	1	Packing Set			900-241RP		
21	2	Studs			900-029		
22	1	Filler Ring (Not shown)	Not Used	Not Used	900-030		
23	1	Gland			920-015		Add 'B' For Bronze
24	2	Hex Nuts			12-129		3/8 – 16
28	1	Retainer Cap Gasket	920-014RP	920-014RP		920-014RP	
29	1	Water Seal	900-024RP	900-087RP		900-215RP	
91	1	WATER SEAL KIT	840-128BRP	840-128DRP	Not Used	840-128ERP	Incl. Items No. 28, 29, 35 & 67
30	4	Retainer Cap Bolts	10-208	10-208		10-208	3/8 – 16 x 7/8
32	1	Seal Retainer Cap	920-020	920-020		920-020	
35	1	Sleeve	900-027BRP	900-027BRP	920-006	900-027BRP	
67	1	Sleeve Gasket	920-007RP	920-007RP	920-007RP	920-007RP	

MOTOR PARTS – NOT PART OF SERIAL NUMBER
–Motor Frame Sizes Must be Specified When Ordering Parts Shown Below–



Item No.	No. Reqd.	DESCRIPTION	MOTOR FRAME SIZE (NEMA STD.) 'T'										REMARKS
			143-145T	182T	184T	213T	215T	254T	256T	284T	284TS	286TS	
65	1	Base Plate (1)	820-957	820-957	820-957	840-418	840-418	840-418	840-418	840-419	840-419	840-419	
77	2	Spacer	840-098	840-003	840-004	840-005	840-006	840-041	840-040	N/A	N/A	N/A	
78	2	Frame Spacer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	840-106	840-106	840-106	
56	1	Coupler	900-193	900-206	900-206	900-195	900-195	900-197	900-197	900-538	900-197	900-199	
38	4	Mtr. Lck. Wshr.	14-104	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5/16
38	4	Mtr. Lck. Wshr.	N/A	14-101	14-101	14-101	14-101	N/A	N/A	N/A	N/A	N/A	3/8
38	4	Mtr. Lck. Wshr.	N/A	N/A	N/A	N/A	N/A	14-100	14-100	14-100	14-100	14-100	7/16
62	4	Frm. Lck. Wshr.	14-102	14-102	14-102	14-102	14-102	14-102	14-102	14-102	14-102	14-102	1/2
13	4	Mtr. Hx. Hd. Blt.	10-254	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5/16-18x1¼
13	4	Mtr. Hx. Hd. Blt.	N/A	10-221	10-221	10-221	10-221	N/A	N/A	N/A	N/A	N/A	3/8-16x1¼
13	4	Mtr. Hx. Hd. Blt.	N/A	N/A	N/A	N/A	N/A	10-209	N/A	N/A	N/A	N/A	7/16-14x1½
13	4	Mtr. Hx. Hd. Blt.	N/A	N/A	N/A	N/A	N/A	N/A	10-202	10-202	10-202	10-202	7/16-14x1¼
61	4	Fr. Hex. Hd. Blt.	10-238	10-238	10-238	10-238	10-238	10-238	10-238	N/A	N/A	N/A	1/2-13x1-5/8
61	4	Fr. Hex. Hd. Blt.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10-217	10-217	10-217	1/2-13x2½
79	4	Spr. Hx. Hd. Blt.	10-230	10-230	10-230	10-230	10-230	N/A	N/A	N/A	N/A	N/A	3/8-16x1
55	1	Coupler Key	13-100	13-100	13-100	13-100	13-100	13-100	13-100	13-100	13-100	13-100	1/4x1/4x1½
47	1	Coupler Guard	820-796	820-796	820-796	820-796	820-796	820-796	820-796	820-796	820-796	820-796	
48	4	CG. RdHd. Scw.	10-400	10-400	10-400	10-400	10-400	10-400	10-400	10-400	10-400	10-400	1/4-20x3/8
111		Coup. Insert	900-512	900-512	900-512	900-513	900-513	900-514	900-514	900-515	900-514	900-515	

(1) Add "A" to base plate number when coupler guard is to be used.

MATERIALS OF CONSTRUCTION – – – 0000-00-000X

DESCRIPTION	1 STANDARD CONSTRUCTION	2 BRONZE FITTED	3 ALL BRONZE	4 ALL IRON	REMARKS
Casing	Iron	Iron	Bronze	Iron	Add Suffix 'B' for Bronze
Suction Cover	Iron	Iron	Bronze	Iron	Add Suffix 'B' for Bronze
Impeller	Iron	Bronze	Bronze	Iron	Add Suffix 'B' for Bronze
Wear Ring	Bronze	Bronze	Bronze		Only When Required
Seal Retainer Cap	Iron	Iron	Bronze	Iron	Add Suffix 'B' for Bronze
Packing Gland	Iron	Iron	Bronze	Iron	Add Suffix 'B' for Bronze
Throttle Bushing	Bronze	Bronze	Bronze	Iron	Add Suffix 'C' for Iron
Sleeve	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	
Shaft	Steel	Steel	Steel	Steel	Add 'SS' for St. Steel

Taco Instruction Sheet

102-052

Horizontal Circulators Nos. 110 thru 120

Plant I.D. No. 001-318

APPLICATION:

1. Maximum recommended working pressure is 125 psi (862 K Pa).
2. Maximum water temperature must not exceed 240°F.
3. Cast Iron Circulators should be used for closed systems only.
4. Bronze circulators must be used in open or fresh water systems and potable water systems.

INSTALLATION:

1. Mounting position — Circulators must be mounted with motor in a horizontal position.
2. Rotating casing — Casing has an arrow on front which indicates direction of flow. To rotate casing remove the casing bolts, rotate casing and replace bolts. Make sure gasket is properly located before tightening bolts.
3. Electrical connections — Observe all applicable codes when connecting to power supply. The motors do not require overload protection.
4. Fill system — It is good practice to flush a new system of foreign matter before starting circulator.

TO REPLACE MOTORS:

1. Disconnect wiring.
2. Loosen the two set screws at pump end of spring coupling, remove bolts between bracket and motor and separate.
3. Loosen other set screw of coupling and remove coupling from old motor.
4. Slide coupler with single set screw over new motor shaft and tighten against flat surface of shaft.
5. Place new motor assembly into bracket and replace bolts.
6. Extend pump end of spring coupling over impeller shaft 3/16" and tighten both set screws. If impeller and shaft move into body during this operation, water will flow from weep hole in bracket. If this does occur, extend spring coupler a little more or until water stops flowing. CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE WEEP HOLE BE PLUGGED.
7. Rewire motor.

TO REPLACE SPRING COUPLING

Follow same procedure outline above.

LUBRICATING INSTRUCTIONS

Re-oil pump and motor annually with SAE No. 30 oil.

*CAUTION: The addition of certain chemical additives to systems utilizing TACO Equipment, voids the warranty.

COMPARE. YOU'LL TAKE TACO.

TACO, Inc., 1160 Cranston St., Cranston, RI 02920 (401) 942-8000 Telex: 92-7627
TACO, (Canada) Ltd., 1310 Aimco Blvd., Mississauga, Ontario L4W 1B2 (416) 625-2160 Telex: 06-961179

REPLACING SEALS

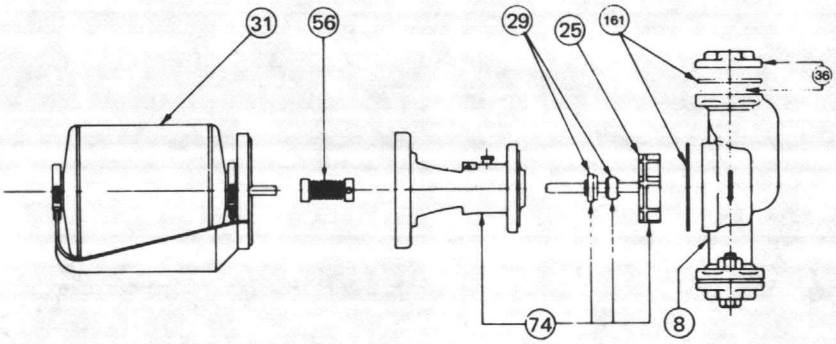
Water flowing from weep hole in bracket normally indicates dirt on the seat or seal needs replacement. Before taking pump apart extend spring coupling and impeller shaft into body as far as it will go. This will separate the seal halves and permit a greater flow thru the weeping hole and wash any foreign matter off the seats. Release and if flow stops, it indicates that the seals do not require replacement. If the flow does not stop, loosen the two set screws on the coupling and extend as far as it will go. If leak stops it means there was insufficient tension on the coupling. If leak continues, indications are that the seal needs replacement. Proceed as follows: —

1. Disconnect wiring.
2. Valve off or drain system.
3. Remove body bolts and pull entire assembly out of body.
4. Loosen the two set screws at pump end of spring coupler, file off any burrs on shaft and pull impeller and shaft from bracket.
5. Pry out old seal seat from bracket with a screwdriver and old part from impeller shaft with a pair of pliers.
6. Clean shaft and seal bearing surfaces thoroughly with clean cloth.
7. Dip CARBON part of seal in water to lubricate, place on top of impeller shaft with carbon facing up. Push down on shaft with palm of hand as far as it will go. Then with both thumbs push all the way down making certain that prongs engage the two holes in the impeller. If there are no holes in the impeller, break off the prongs with a pair of pliers and smooth burrs with a file.
8. Separate rubber from ceramic part, wet it and set into recess in bracket. Set ceramic seal into rubber with seat facing out by starting at a slight angle first, then pushing away and down simultaneously. The rubber rings should not be folded over during the operation. Make certain that both the rubber and ceramic are "bottomed" squarely.
9. Clean both seal surfaces with a clean lintless cloth.
10. Place a few drops of oil along the impeller shaft and push slowly with a twisting motion through ceramic part into bracket and spring coupling.
11. While holding impeller and shaft with seal faces mating, insert an Allen wrench into one of the set screws in the coupling, extend spring — 3/16".
12. Remove old body gasket, clean surfaces and replace with new gasket.
13. Place entire assembly into body, replace and tighten bolts gradually and evenly all around.
14. Refill system. If water leaks from weep hole in bracket increase tension on spring coupling slightly more or until leak stops.
15. Rewire motor.

REPLACEMENT PARTS LIST	
NUMBER **104-003**	Effective: April 15, 1987 Supersedes: PL100-1.2 dated 6/1/83

REPLACEMENT PARTS FOR 110 Through 120

REFER TO 103-012 for LIST PRICES



PARTS FOR 110 to 120 CIRCULATORS

NAMEPLATE MODEL NO.	ITEM 8 BODY	ITEM 25 IMPELLER & SHAFT	ITEM 31 MOTOR	ITEM 74 BEARING BRACKET	ITEM 161 GASKETS
CAST IRON					
HC, 110, 110C	110-226RP	110-207RP	110-223RP	110-361RP	110-127RP
HDH, 111, 111C	111-004RP	111-053RP	110-185RP	111-058RP	110-127RP
112	110-226RP	112-043RP	112-074RP	112-120RP	110-127RP
113	113-001RP	113-009RP	110-185RP	113-013RP	110-127RP
120-1 to 120-5	N/A	120-056RP	120-105RP	120-076RP	120-073RP
120-6 to 120-12	120-083RP	120-038RP	120-105RP	120-067RP	120-073RP
CAST IRON WITH NON-FERROUS IMPELLER					
112C	110-226RP	112-055RP	112-074RP	112-103BRP	110-127RP
113C	113-001RP	113-009RP	110-185RP	113-013RP	110-127RP
120C-1 to 120C-5	N/A	120-060RP	120-105RP	120-078RP	120-073RP
120C-6 to 120C-12	120-083RP	120-054RP	120-105RP	120-069RP	120-073RP
BRONZE					
HCB, 110B	110-226BRP	110-207RP	110-223RP	110-362BRP	110-127RP
111B	111-004BRP	111-053RP	110-185RP	111-059BRP	110-127RP
112B	110-226BRP	112-055RP	112-074RP	112-103BRP	110-127RP
113B	113-001BRP	113-009RP	110-185RP	113-012BRP	110-127RP
117B	N/A	110-207RP	110-223RP	110-362BRP	110-127RP
117B-S2, -S3	N/A	110-207RP	110-223RP	110-362BRP	110-127RP
120B-1 to 120B-5	N/A	120-060RP	120-105RP	120-077BRP	120-073RP
120B-6 to 120B-12	120-083BRP	120-054RP	120-105RP	120-068BRP	120-073RP

ITEM 29 –
Water Seal 110-275RP

ITEM 56 –
Coupler, 110-009RP

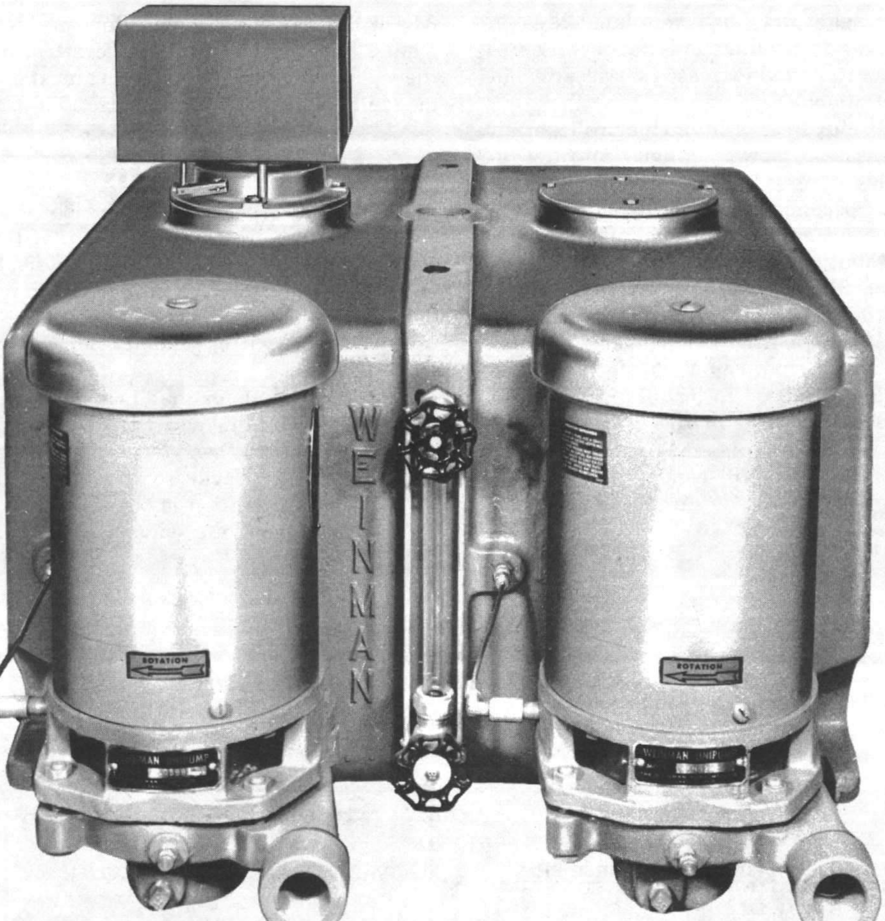
ITEM –
Flange Set
¾", 1", 1¼", & 1½"
Interchangeable.
Refer to Price Sheets 103-003. For 120 models with 2 holes, specify 1600-032BRP for Bronze, 1600-032RP for Cast Iron.

For 120 models with 4 holes, specify 120-044RP for Cast Iron, 120-044BRP for Bronze.

for quality, efficiency, dependability...

WEINMAN

CONDENSATE RETURN AND BOILER FEED UNITS TYPES ACV, ACKV, AEV, AEKV, ADV and AFV



INSTALLATION and OPERATING INSTRUCTIONS

These instructions are important. Please read them thoroughly before installing your Weinman Unit. Quiet, trouble-free operation depends on proper installation and operation procedure. By carefully following the procedure outlined you will insure top performance from your Weinman equipment over a long period of time.

Keep these instructions on hand for future reference, along with the enclosed parts list which will be of help to you should you need replacement parts.

Mueller Pump
AERMOTOR-MIDLAND-WEINMAN
A MUELLER COMPANY
P.O. Box 1364 Commerce & Exchange
Conway, Arkansas 72032 501-329-9811

Section Nos. 900 and 910

How to install, maintain and operate WEINMAN Condensate Return and Boiler Feed Units

Your Weinman Condensate Return and Boiler Feed Units are precision designed and built with quality materials and fine workmanship to warrant superior performance under the toughest operating conditions. To insure continued successful operation it is essential the following installation, maintenance and operation instructions be followed in every detail.

INSTALLATION

STEP 1: Choose a clean, dry, well ventilated area in which to install your unit. This not only assures proper operation and increased service life, but speeds maintenance.

STEP 2: Install the unit in a position that will permit the condensate to flow by gravity into the receiver. This eliminates the possibility of the return lines becoming moisture laden, thus preventing the system from freeing itself of air.

STEP 3: After installation, be certain the unit is perfectly level. Shim it when necessary to level.

STEP 4: Connect the discharge piping carefully. Be sure that it is supported independently to prevent pipe strain from being transferred to the pump casing. It's good to install a union, gate valve, and check valve in the discharge line.

STEP 5: Hook up the return piping making certain that it slopes slightly toward condensate receiver.

STEP 6: Install the vent piping. Be sure it is open to the atmosphere at all times.

WIRING

Check the motor nameplate for specific wiring requirements. For safe and proper operation, fuses installed in the safety switches and all wiring must conform to recommendations of the National Electrical Code.

PUMP ROTATION

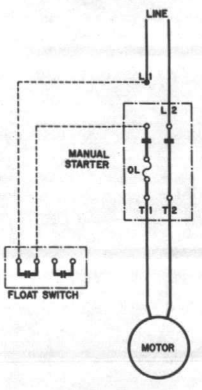
Pump rotation is clockwise as you look down on the pump. Single phase motors are wired so that they rotate clockwise automatically. Three phase motors, however, should be checked carefully for proper rotation prior to operation. To do this:

1. Connect wiring leads to pump motor in the usual manner.
2. Start the motor the first time by just touching the starter button and then stopping the motor immediately. When you do this check the pump shaft for proper clockwise rotation.
3. If pump rotation is counter-clockwise, switch any two of the motor wires to obtain proper rotation.

TYPICAL WIRING DIAGRAMS

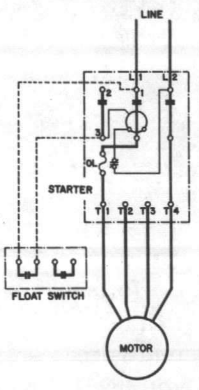
FLOAT SWITCH

SINGLE PHASE MANUAL STARTER



When using manual starter with three position selector switch (Hand-Off-Auto), connect line L1 to "Hand" terminal of switch, and float switch in series to "Auto" terminal and to line L1.

SINGLE PHASE MAGNETIC STARTER

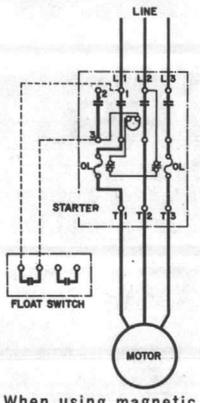


When using magnetic starter with three position selector switch (Hand-Off-Auto), connect float switch to terminals 1 and 2.

For low voltage, connect terminals T1 to T2, and T3 to T4.

For high voltage, connect terminal T2 to T3.

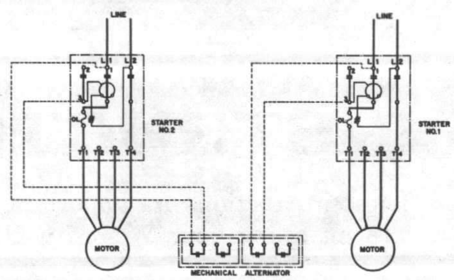
THREE PHASE MAGNETIC STARTER



When using magnetic starter with three position selector switch (Hand-Off-Auto), connect float switch to terminals 1 and 2.

MECHANICAL ALTERNATOR

SINGLE PHASE MAGNETIC STARTER

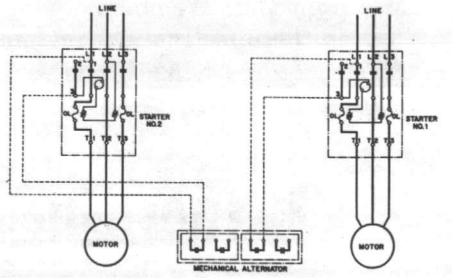


When using magnetic starter with three position selector switch (Hand-Off-Auto), connect alternator to terminals 1 and 2.

For low voltage, connect terminals T1 to T2 and T3 to T4.

For high voltage, connect terminal T2 to T3.

THREE PHASE MAGNETIC STARTER



When using magnetic starter with three position selector switch (Hand-Off-Auto), connect alternator to terminals 1 and 2.

LUBRICATION

Under normal condensate service requirements, lubricate motor bearings about once a year. WARNING! EXCESSIVE GREASING DAMAGES BEARINGS JUST AS QUICKLY AS INSUFFICIENT GREASING. It is essential to use a good grade of grease. Any of the following brands are acceptable for Weinman Pumps:

American Oil Company	Amolith No. 2
Cities Service Oil Company	Trojan H2
Humble Oil & Refining Company	Nebula EP No. 2
Shell Oil Company	Alvania No. 2
Sinclair Refining Company	Litholine 2
Texaco Inc.	Multifak 2
Union Oil Company	UNOBA No. 2

OPERATION

Operation of Weinman Condensate Return and Boiler Feed Units is simple and easy, if you observe these rules in keeping them in proper condition.

New or repaired water systems must be flushed for several days to eliminate all impurities and make sure the entire system is clean. This simple precaution will give you years more of maintenance-free service.

Heating systems should be flushed thoroughly at the start of each heating season for the same reason.

To flush your Weinman Unit . . . remove the drain plug at the receiver and drain the system water into the sewer. If the system water remains dirty after flushing . . . operate it for several days, draining the water into the sewer until it becomes clean.

DISASSEMBLY

Whenever it is necessary to repair the motor or replace the mechanical seal, the pump can be removed from its casing quickly and easily without disturbing the piping.

INSTALLING A NEW MECHANICAL SEAL

CAUTION: This seal is a precision product and should be handled accordingly. Be especially careful not to scratch or chip the lapped sealing faces of the washer and floating seat. If reinstalling a used seal, both sealing faces should be relapped.

INSTALLING STATIONARY ELEMENT

The seat must be seated securely in the seat ring with the lapped face out. The *unlapped* face is marked and correctly assembled when shipped. Oil the seat ring with *light oil* and seat it firmly and squarely. If this cannot be done with the fingers, use a sleeve as shown in Fig. 1, inserting the cardboard shipping disc between the sleeve and the lapped face to prevent scratching sealing face.

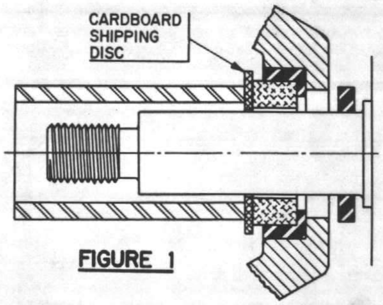


FIGURE 1

INSTALLING ROTATING ELEMENT

Oil shaft with *light oil.* Shaft should be clean and polished smooth. Slide seal body on shaft (washer end *first*) and seat firmly. A sleeve as shown in Fig. 2 will facilitate this operation and prevent the rubber driving ring from pulling out of place as the seal body is slid along the shaft. Assembly of impeller automatically sets seal in proper position.

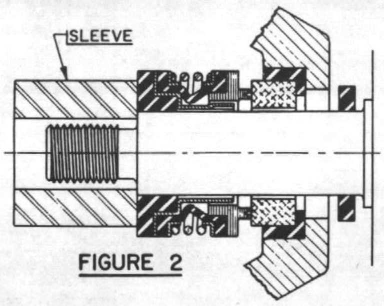
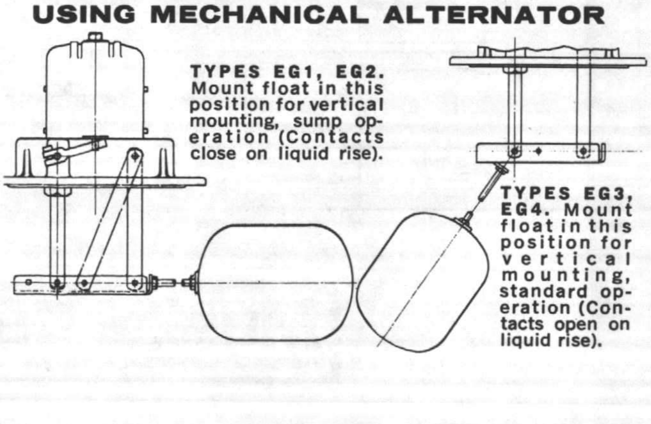


FIGURE 2

Make sure at all times, and particularly before final assembly, that both sealing faces are absolutely clean. Sealing faces should be oiled with clean, light oil.

NEVER RUN THE SEALING FACES DRY. The liquid being handled insures proper lubrication unless other methods of lubrication have been specified. In some cases a short period of operation is required to clear up slight leakage.

REVERSING FLOAT POSITION WHEN USING MECHANICAL ALTERNATOR



TYPES EG1, EG2. Mount float in this position for vertical mounting, sump operation (Contacts close on liquid rise).

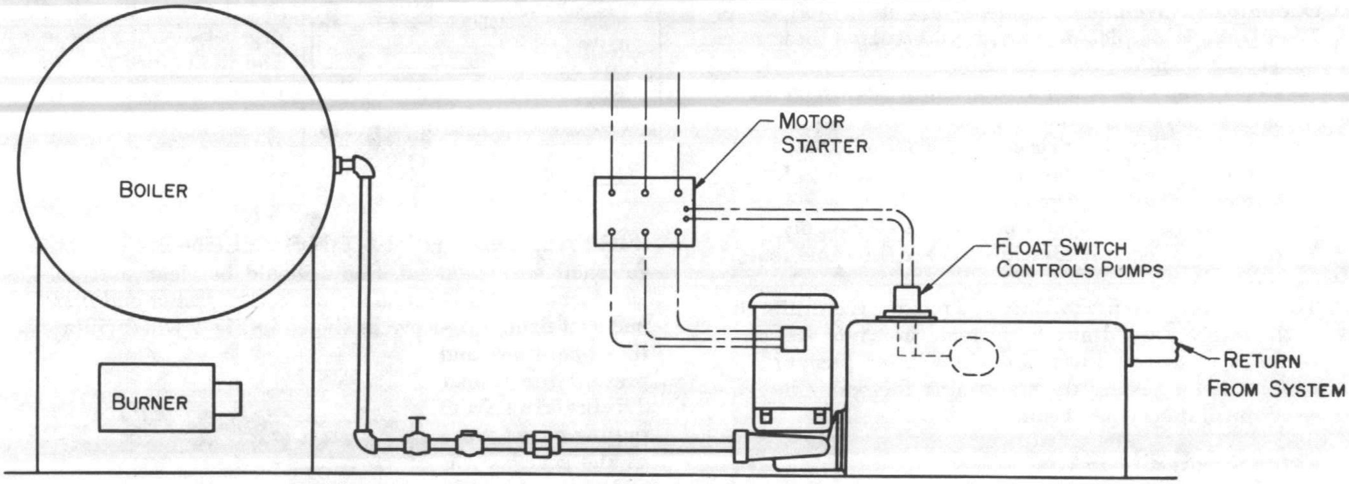
TYPES EG3, EG4. Mount float in this position for vertical mounting, standard operation (Contacts open on liquid rise).

PUMP TROUBLES AND THEIR CAUSES

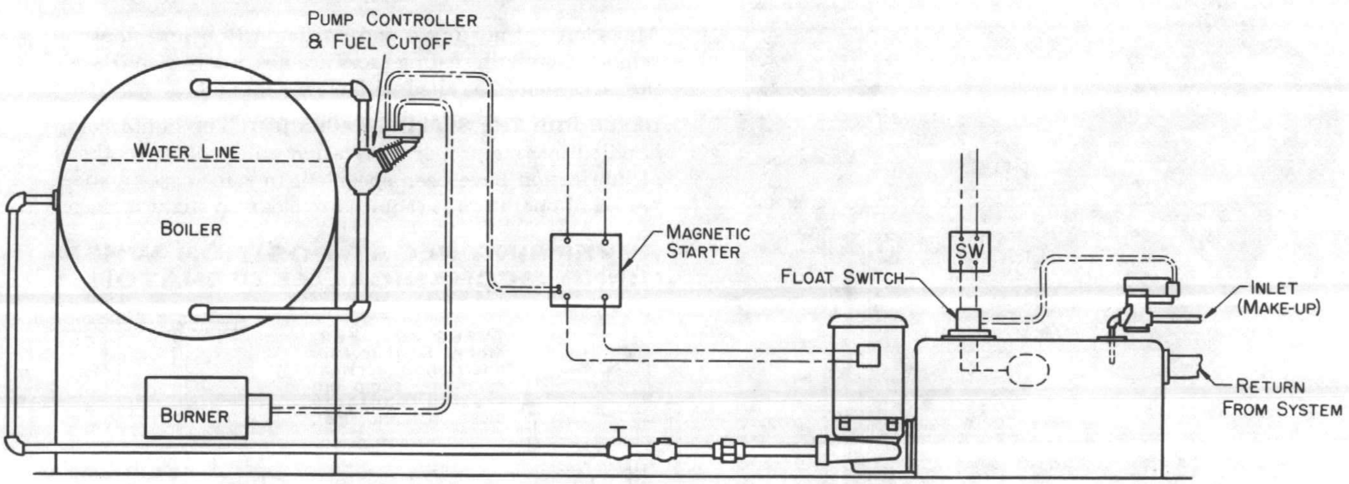
A. Failure to Pump
1. No water in the receiver
2. Rotation in wrong direction
3. Speed too low
4. Return water too hot
5. Total head too high

B. Overloaded Driving Unit
1. Total head too low
2. Unit misalignment (check for piping strains)

CONDENSATE RETURN UNIT CIRCUIT



BOILER FEED UNIT CIRCUIT



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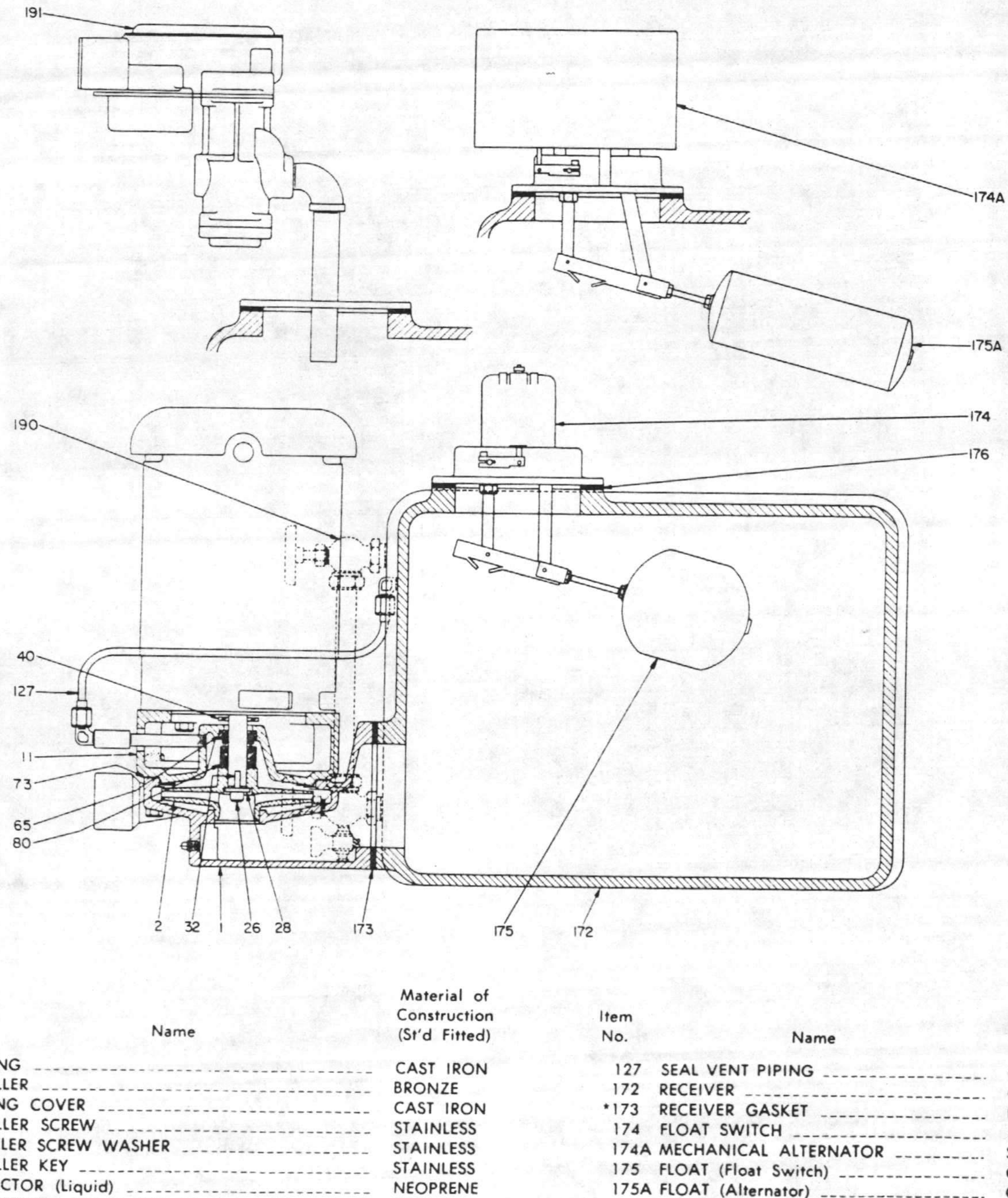
REPAIR PARTS LIST

TYPES "ACV & AEV" VERTICAL CONDENSATE UNIT CAST IRON RECEIVERS (With Type 6 Mechanical Shaft Seal)



Item No.	Name	Material of Construction (St'd Fitted)
1	CASING	CAST IRON
* 2	IMPELLER	BRONZE
11	CASING COVER	CAST IRON
*26	IMPELLER SCREW	STAINLESS
*28	IMPELLER SCREW WASHER	STAINLESS
*32	IMPELLER KEY	STAINLESS
40	DEFLECTOR (Liquid)	NEOPRENE
† *65	MECHANICAL SHAFT SEAL (Stationary Element)	CERAMIC
*73	CASING GASKET	ASBESTOS
† *80	MECHANICAL SHAFT SEAL (Rotating Element)	CARBON

Item No.	Name	Material of Construction (St'd Fitted)
127	SEAL VENT PIPING	COPPER
172	RECEIVER	CAST IRON
*173	RECEIVER GASKET	RUBBER
174	FLOAT SWITCH	Sq. D. #9037
174A	MECHANICAL ALTERNATOR	Sq. D. #9038
175	FLOAT (Float Switch)	COPPER
175A	FLOAT (Alternator)	COPPER
176	FLOAT SWITCH GASKET	RUBBER
190	WATER GAUGE	BRASS
191	MAKE-UP VALVE (When Specified)	McDonnell #101

* FOR DOMESTIC SERVICE WE RECOMMEND THESE PARTS BE CARRIED IN STOCK AS SPARES.

† FURNISHED ONLY IN PAIRS AS COMPLETE UNIT.

WHEN WRITING THE FACTORY REGARDING YOUR PUMP — ALWAYS INCLUDE SERIAL NUMBER

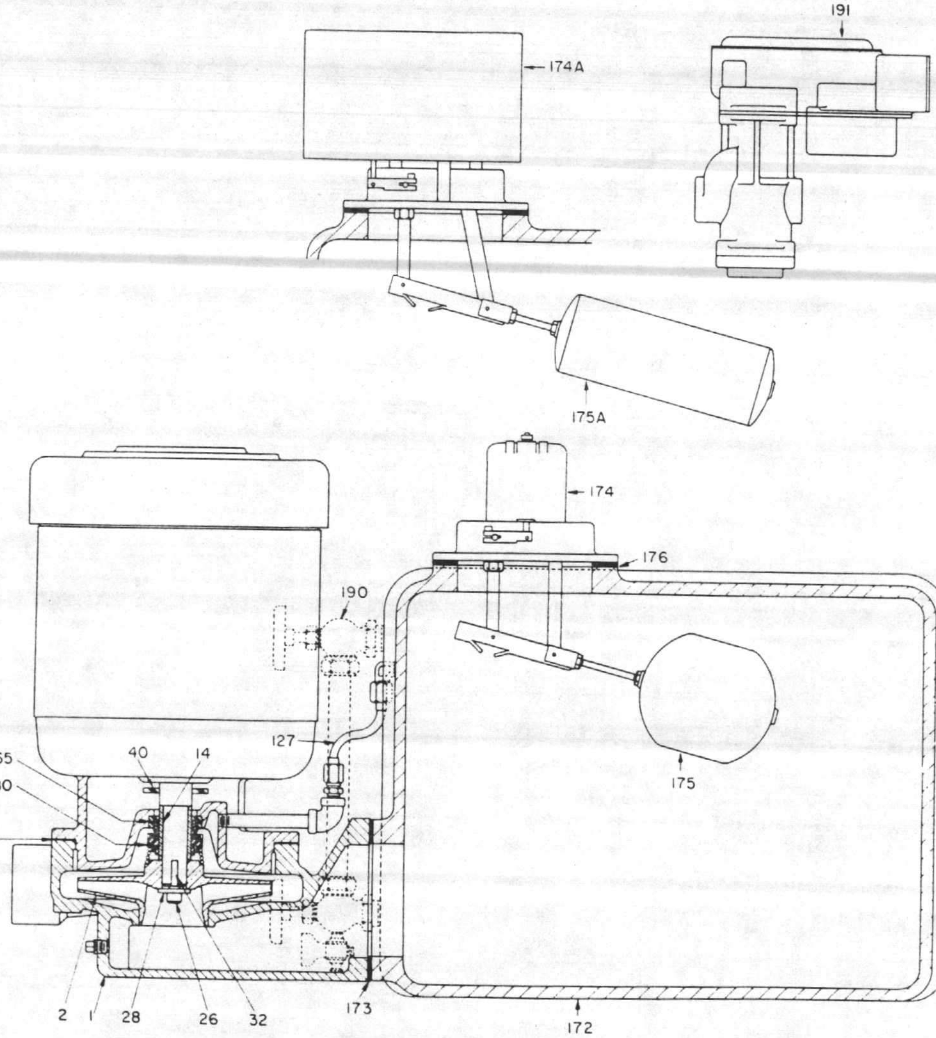
Supersedes Section No. 900, Page 501
Dated January 1972

WEINMAN

Mueller Pump
AERMOTOR-MIDLAND-WEINMAN
A MUELLER COMPANY
P.O. Box 1364 Commerce & Exchange
Conway, Arkansas 72032 501-329-9811

REPAIR PARTS LIST

TYPES "ACV & AEV" VERTICAL CONDENSATE UNIT CAST IRON RECEIVERS (With Type 21 Mechanical Shaft Seal)



Item No.	Name	Material of Construction (St'd Fitted)
1	CASING	CAST IRON
* 2	IMPELLER	BRONZE
*14	SHAFT SLEEVE	BRONZE
*26	IMPELLER SCREW	STAINLESS
*28	IMPELLER SCREW WASHER	STAINLESS
*32	IMPELLER KEY	STAINLESS
40	DEFLECTOR (Liquid)	NEOPRENE
† *65	MECHANICAL SHAFT SEAL (Stationary Element)	CERAMIC
*73	CASING GASKET	ASBESTOS
† *80	MECHANICAL SHAFT SEAL (Rotating Element)	CARBON
127	SEAL VENT PIPING	COPPER
172	RECEIVER	CAST IRON
*173	RECEIVER GASKET	RUBBER
174	FLOAT SWITCH	Sq. D. #9037
174A	MECHANICAL ALTERNATOR	Sq. D. #9038
175	FLOAT (Float Switch)	COPPER
175A	FLOAT (Alternator)	COPPER
176	FLOAT SWITCH GASKET	RUBBER
190	WATER GAUGE	BRASS
191	MAKE-UP VALVE (When Specified)	McDonnell #101

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WHEN WRITING THE FACTORY REGARDING YOUR PUMP — ALWAYS INCLUDE SERIAL NUMBER

Supersedes March 26, 1962 Issue

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Taco	INSTRUCTION SHEET
NUMBER IS-400-1.1 (281)	Effective: March 1, 1981 Supersedes: IS400-2-1 dated 7/30/76

AIR CONTROL

1 — Select proper size based on flow (GPM) thru System

Taco Air Control Less Strainer	Maximum Flow GPM	Taco Air Control With Strainer
AC2	80	AC2F
AC25	130	AC25F
AC3	190	AC3F
AC4	330	AC4F
AC5	550	AC5F
AC6	900	AC6F
AC8	1500	AC8F
AC10	2600	AC10F
AC12	3400	AC12F
AC14	4700	AC14F
AC16	6000	AC16F
AC18	8000	AC18F
AC20	10000	AC20F

2 — Install Air Control in Supply Line between boiler and pump(s) as indicated in Diagram on reverse side.

3 — Install Expansion Tank (s) as close to Air Control as possible with horizontal pipe (if any) pitching up to tank.

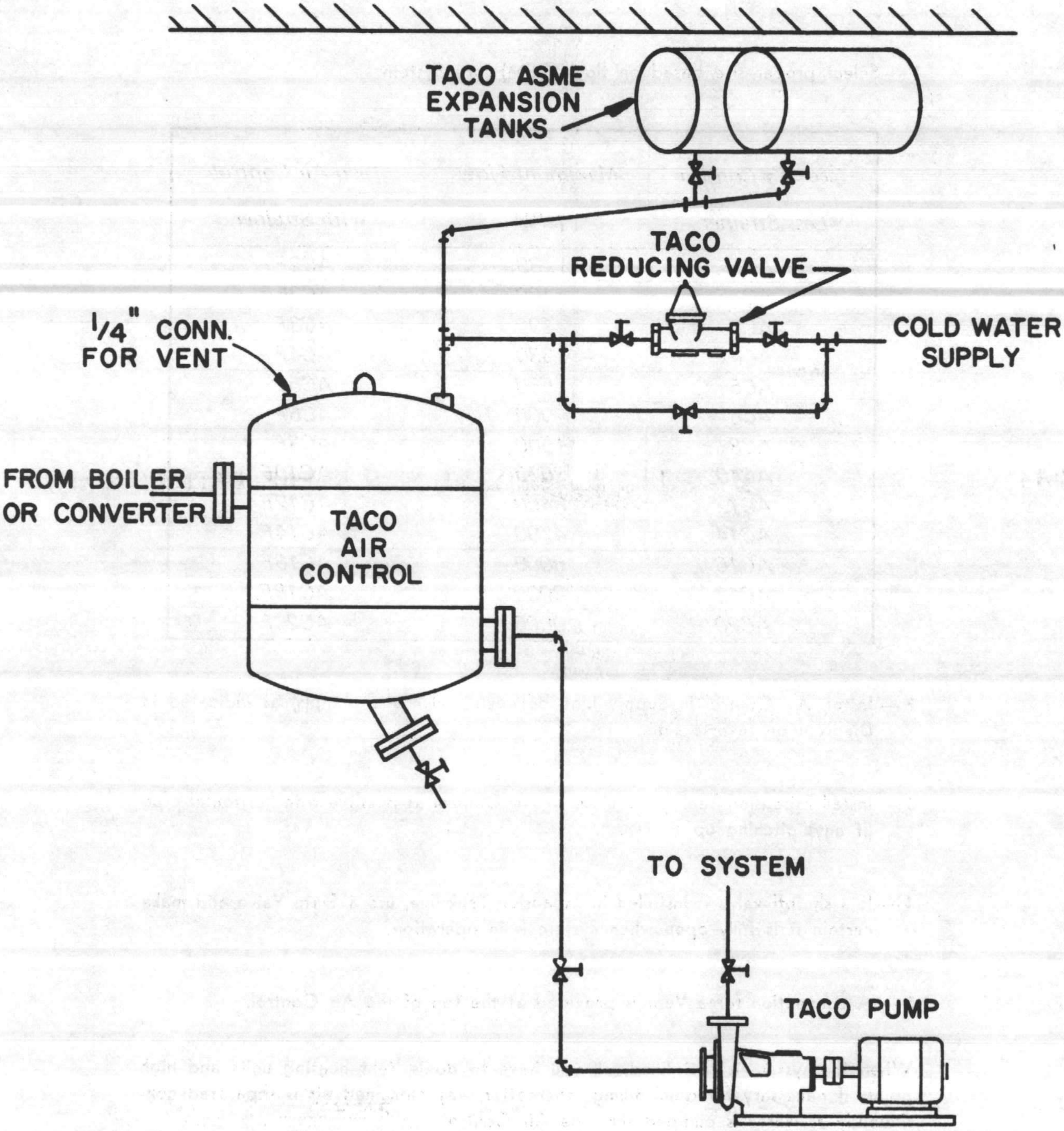
4 — If a shutoff valve is installed in Expansion Tank line, use a Gate Valve and make certain it is fully open when system is in operation.

5 — A connection for a Vent is provided at the top of the Air Control.

When the system is first filled, all you have to do is Vent heating units and high points if necessary for quick filling. Thereafter, any entrained air is separated continuously as water is pumped thru the Air Control.

Taco, Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone: (401) 942-8000 Telex: 92-7627
Litho in U.S.A.
Taco (Canada) Ltd. 3090 Lenworth Drive, Mississauga, Ontario Telephone: (416) 625-2160 Telex: 06-961179

AIR CONTROL



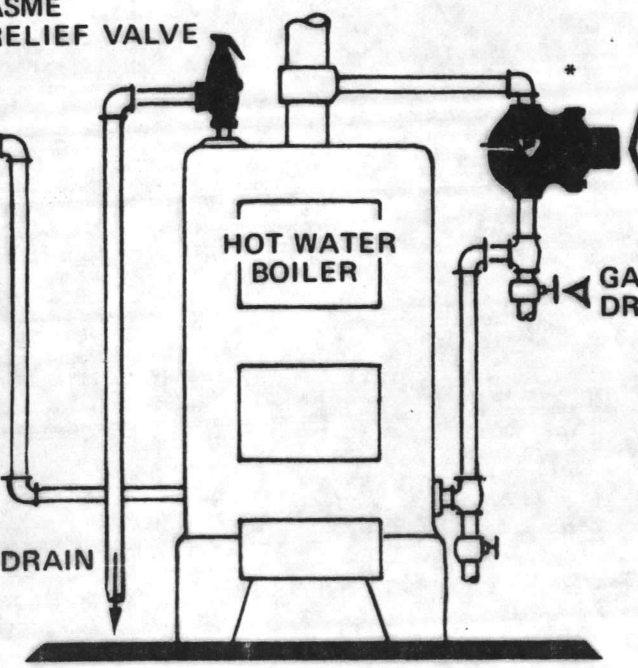
TACO ASME
EXPANSION
TANKS
TACO
REDUCING VALVE
COLD WATER
SUPPLY
1/4" CONN.
FOR VENT
FROM BOILER
OR CONVERTER
TACO
AIR
CONTROL
TO SYSTEM
TACO PUMP

Taco	INSTRUCTION SHEET
NUMBER IS-100-2.2A	Effective: May 1, 1983 Supersedes: IS100-2.2A dated 8/1/81

TACO REDUCING VALVE PRESSURE REGULATORS

INSTRUCTIONS FOR INSTALLING

INSTALLATION DIAGRAM



DUAL CONTROL SERVICE

The installation of a separate Feed Water Pressure Regulator and an ASME Pressure Relief Valve provides the dual service accomplished by a dual control Hot Water Heating Regulator (see reverse side) and, in addition conforms to the ASME requirements for low pressure heating boilers. (Many state and local regulations are based on ASME boiler codes.) Where local or state codes are in effect, installations must be in compliance.

*The use of a low water cut-off is strongly recommended for protection against a low water level condition in the boiler which could result from continuous firing should controls become inoperative or a break occur in the return piping.

FEED WATER PRESSURE REGULATORS

These regulators must be installed in the cold water supply line to the boiler and in a horizontal position. When piping is ready to receive the regulator, flush out the supply pipe to clear it of chips scale, dirt, etc. before installing regulator. Install regulator with the supply line connected to the inlet. Install a shut-off valve ahead of the regulator. Regulator is set to feed water at approximately 15 lbs. pressure. To readjust regulator, follow instruction No. 7 on reverse side of this sheet. These regulators have a strainer screen which should be removed and cleaned at least twice a year.

SERIES WITH FAST FILL AND PURGE LEVER

These valves are equipped with a unique and simple "fast fill and purge lever" . . . which permits rapid filling of the system . . . and sustained flow for air purging.

This advanced design incorporates a removable "push" rod which is actuated by the position of the "purge lever." When the lever is raised to the vertical position, it presses the "push" rod down which manually forces the valve wide open for maximum flow. Returning the lever to its normal position releases tension on the rod permitting the valve to maintain normal pressure in the system automatically.

*LOW WATER CUT-OFF

Install a low water cut-off so that the raised line cast on float chamber body is on a level with the top of the boiler. Top of switch box should be reasonably level. Piping to the top and bottom float chamber connections should conform to that shown on installation diagram. Keep the float chamber clean by periodically opening the valve below the float chamber to flush out mud and sediment. Do this at least once each month.

IMPORTANT:

When water main pressure exceeds 100 lbs. or is variable, a domestic service type water pressure reducing valve should also be installed in addition to this feed valve regulator. This reduces the pressure for accurate, longer life feed valve performance, as well as providing quiet, economical service pressure to the domestic fixtures.

Taco, Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone: (401) 942-8000 Telex: 92-7627

Litho in U.S.A.

Taco (Canada) Ltd. 3090 Lenworth Drive, Mississauga, Ontario Telephone: (416) 625-2160 Telex: 06-961179

TACO HOT WATER
HEATING DUAL CONTROLS

INSTRUCTIONS FOR INSTALLING

1. These TACO DUAL CONTROLS must be installed in the cold water supply line to the boiler and in a horizontal position above the top of the boiler as shown on diagram.

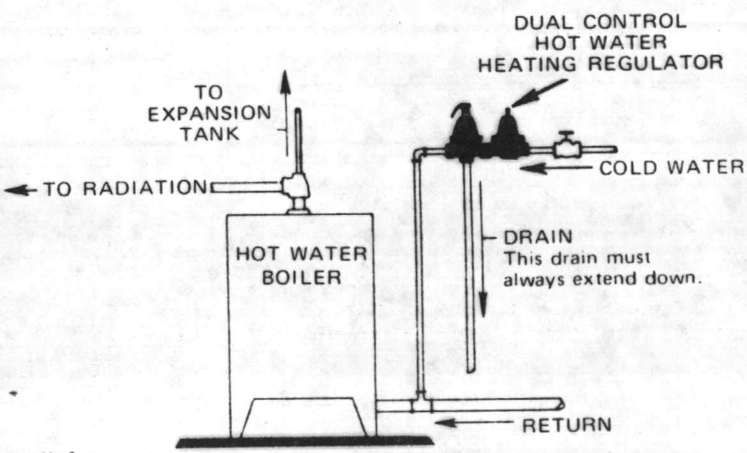
2. When the piping is ready to receive the Regulator, flush out the supply pipe to clear it of chips, scale, dirt, etc. before installing the Regulator.

3. Install the "Regulator" with the supply line connected to the inlet. Install a shut-off valve ahead of the Regulator.

4. Connect a pipe from the "DRAIN" tapping in the relief valve to above some convenient open drain such as a floor drain or set tubs. Always obey local regulations.

   Do not install a valve of any kind in this line. This drain must always pitch down from the regulator. No portion of the drain line should be above the regulator. Drain pipe must not be smaller than the drain tapping provided. The relief valve is non-adjustable and set to relieve at 30 lbs.

INSTALLATION DIAGRAM



IMPORTANT

Please Note Footnote at Bottom of Reverse Side of This Sheet

5. To fill the system, open the shut-off valve ahead of the Regulator. This valve must always be kept open when the system is in operation. Water will flow into the system until it is full and under pressure.

6. The pressure reducing valve of the Regulator is set to deliver water to the boiler at approximately 15 lbs. pressure. This pressure is sufficient for a 3-story building.

7. To reset the reducing valve for higher pressure (when the pressure is not sufficient to lift the water to highest radiation), calculate the number of feet from the regulator to the top of highest radiation. Multiply this by .43 and add 3 lbs. This will give the pressure needed to raise the water to the highest radiator and keep it under pressure – loosen lock nut. Turn adjusting screw clockwise slowly until the gauge indicates the pressure calculated. Then lock adjustment.

8. The regulator screen should be cleaned at beginning of each heating season.

9. **The air cushion tank sometimes becomes filled with water (waterlogged). This is usually indicated by dripping of the relief valve when the burner is running. To recharge with air, close gate valve between tank and system and open gate valve in drain pipe. Allow tank to completely drain (this requires from 10 to 15 minutes), then close drain valve and open valve between tank and system.**

TACO HOT WATER
HEATING DUAL CONTROLS

INSTRUCTIONS FOR INSTALLING

INSTALLATION DIAGRAM

1. These TACO DUAL CONTROLS must be installed in the cold water supply line to the boiler in a horizontal position above the top of the boiler as shown on diagram.

the Regulator, then out the ... sure ... dirt ... to the R...

3. Install the Regulator with the ... shut off valve ahead of the Regulator.

4. Connect a pipe from the "DRAIN" opening of the relief valve to ... convenient open drain ... Always obey local regulations.

Do not install a valve of any kind in this line. This ... portion of the ... should be ... the Regulator. Drain pipe must not be smaller than ... opening provided. The relief valve is non-adjustable ...

IMPORTANT
Please Note Footnote on Reverse Side of This Sheet

5. To fill the system, open the shut off valve ahead of the Regulator. This valve must always be kept open when the system is in operation. Water will flow into the system until it is full and under pressure.

6. The pressure reducing valve of the Regulator is set to deliver water to the boiler at approximately 15 lbs. pressure. This pressure is sufficient for a three story building.

7. To reset the reducing valve for higher pressure (when the pressure is not sufficient to fill the ... highest radiation), calculate the number of feet from the Regulator to the top of highest radiation. Multiply this by .43 and add 3 lbs. This will be the ... needed to raise the water to ... Turn the adjusting screw clockwise slowly until the gauge indicates the pressure calculated ... adjustment.

8. The Regulator screen should be cleaned at beginning of each heating season.

9. The expansion tank sometimes becomes filled with water (waterlogged). This is usually indicated by dripping of the relief valve when the burner is running. To recharge with air, close gate valve between tank and system and open gate valve in drain pipe. Allow tank to completely drain (this requires from 10 to 15 minutes), then close drain valve and open valve between tank and system.

Taco Instruction Sheet

402-002

CA & CAX Expansion Tanks

Plant I.D. No. 001-398

1. Note location on the tank of the system connection, charging valve enclosure, and the drain plug. Note labels on the tank or refer to Diagram #1 – Location of Tank Fittings.

2. Carefully start to unscrew the shipping pipe-plug in the system connection coupling located at the center of the cover flange. Pause before completely removing to allow any trapped air to escape without "popping" the plug. There should not be much, if any, air pressure under this plug.

3. Remove the 1½" pipe plug covering the charging valve enclosure.

CAUTION: DO NOT REMOVE THE PIPE PLUGS LOCATED ON THE SIDE AND BOTTOM OF THE TANK (TANK DRAINS). THESE PLUGS SHOULD NEVER BE REMOVED UNLESS NECESSARY AND THEN ONLY AFTER THE AIR PRESSURE IN THE TANK HAS BEEN BLED OFF TO ZERO GAUGE PRESSURE. BEFORE BLEEDING OFF ANY OF THE AIR CHARGE ALWAYS ISOLATE THE TANK FROM THE SYSTEM WITH A SHUT-OFF VALVE.

CA Tanks

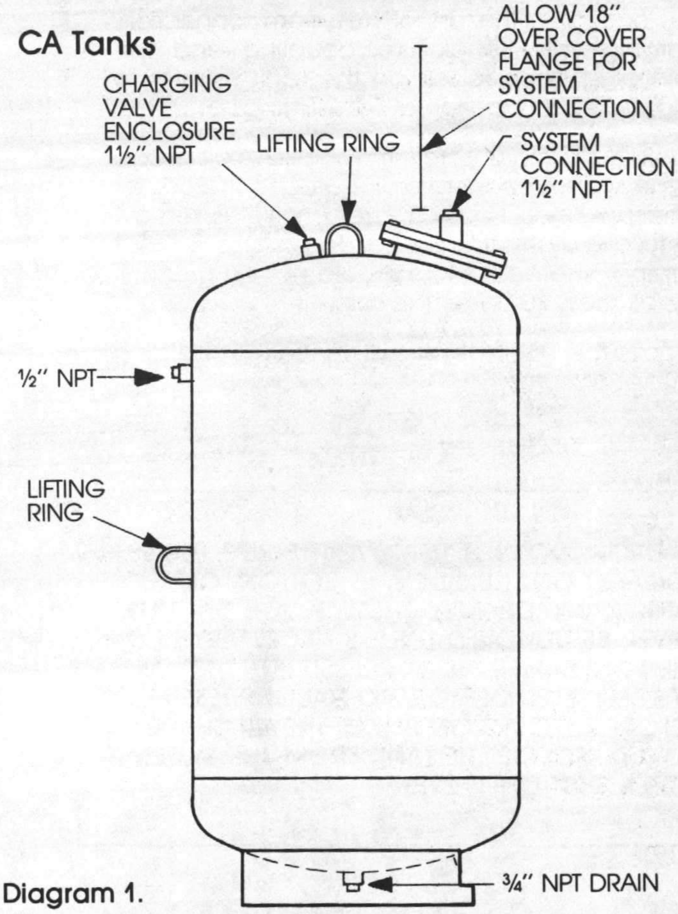


Diagram 1.

4. Before making any connections to the tank, check the tank air charge. Use an accurate automotive or similar type gauge on the air valve located under the pipe plug in step #3. The air charge pressure must be equal to the pre-charge pressure specified for the system. Refer to the label on the tank for the specified tank pre-charge pressure. In most cases the specified tank pre-charge pressure is equal to the system fill pressure at the tank location. Use Diagram #3 Air Charge Check Chart to correct the value read on the pressure gauge for the ambient temperature at the tank location.

5. After making sure that the air charge pressure is correct, replace the pipe plug over the charging valve for protection.

6. The pipe connection to the system may now be made. The piping requirements for captive air tanks are different from those of plain steel expansion tanks, note the Captive Air Tank Piping Diagrams. Piping and air elimination devices should be arranged so that air will not be trapped in the tank, above the tank, or in the nozzle. Pitch the piping connection up away from the tank and use automatic air vents where necessary, note the piping diagram.

7. Locate the CA tank connection as close as possible to the suction side of the pump. This ensures that the pressures realized from the pump head will be additive in the system. A combination shut-off and drain valve should located in the connection piping to provide for tank isolation during the initial hydrostatic test.

Quality Through Design — COMPARE.

TACO INC., 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone (401) 942-8000 Telex 92-7627
TACO (Canada) Ltd. 1310 Aimco Blvd., Mississauga, Ontario L4W 1B2 Telephone (416) 625-2160 Telex 06-961179

CAX TANKS

1. Note location of the tank of the system connection, charging valve enclosure, coupling and the drain plug. Note labels on the tank or refer to Diagram #2 – Location of Tank Fittings.
2. Carefully start to unscrew the shipping pipe-cap on the system connection located in the center of the tank head. Pause before completely removing to allow any trapped air to escape without "poping" the cap. There should not be much, if any, air pressure under this cap.
3. Remove the 1½" pipe plug covering the charging valve enclosure.

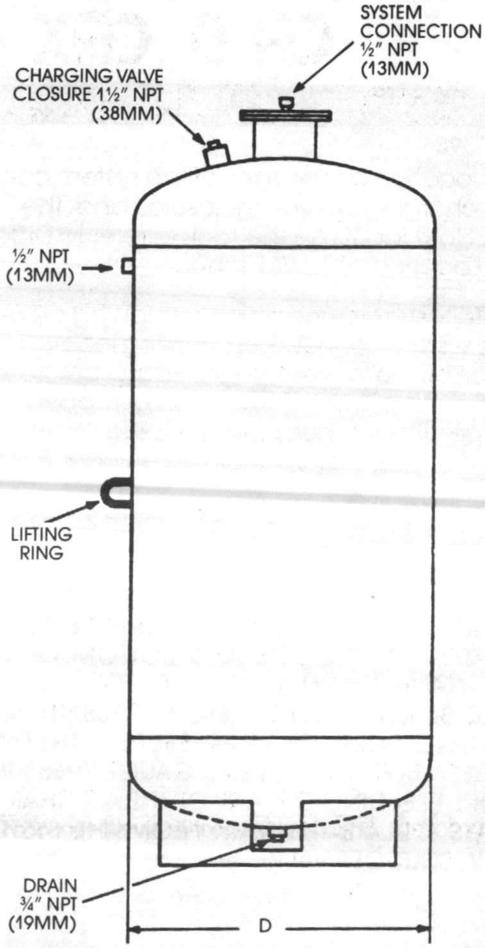


Diagram 2.

CAUTION: DO NOT REMOVE THE PIPE PLUGS LOCATED ON THE SIDE AND BOTTOM ON THE TANK (TANK DRAINS). THESE PLUGS SHOULD NEVER BE REMOVED UNLESS NECESSARY AND THEN ONLY AFTER THE AIR PRESSURE IN THE TANK HAS BEEN BLED OFF TO ZERO GAUGE PRESSURE. BEFORE BLEEDING OFF ANY OF THE AIR CHARGE ALWAYS ISOLATE THE TANK FROM THE SYSTEM WITH A SHUT-OFF VALVE.

4. Before making any connections to the tank, check the tank air charge. Use an accurate automotive or similar type gauge on the air valve located under the pipe plug in step #3. The air charge pressure must be equal to the pre-charge pressure specified for the system. Refer to the label on the tank for the specified pre-charge pressure. In most cases the specified tank pre-charge pressure is equal to the system fill pressure at the tank location. Use diagram #2 Air Charge Check Chart to correct, value read on the pressure gauge for the ambient temperature at the tank location.
5. After making sure that the air charge pressure is correct, replace the pipe plug over the charging valve for protection.
6. The pipe connection to the system may now be made. The piping requirements for captive air tanks are different from those of plain steel expansion tanks, note the Captive Air Tank Piping Diagrams. Piping and air elimination devices should be arranged so that air will not be trapped in the tank, above the tank, or in the nozzle. Pitch the piping connection up away from the tank and use automatic air vents where necessary, note the piping diagram.
7. Locate the CA tank connection as close as practicable to the suction side of the pump. This ensures that the pressures realized from the pump head will be additive in the system. A combination shut-off and drain valve should be located in the connection piping to provide for tank isolation during the initial hydrostatic test.

AIR CHARGE CHECK CHART

Specified Pre Charge Pressure, P.S.I. (at 68°F)	AMBIENT TEMPERATURE, °F								
	36	44	52	60	68	76	84	92	100
12	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.2	13.6
20	17.9	18.4	18.9	19.5	20.0	20.5	21.1	21.6	22.1
30	27.3	28.0	28.6	29.3	30.0	30.7	31.4	32.0	32.7
40	36.7	37.5	38.2	39.2	40.0	40.8	41.6	42.5	43.3
50	46.1	47.1	48.0	49.0	50.0	51.0	52.0	52.9	53.9
60	55.5	56.6	57.7	58.9	60.0	61.1	62.3	63.4	64.5
70	64.9	66.1	67.4	68.7	70.0	71.3	72.6	73.9	75.1

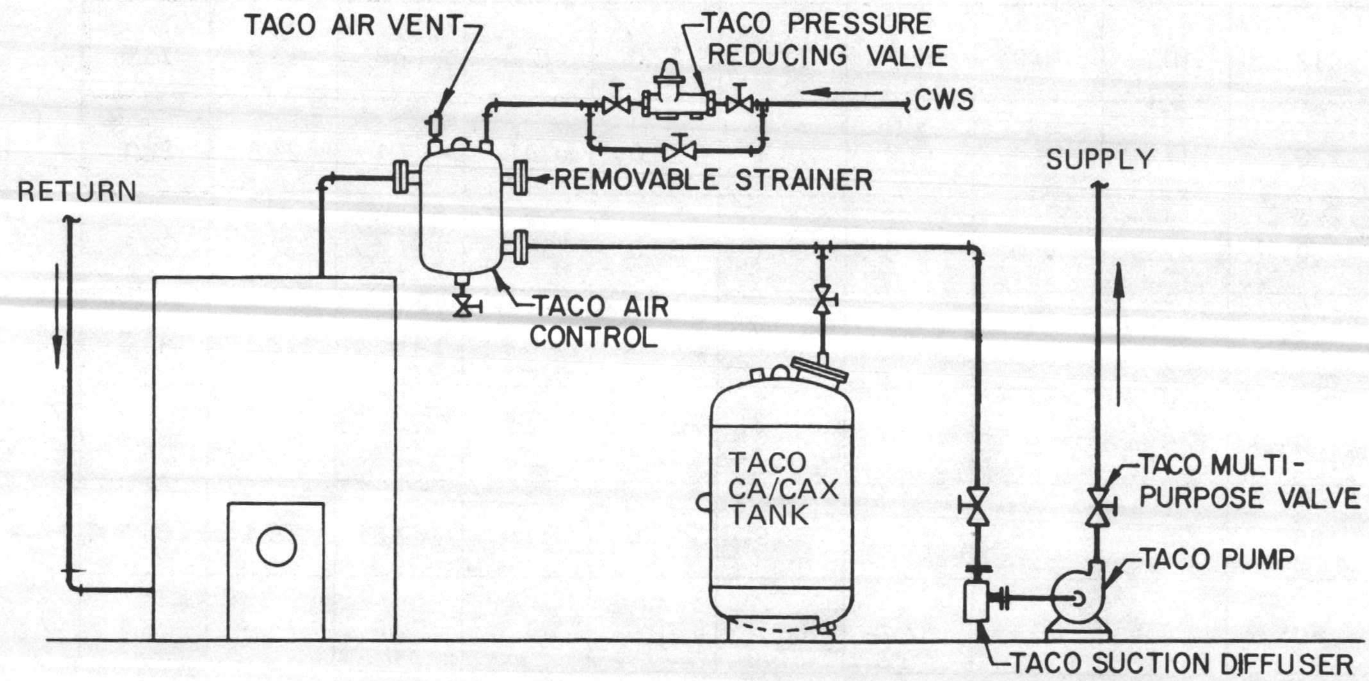
Diagram 3

HOW TO USE THE CHART

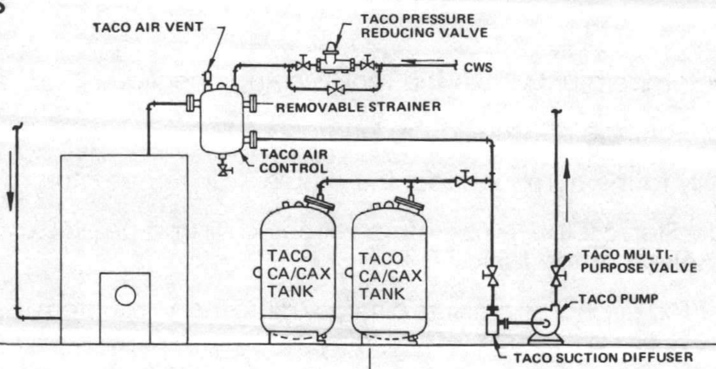
1. Determine abmient air temperature where the tank is being checked.
2. Locate the specified pre-charge pressure in the left hand column.
3. Follow across horizontally to the number under the ambient air temperature.
4. The number found under Step 3 is the temperature corrected air charge pressure in p.s.i. and should agree with the gauge reading observed at the tank.
5. If the temperature corrected air charge pressure differs by more than 1 p.s.i. from the pre-charge pressure specified for the system then correct it by bleeding pressure through the air charge valve, or by adding pressure with an air compressor.

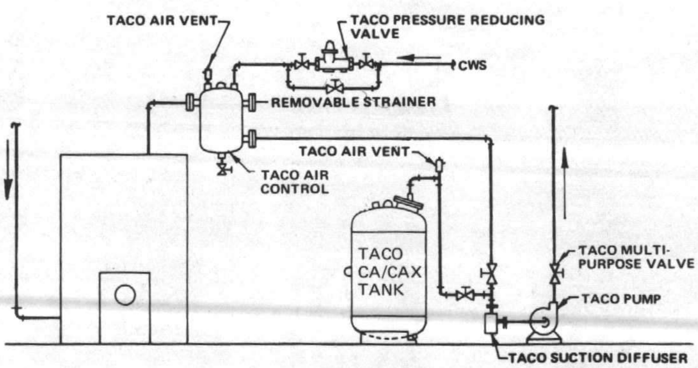
CAPTIVE AIR TANK PIPING DIAGRAMS

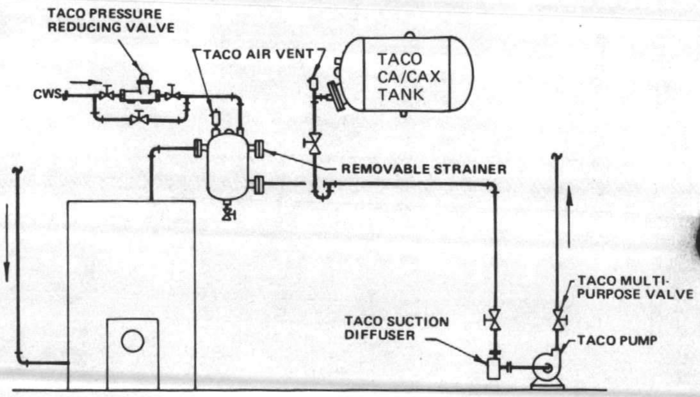
RECOMMENDED LOCATION



ALTERNATE LOCATIONS







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Chet Adams Company

Sales Engineers

HEATING AIR CONDITIONING EQUIPMENT VENTILATING

AIR POLLUTION SYSTEMS ENERGY CONSERVATION

April 7, 1988

MAINTENANCE AND OPERATING INSTRUCTIONS

Project: Headquarters & Maintenance Facility
New River, Jacksonville, NC

Contractor: Sneeden, Inc.
Wilmington, NC

P.O.#

Architect: Blackwell/Hoke

Engineer: Buffaloe, Morgan & Associates

Sales Rep: Chet Adams Company
Cary, NC

Manufacturer: Ilg Industries

EXHAUST FANS

EF-1 1 - CRF 135 Centrirugal direct drive PRV, 2482 CFM @ 5/8" SP, 1 HP, 208/3/60, with birdscreen, backdraft damper, disconnect, and prefab curb.

EF-2 1 - QA 330 Inline centrifugal ceiling ventilator, 268 CFM @ 1/4" SP, 1/20 HP, 120/1/60, with inline adapter, backdraft damper, disconnect, and wall cap.

EF-3 1 - CRF 122 DITTO EF-1 except 947 CFM @ 3/8" SP, 1/8 HP, 120/1/60.

CARY, N.C. 27511 Box 5218 919/851-6331 | GREENSBORO, N.C. 27402 Box 3073 919/273-0566 | CHARLOTTE, N.C. 28299 Box 9158 704/375-4483 | COLUMBIA, S.C. 29210 16 Nob Hill Road 803/798-0602 | CHARLESTON, S.C. 29412 1058 Fort Sumter Dr. 803/762-1045

Chet Adams Company

Sales Engineers

HEATING AIR CONDITIONING EQUIPMENT VENTILATING

AIR POLLUTION SYSTEMS ENERGY CONSERVATION

April 7, 1988

MAINTENANCE AND OPERATING INSTRUCTIONS

Project:	Ground Support Equipment Facilities New River Air Station Jacksonville, NC
Contractor:	Sneeden, Inc. Wilmington, NC
P.O.#	
Architect:	Thomas P. Turner, Jr.
Engineer:	Richard Crockford
Sales Rep:	Chet Adams Company Cary, NC
Manufacturer:	Ilg Industries

FANS

EF-1	1 - CRF 100 Centrifugal direct drive PRV, 570 CFM @ 1/4" SP, 1/10 HP, 120/1/60, with birdscreen, backdraft damper, disconnect switch and speed control.
EF-2	1 - CRF 82 DITTO EF-1 except 360 CFM @ 1/4" SP, 1/25 HP and DOES NOT include speed control.
EF-3	1 - CRF 100 DITTO EF-1 except 476 CFM @ 1/4" SP.
EF-4	1 - CRF 122 DITTO EF-1 except 924 CFM @ 1/4" SP, 1/8 HP.
EF-5,6	2 - CRB 12 Centrifugal belted PRV, 1110 CFM @ 1/4" SP, 1/4 HP, 120/1/60, with birdscreen, backdraft damper and disconnect.
EF-7	1 - CRF 100 DITTO EF-1 except 421 CFM @ 1/4" SP, 1/4 HP, with explosion proof motor and DOES NOT include speed control or disconnect.
EF-8,9,10	3 - CRB 18 DITTO EF-5 except 3798 CFM @ 1/4" SP, 1 HP, 460/3/60.
EF-11	1 - CRF 82 DITTO EF-1 except 200 CFM @ 1/4" SP, 1/25 HP.

FANS (continued)

EF-12 1 - CRF 67 DITTO EF-1 except 150 CFM @ 1/4" SP, 1/70 HP.

EF-13 1 - CRB 12 DITTO EF-5 except 590 CFM @ 1/4" SP, 1/4 HP.

EF-14 1 - CRF 100 DITTO EF-1 except 421 CFM @ 1/4" SP, 1/4 HP, with explosion proof motor and DOES NOT include speed control or disconnect.

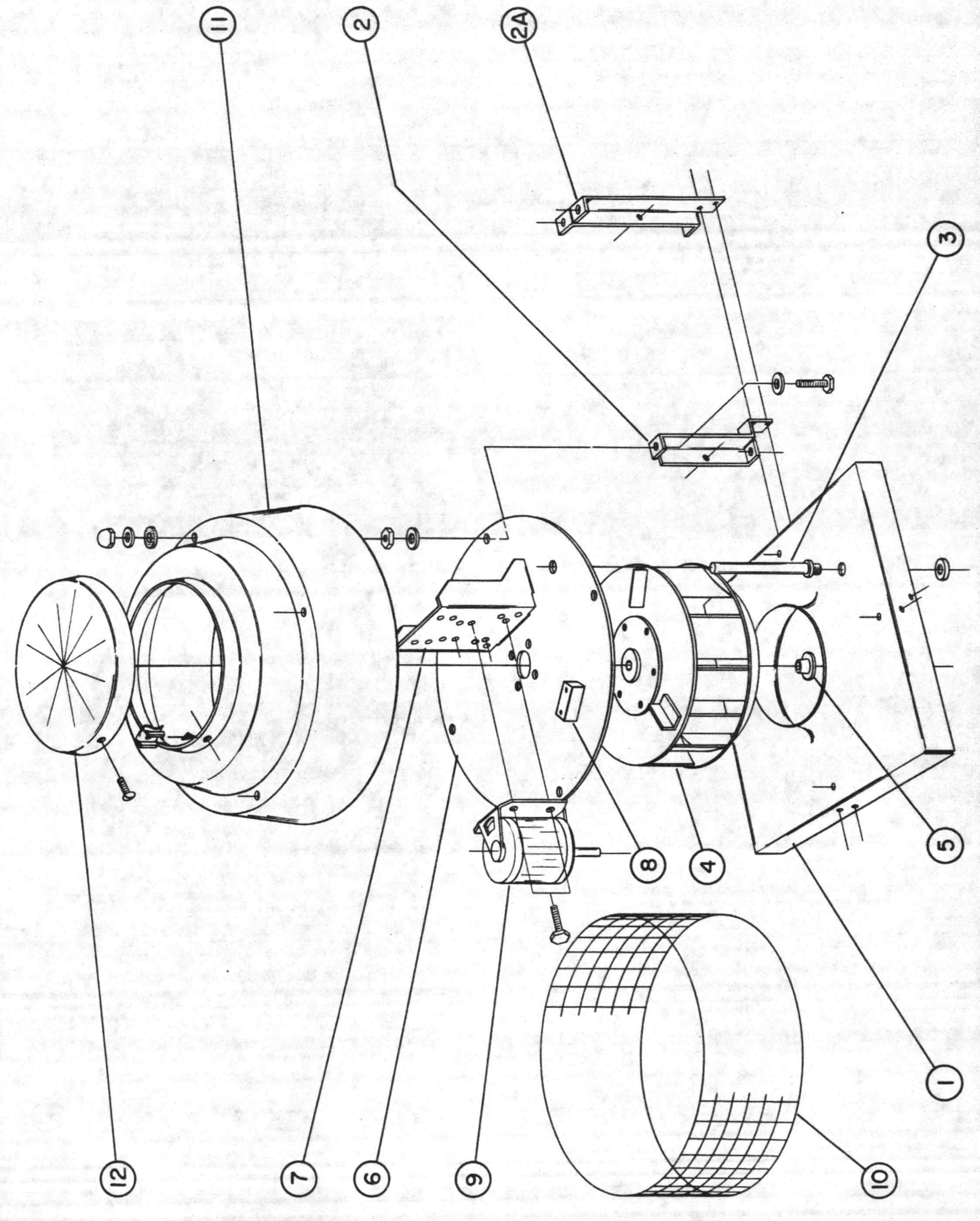
EF-15 1 - CRB 12 DITTO EF-5 except 640 CFM @ 1/4" SP, 1/4 HP.

AN 23741-1

ILG

CRF 122 TO 150 ROOF VENTS.
—BASE MOUNTED MOTORS—

DRAWN BY: AL. LUTZ
DATE: MAY 1985
APPROVED BY: G.R.I.



2850 NORTH PULASKI ROAD, CHICAGO, ILLINOIS 60641

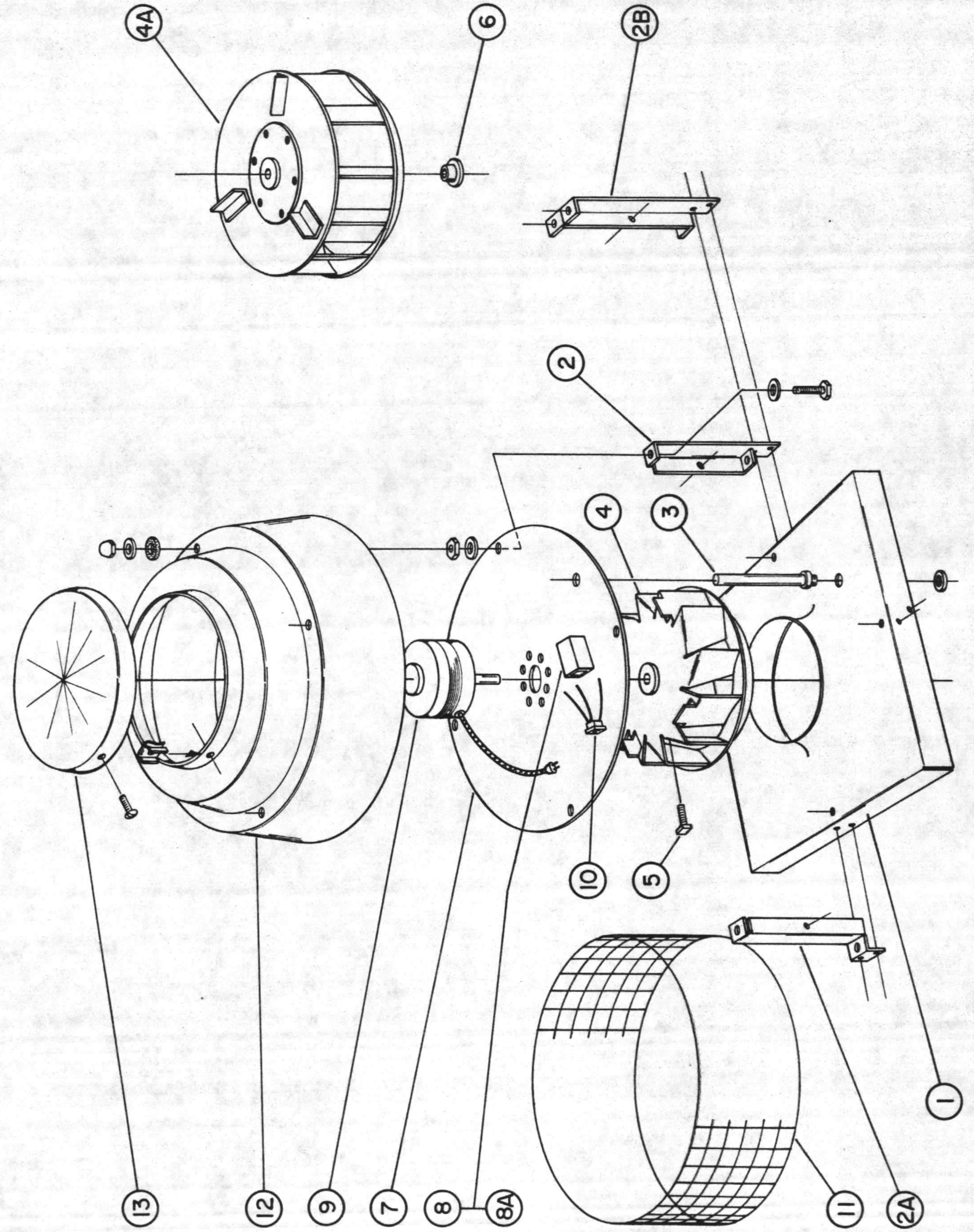
DRAWN LUTZ	1	CREATED	MAY 1985	SHEET 2 OF 2
CHECKED				
DATE MAY 1985	CRF 122 TO 150 ROOF VENTS.—BASE MOUNTED MOTORS—			AN 23741-1

NO.	NAME OF PART		122	135	150
			PART NO.		
1	INLET BASE	CN 21147	2112-1807B	2113-1807B	2115-1805B
2	MOTOR SUPPORT		A2112-5214A	—	—
2A	BRACKET		—	A2113-5210A	
3	CONDUIT & CONNECTOR		A2112-0412A	A2113-0405A	
4	WHEEL ASSEMBLY		B2112-9406C	—	—
		CN 23417	—	2113-9311B	2115-9306C
5	BUSHING	½" BORE	—	8000-0107	8000-0107
		⅝" BORE	8000-0108	8000-0108	8000-0108
		⅞" BORE	—	—	8000-0109
6	MOTOR PLATE		C2112-1117A	C2113-1115B	
7	MOTOR MOUNT		C2112-1116B		
8	DISCONNECT SWITCH SELECTION SHT.		AN 16512		
9	MOTOR		AS SPECIFIED		
10	BIRDSCREEN	BN 20461	8500-4807		
11	ROOF	CN 20448	2112-2412B	2113-2406B	
12	DOME		B2106-2413B		

CRF 67 TO 150 ROOF VENTS. —FACE MOUNTED MOTORS—

ILG

DRAWN BY: AL. LUTZ
DATE: MAY 1985
APPROVED BY: G.R.I.



DRAWN LUTZ	1	CREATED	MAY 1985	
CHECKED				SHEET 2 OF 2
DATE MAY 1985		CRF 67 TO 150 ROOF VENTS. —FACE MOUNTED MOTORS—		AN 23740-1

CRF 67 TO 150 ROOF VENTS. —FACE MOUNTED MOTORS—

NO.	NAME OF PART		67	82	100	122	150
			PART NO.				
1	INLET BASE	CN 21147	2106-1803B	2108-1803B	2110-1803B	2112-1807B	2115-1805B
2	MOTOR SUPPORT BRACKET		A2106-5206A			———	———
2A			———	———	———	A2112-5214A	———
2B			———	———	———	———	A2113-5210A
3	CONDUIT & CONNECTOR		A2106-0405A			A2112-0412A	A2113-0405A
4	WHEEL ASSY. AN 16771	5/16" BORE	2106-9010B	———	———	———	———
		3/8" BORE	———	2108-9006A	———	———	———
		1/2" BORE	2106-9011B	2108-9005A	2110-9005B	———	———
4A	WHEEL ASSY.	———	———	———	———	B2112-9406C	———
		CN 23417	———	———	———	———	2115-9306B
5	SET SCREW, SQ. HD.		1/4-20 × 3/4"			———	———
6	BUSHING		———	———	———	8000-0107	
7	MOTOR PLATE		C2106-1107A			C2112-1117A	C2113-1115B
8	OUTLET BOX & COVER		A2106-1601B & A9919-1700A			———	———
8A	DISCONNECT SWITCH SELECTION SHT.		———	———	———	AN 16512	
9	MOTOR		AS SPECIFIED				
10	RECEPTACLE & TERMINAL ASSY.		AN 21152			———	———
11	BIRDSCREEN	BN 20461	8500-4807				
12	ROOF	CN 20448	2106-2414B			2112-2412B	2113-2406B
13	DOME		B2106-2413B				

ILG

QUIET ACHIEVER

MODEL NO. QA220 & QA330

READ AND SAVE THESE INSTRUCTIONS

1. ALL ELECTRICAL WORK MUST BE DONE IN ACCORDANCE WITH LOCAL AND/OR NATIONAL ELECTRICAL CODE AS APPLICABLE. **FOR SAFETY, THIS PRODUCT MUST BE GROUNDED.** IF YOU ARE UNFAMILIAR WITH METHODS OF INSTALLING ELECTRICAL WIRING, SECURE THE SERVICES OF A QUALIFIED ELECTRICIAN.
2. TURN OFF POWER AT SERVICE ENTRANCE BEFORE INSTALLING, WIRING OR SERVICING THIS PRODUCT.
3. Use only metal duct. DO NOT USE PLASTIC DUCT! Tape all duct connections.
4. **CAUTION: Always vent this product to the outside - NOT into spaces within walls or ceilings, attics, crawl spaces, garages, etc.**
5. To avoid motor bearing damage and noisy and/or unbalanced impellers, keep drywall spray, construction dust, etc. off power unit.
6. Fireplaces, gas furnaces, water heaters and the like, require proper flow of combustion air and exhaust. Make sure this flow is not altered when using any exhaust fan.
7. Your ventilator was designed to be installed in family rooms, offices, bathrooms, conference rooms, and other locations where quiet ventilation is required. When ventilating near cooking equipment, install a range hood or other suitable exhaust fan.
8. This unit is designed to adapt to many different installation requirements. Plan your installation carefully. For various ducting, mounting, and wiring options, see pages 2 and 3. This page shows the most common installation.
9. Please read specification label on product for further information and requirements.

TYPICAL MOUNTING

1. **Provide Frame** - This unit is designed to fit within joists on 16" centers. If ceiling joists are on larger centers, frame in housing location. Provide a solid frame to assure lowest sound levels. See Figure 1 for typical installation.

Brackets are factory set for ½" ceiling thickness. Make sure that housing will be flush with finished ceiling.

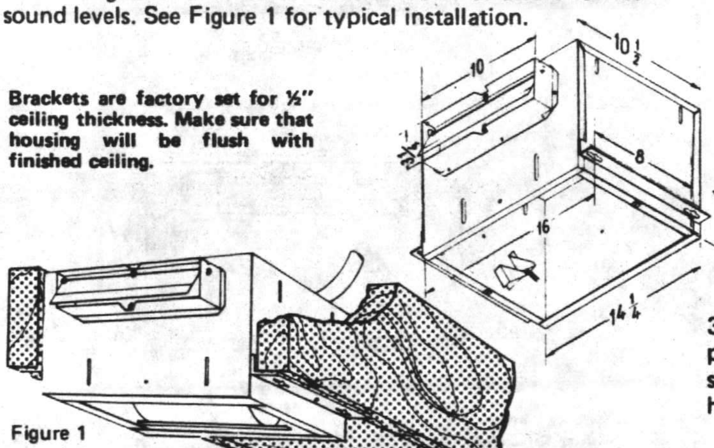


Figure 1

2. **Trace Keyhole Slots** - Hold unit against joists and trace keyhole slots in mounting brackets onto joists. Start screws provided in same end of all traced keyhole openings. Leave about 3/8" of screws projecting from joists. (Fig. 2)

Figure 2

3. **Hang Unit** - Tighten mounting screws as firmly as possible to assure lowest sound levels. For additional support, fasten unit to joists with nail or screw through hole in center of each mounting bracket.

TYPICAL WIRING

SAFETY WARNING
TURN OFF PROPER 120 VOLT CIRCUIT AT THE SERVICE ENTRANCE BEFORE WIRING THE VENTILATOR.
ALL ELECTRICAL CONNECTIONS MUST BE MADE IN ACCORDANCE WITH LOCAL CODES, ORDINANCES, AND NATIONAL ELECTRICAL CODE. IF YOU ARE UNFAMILIAR WITH METHODS OF INSTALLING ELECTRICAL WIRING, SECURE THE SERVICES OF A QUALIFIED ELECTRICIAN.

4. **Wire Unit** - Remove wiring adapter plate, which is located on top of housing (See Fig. 9), and attach electrical cable with appropriate electrical connector. Fasten incoming ground wire (bare or green wire) to adapter plate with green ground screw provided. Connect white wire to white, black wire to black. (Fig. 3) Replace wiring adapter plate so that tab on housing slides through slot on plate. (See Fig. 9)

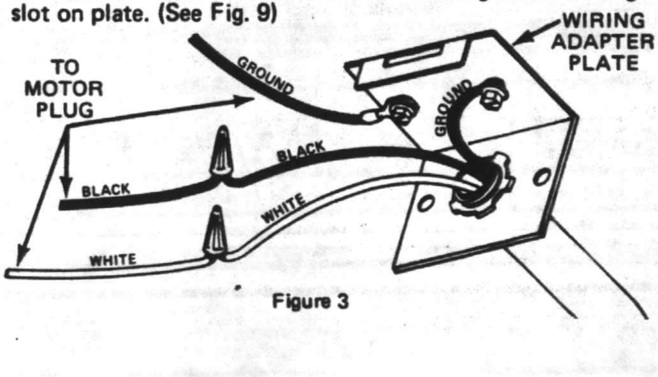


Figure 3

TYPICAL DUCTING

5. **Connect Ductwork** - Connect ductwork to damper/duct connector. Tape all joints with duct tape. (Fig. 4)

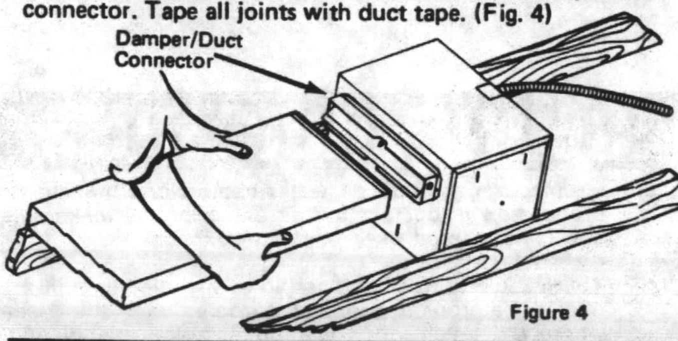


Figure 4

NOTE
MAKE SURE THAT BLOWER DISCHARGE OPENING MATCHES DAMPER POSITION ON VENTILATOR HOUSING.
HOUSING SHOULD BE FLUSH WITH FINISHED CEILING. SEE "To adjust brackets" IN "INSTALLATION OPTIONS" SECTION.

GRILLE MOUNTING

6. Install grille using screws provided. Do not over-tighten.

INSTALLATION OPTIONS

Mounting brackets may be adjusted and/or moved for various types of installations shown below.

To adjust bracket position, loosen 7/16" hex nuts and move brackets up or down. Re-tighten hex nuts securely. (Fig. 5)

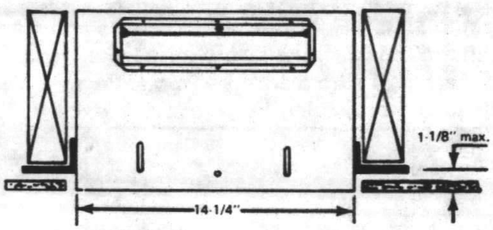
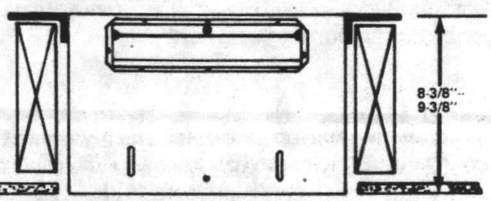


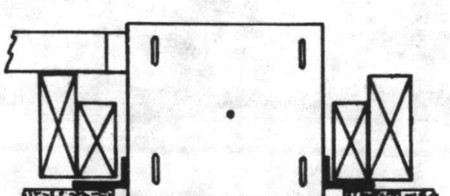
Figure 5

To move brackets, remove 7/16" hex nuts. Re-position brackets on different set of slots. Replace hex nuts and tighten securely. (Fig. 6)



Installation from above finished ceiling.

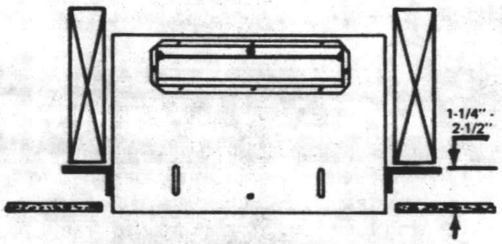
Figure 6A



Installation with ductwork running across joists.

Figure 6B

Reverse brackets to give approximately 1" more clearance. Remove hex nuts, flip brackets over, and replace hex nuts. Tighten nuts securely. (Fig. 7)



Installation with suspended ceiling.

Figure 7A

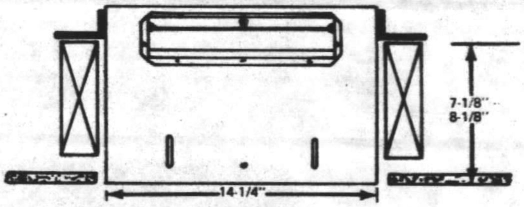


Figure 7B

For in-line installations, remove 7/16" hex nuts. Re-position brackets so that housing opening is at the side instead of the bottom. (Fig. 8)

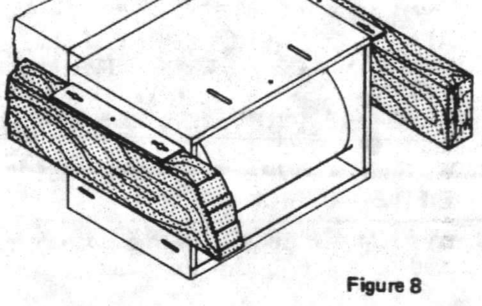


Figure 8

WIRING OPTIONS

If you do not have adequate access to wiring compartment from outside housing, wire unit from inside. Remove blower (described in "Vertical Ducting" section below.) Wiring compartment cover is fastened with two sheet metal screws.

Wiring may enter the unit from top or side. To change wiring adapter plate position, remove sheet metal screws, flip plate over, and replace screw. Make sure that tab on housing slides through slot on plate. (Fig. 9)

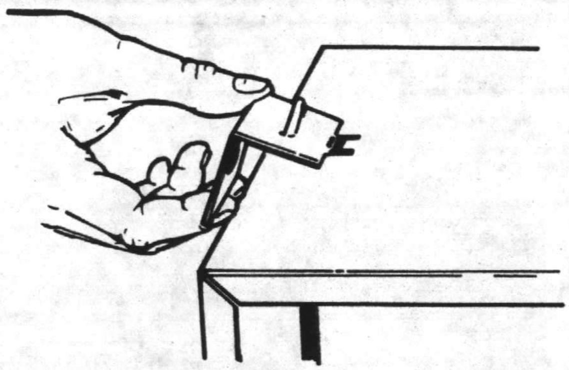


Figure 9

Unit may be installed with a variable speed switch to control fan speed and noise levels. Use a Solid State switch and single-gang switch box. Wire unit as shown in Figure 10.

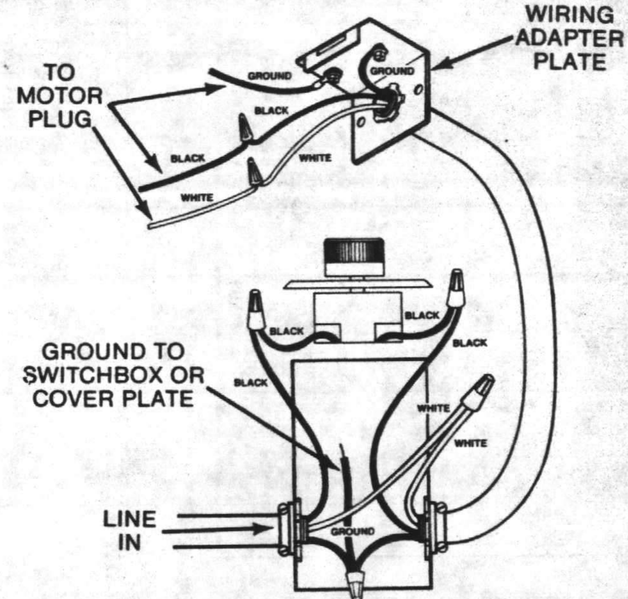
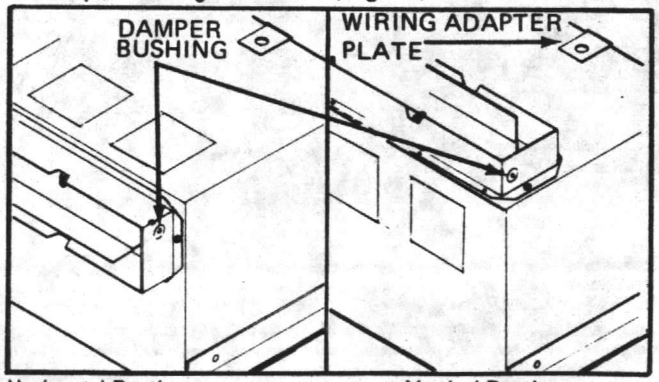


Figure 10

DUCTING OPTIONS

To duct ventilator vertically, change blower as follows:

a.) Remove and install damper on top of unit with damper bushings as shown. (Fig. 11)



Horizontal Ducting
(Unit is shipped in this position)

Vertical Ducting

Figure 11

b.) Unplug electrical connector from blower. Do not pull on plug wires. (Fig. 12)

c.) Remove 7/16" hex nuts holding blower in place.

d.) Lift out blower and line up blower dishcarge with vertical opening. See Figure 13. Do not grasp blower by blower wheel, as wheel may be damaged.

e.) Replace hex nuts and tighten securely.

f.) Plug in blower.

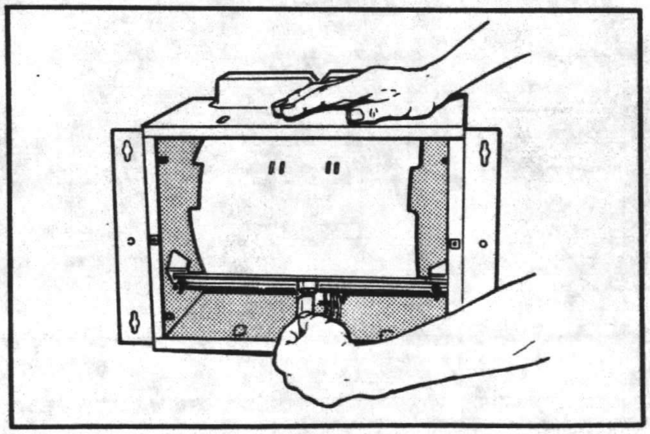


Figure 12

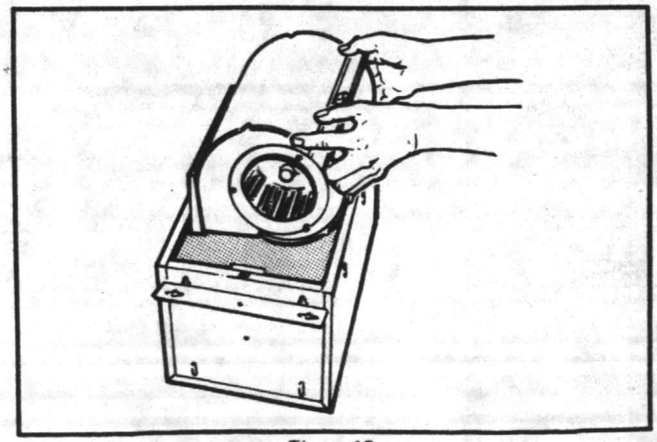


Figure 13

PARTS LIST - QA220 & 330

KEY NO.	PART NO.	DESCRIPTION	QTY.
1	97005594	Damper Assembly	1
2	99170245	#8B x ⅜" Screw	14
3	97006018	Housing Assembly	1
4	99420466	Insulation Mounting Clip	4
5	98005512	Wiring Adapter Plate	1
6	99150471	#10-32 x ½" Ground Screw (Green)	2
7	97006039	Wiring Harness	1
8	97006061	Mounting Bracket Assembly	2
9	99260477	¼—20 Whiz Nut	6
10	99420470	Grille Nut	2
11	98005513	Outlet Box Cover	1
12	99400035	Strain Relief Bushing	1
13	99500317	Wrapper Insulation	1
14	99500316	Side Insulation	2
15	99150417	#8A x ¼" Screw	6
16	98006714	Venturi Ring	2
17	99020014	Blower Wheel, Clockwise	1
18	98005533	Motor Cup	2
19	97007314	Blower Assembly	1
20	99100412	Motor Mounting Rubber	2
21	99080151	Motor QA220	1
	99080152	Motor QA330	1
22	99020015	Blower Wheel - Counterclockwise	1
23	97008164	Grille Assembly	1
24	99150472	#8-18 x 1¼" Screw	2
25	99150480	#10 x .875 Screw*	4

*Standard Hardware, may be purchased local'

WARRANTY AND LIMITATIONS OF LIABILITY

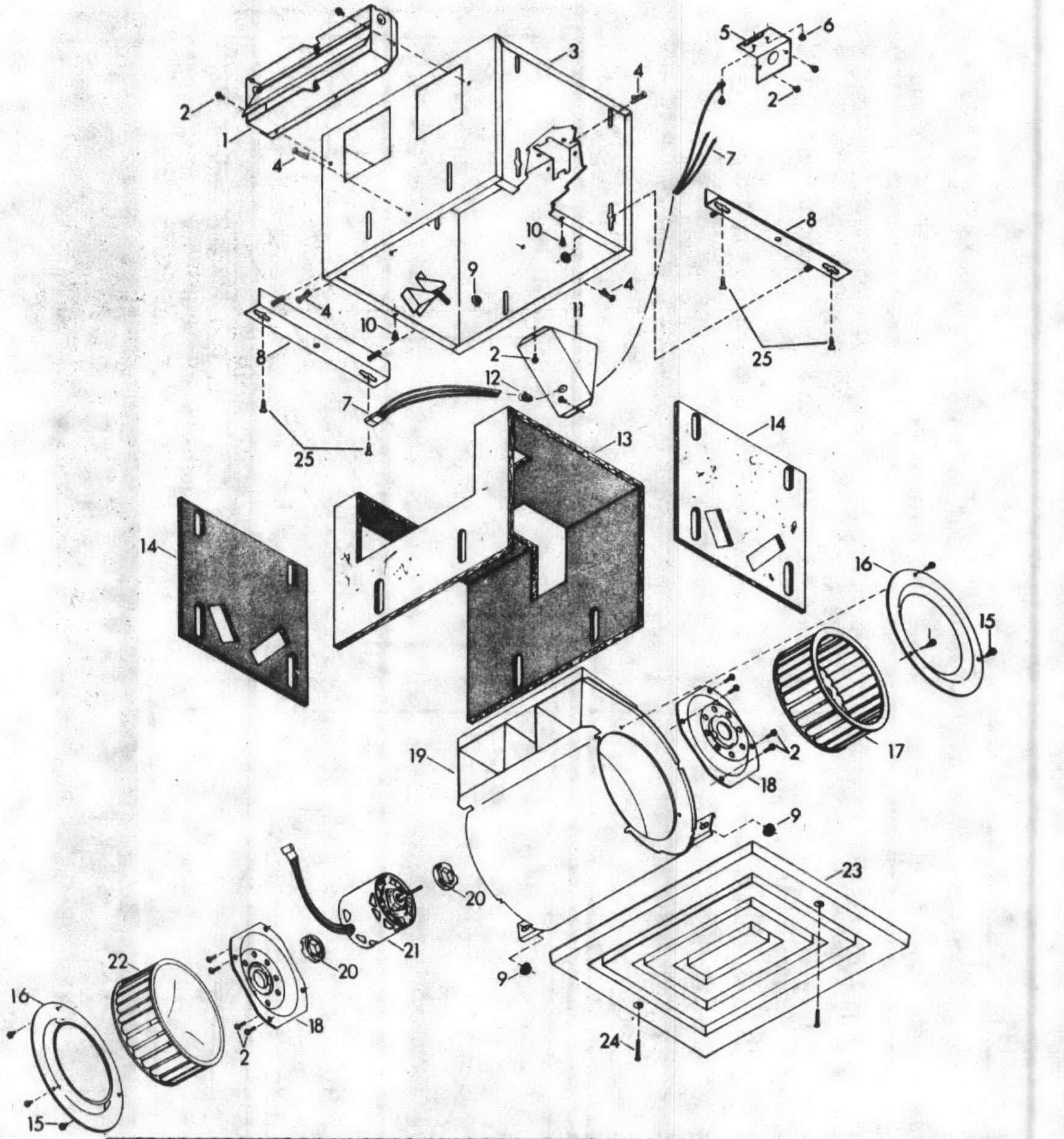
SELLER WARRANTS THAT THE GOODS SHALL BE FREE FROM DEFECTS IN MATERIALS OR WORKMANSHIP FOR A PERIOD OF ONE (1) YEAR FROM THE DATE OF INITIAL INSTALLATION OR FOR A PERIOD OF EIGHTEEN (18) MONTHS FROM DATE OF SHIPMENT, WHICHEVER PERIOD FIRST EXPIRES. NO WARRANTY IS MADE OR OFFERED WITH RESPECT TO ANY PROTECTIVE COATINGS APPLIED TO THE GOODS. SELLER'S WARRANTY OBLIGATIONS WITH RESPECT TO GOODS NOT MANUFACTURED BY SELLER SHALL NOT EXCEED THE OBLIGATIONS UNDERTAKEN BY THE MANUFACTURER THEREOF UNDER EXPRESS WARRANTY TO SELLER.

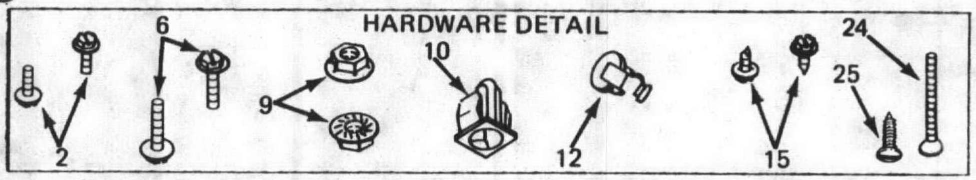
If, in Buyer's judgment, the goods do not meet the warranties expressed above, and the Buyer notifies Seller of the defect within a reasonable time after discovery of the defect and within the warranty period, Seller agrees to correct the defect by repairing or replacing, F.O.B. point of manufacture, any parts or components of the goods determined by Seller to be defective, or at its option by issuing credit for the defective parts or components. Seller shall not be liable for labor or other charges, costs or expenses related to the removal, shipping, handling, installation or re-installation of any goods or components.

THE EXPRESS WARRANTIES SET FORTH ABOVE ARE GIVEN BY SELLER IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IT IS EXPRESSLY AGREED THAT BUYER'S EXCLUSIVE REMEDY AND SELLER'S LIABILITY SHALL BE LIMITED TO THE REPAIR OR REPLACEMENT OF, OR THE ISSUANCE OF CREDIT FOR, DEFECTIVE PARTS OR COMPONENTS.

SELLER EXPRESSLY DISCLAIMS ANY AND ALL LIABILITY FOR AND SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES RESULTING FROM OR ARISING FROM OR OUT OF DEFECTIVE GOODS, SELLER'S NEGLIGENCE, BREACH OF WARRANTY, BREACH OF CONTRACT, ANY TORT, OR CLAIMS BASED UPON STRICT LIABILITY OF THE SELLER. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES OR LOSSES COMMERCIAL IN NATURE.

ILG Industries Inc. 2850 North Pulaski Road, Chicago, Illinois 60641





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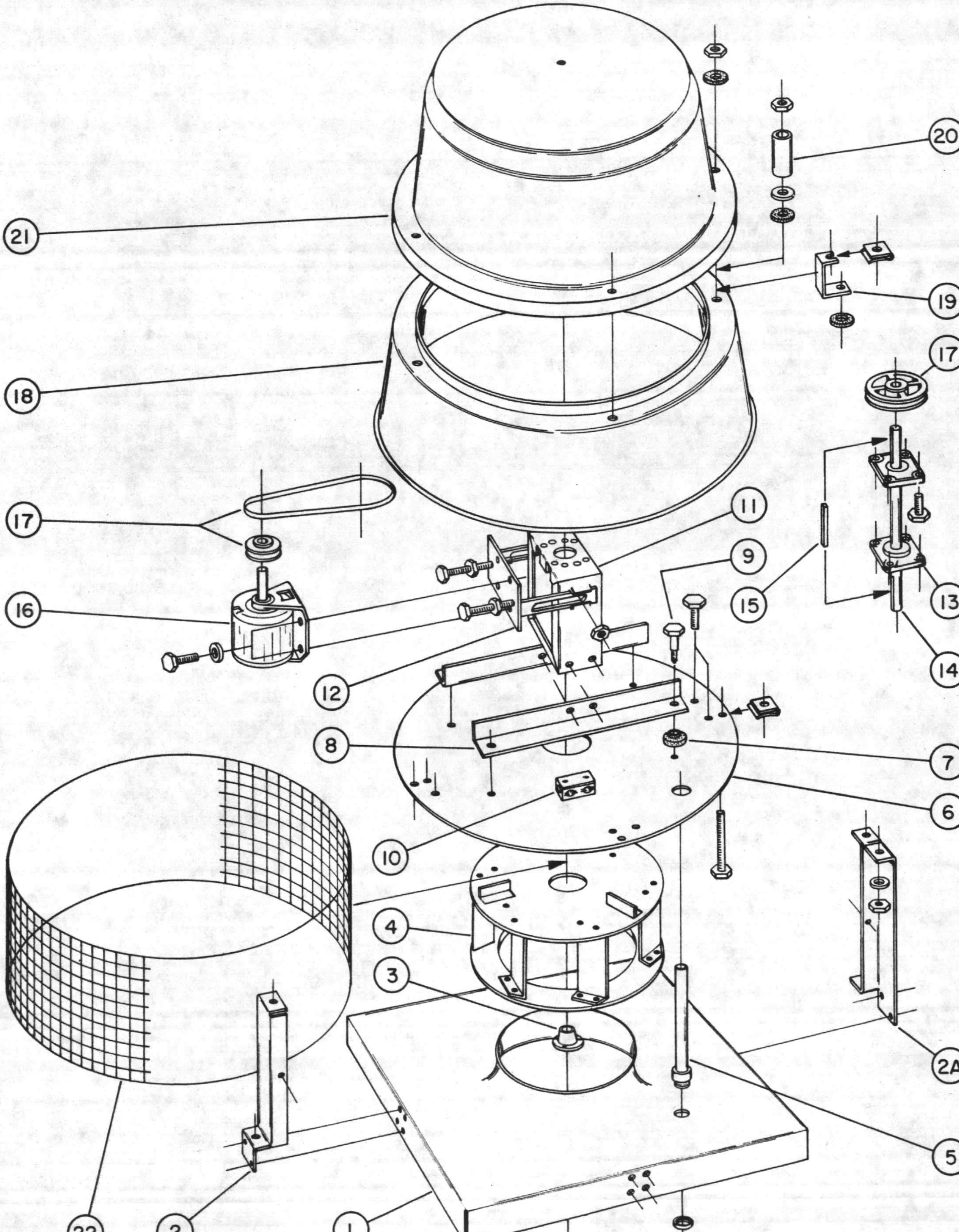
AN 23736-1

CRB 12 TO 18 ROOF VENTILATOR

ILG

DRAWN BY: AL. LUTZ
DATE: FEB. 1985
APPROVED BY: G.R.I.



DRAWN	I	CREATED	FEB. 1985		
LUTZ					
CHECKED					SHEET 2 OF 2
DATE FEB. 1985	CRB 12 TO 18 ROOF VENTILATOR — PARTS CAT. DRG.				AN 23736

NO.	NAME OF PART		12	15	18
			PART NO.		
1	INLET BASE	CN 23462	2112-1808A	2115-1806A	2118-1802A
2	DISC SUPPORT BRACKET	—	A2112-5224A	A2115-5208A	—
2A	DISC SUPPORT BRACKET	—	—	—	A2118-5210A
3	BUSHING	CN 21851	8000-0063		
4	WHEEL ASSY.	CN 23457	2112-9306B	2115-9307B	2118-9304B
5	CONDUIT	AN 23446	2112-0413A	2115-0404A	2118-0401A
6	COMPARTMENT DISC	CN 23454	2112-2606A		2118-2602B
7	VIBRATION ISOLATOR		A8500-6325		
8	DRIVE PAK BASE		A2112-1121A		A2118-1113B
9	ISOLATOR SCREW		A7442-3037		
10	DISCONNECT SWITCH		AS REQUIRED		
11	BEARING FRAME		C2112-1120A		
12	MOTOR PLATE ASSY.		A2112-9032A		
13	BEARINGS	BN 23478	8000-1367		
14	SHAFT	BN 21131	2113-2500B		
15	KEY		7851-0004		
16	MOTOR		AS SPECIFIED		
17	DRIVE		AS REQUIRED		
18	ROOF SKIRT	BN 23449	2112-2415A		2118-2404B
19	ROOF SKIRT BRACKET		—	—	A2118-1114A
20	SPACER		A2112-1122A		—
21	ROOF		C2112-2413A		CN 23450 2118-2405A
22	BIRDSCREEN	AN 23445	2112-5223A	2115-5207A	2118-5204A

STANDARD TERMS AND CONDITIONS OF SALE

No provision, term or condition of Buyer's order which is inconsistent with, different from or in addition to Seller's terms and conditions shall be binding upon Seller unless expressly agreed to in writing and signed by a duly authorized representative of Seller. Seller shall not be obligated to Buyer in any way until written acceptance of Buyer's order is made by Seller's duly authorized representative at its offices: 2850 North Pulaski Road, Chicago, Illinois. Seller's quotation shall be considered as an invitation to trade and shall not be construed as an offer to contract. The equipment and products described are herein referred to as the "goods."

PRICE

1. Prices are F.O.B. point of shipment.
2. Prices set forth on Seller's quotation are firm for a period of thirty (30) days from the date of the quotation. In the event of any changes in specifications indicated by Buyer's purchase order, Seller may adjust the price to cover such changes.
3. If, at Buyer's request, shipment is extended beyond six (6) months from date of Seller's written quotation, Seller may increase the stated price of the unshipped goods one percent (1%) per month.
4. Prices of goods not manufactured by Seller are at all times subject to revision to reflect price increases by Seller's suppliers.
5. All prices are subject to the addition of any Federal, State or local taxes which may be applicable to the sale, purchase, delivery, storage, use or processing of the goods sold. Any such tax shall be due and payable to Seller at or before the time the tax is payable by Seller to the taxing authority, or in lieu thereof, Buyer may provide Seller with a tax exemption certificate acceptable to the taxing authority.

PAYMENT TERMS

1. Terms of payment are thirty (30) days net from date of invoice, no discounts, unless otherwise specified.
2. Interest at the rate of one and one-half percent (1.5%) per month (18% per annum), or the maximum lawful rate allowable, will be charged, whichever is less, on all past due invoices.
3. No payments made to representatives or agents will be valid. Payments shall be made directly to Seller, at its home office, Chicago, Illinois.
4. Minimum billing for any goods sold by the Seller shall be $25.00 net, exclusive of all transportation.
5. Pro rate retainage fees or back charges will not be accepted by Seller. Collection of such deductions from payments will be enforced at Buyer's expense.
6. Seller shall not be liable for any liquidated damages or penalties whatsoever unless otherwise agreed to in writing.
7. Seller reserves the right to require full payment in advance of shipment, posting of security for payment, or other payment arrangements when in Seller's judgment, open billing terms are not acceptable.

DELIVERY AND ACCEPTANCE

1. Delivery dates are estimated by Seller and are not guaranteed.
2. Shipments shall be made by the method or carrier deemed most feasible by Seller and Seller reserves the right to ship all or part of the goods from any shipping point other than the points specified herein.
3. Risk of loss or damage passes to the Buyer upon delivery of the goods to the carrier at point of shipment.
4. Buyer shall inspect all goods upon receipt. If Buyer rejects all or part of the goods, Buyer shall give Seller written notice of rejection, specifying the reasons therefore within five (5) days after receipt of the goods. In the event Buyer does not so notify Seller, Buyer shall be deemed to have accepted the goods.

WARRANTY AND LIMITATIONS OF LIABILITY

SELLER WARRANTS THAT THE GOODS SHALL BE FREE FROM DEFECTS IN MATERIALS OR WORKMANSHIP FOR A PERIOD OF ONE (1) YEAR FROM THE DATE OF INITIAL INSTALLATION OR FOR A PERIOD OF EIGHTEEN (18) MONTHS FROM DATE OF SHIPMENT, WHICHEVER PERIOD FIRST EXPIRES. NO WARRANTY IS MADE OR OFFERED WITH RESPECT TO ANY PROTECTIVE COATINGS APPLIED TO THE GOODS. SELLER'S WARRANTY OBLIGATIONS WITH RESPECT TO GOODS NOT MANUFACTURED BY SELLER SHALL NOT EXCEED THE OBLIGATIONS UNDERTAKEN BY THE MANUFACTURER THEREOF UNDER EXPRESS WARRANTY TO SELLER.

If, in Buyer's judgment, the goods do not meet the warranties expressed above, and the Buyer notifies Seller of the defect within a reasonable time after discovery of the defect and within the warranty period, Seller agrees to correct the defect by repairing or replacing, F.O.B. point of manufacture, any parts or components of the goods determined by Seller to be defective, or at its option by issuing credit for the defective parts or components. Seller shall not be liable for labor or other charges, costs or expenses related to the removal, shipping, handling, installation or re-installation of any goods or components.

THE EXPRESS WARRANTIES SET FORTH ABOVE ARE GIVEN BY SELLER IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IT IS EXPRESSLY AGREED THAT BUYER'S EXCLUSIVE REMEDY AND SELLER'S LIABILITY SHALL BE LIMITED TO THE REPAIR OR REPLACEMENT OF, OR THE ISSUANCE OF CREDIT FOR, DEFECTIVE PARTS OR COMPONENTS.

SELLER EXPRESSLY DISCLAIMS ANY AND ALL LIABILITY FOR AND SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES RESULTING FROM OR ARISING FROM OR OUT OF DEFECTIVE GOODS, SELLER'S NEGLIGENCE, BREACH OF WARRANTY, BREACH OF CONTRACT, ANY TORT, OR CLAIMS BASED UPON STRICT LIABILITY OF THE SELLER. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES OR LOSSES COMMERCIAL IN NATURE.

NUCLEAR USE

1. Buyer covenants, represents and warrants that neither Buyer nor any third party shall use, re-sell or otherwise dispose of any goods or part thereof in connection with any activity or process involving nuclear fission or fusion or any use or handling of any source, special nuclear or by-product material, as those materials are defined in the U.S. Atomic Energy Act of 1954 (as amended), without Seller's prior written consent, and until such time as Buyer, or such third party, at no expense to Seller, shall have arranged for insurance coverage, indemnities, and waivers of liability, recourse and subrogation, all acceptable to Seller, and all fully adequate in the opinion of Seller, to protect Seller (and its subcontractors and suppliers) against liability of any kind whether in contract, tort (including negligence), strict liability or otherwise. The aforesaid covenants, representations and warranties shall survive this contract and sale.
2. Seller shall not be obligated to deliver the goods until such insurance, indemnities and waivers have been procured and are legally operative in Seller's favor. Buyer's failure to comply with any provisions of this paragraph entitled "Nuclear Use" shall be cause for Seller to cancel this contract without liability to Seller, and pursue any remedies provided in law or equity by this contract, the Uniform Commercial Code, or otherwise.

EXCUSABLE DELAY

Seller shall not be deemed to be in default on account of delays in the delivery of goods or in the performance of this contract or any other act to be performed by Seller due to any of the following causes: acts of God; acts of Buyer; insurrections or riots; fires; floods; explosions; earthquake or serious accidents; epidemics or quarantine restrictions; any act of government affecting prices, fuels, materials, facilities or completed goods; strikes, labor troubles causing cessation, slow-down or interruption of work; shipment delays; inability to obtain materials, fuel, accessories, manufacturing facilities, transportation, equipment or parts; any other cause to the extent it is beyond Seller's control.

TERMINATION AND RETURNED GOODS

1. Termination of the order by Buyer, or any part thereof, will not be effective unless agreed to in writing by Seller. Accepted terminations will be subject to all charges incurred by Seller for material consumed, work performed and all other expenses incurred to the date of acceptance.
2. Goods accepted for return and credit are subject to a twenty percent (20%) charge for handling and/or reconditioning, unless otherwise agreed by Seller. Transportation charges for returned goods must be prepaid by Buyer. Before returning goods Buyer must obtain Seller's authorization, and attach Seller's "Return Material Tag" to all shipments. Notice of shipment must be given to Seller on the day of shipment and Buyer must furnish a copy of the Bill of Lading, order number and invoice date.
3. Goods manufactured specifically to order or to specifications of Buyer may not be returned for credit. Changes requested by Buyer in non-stock goods after commencement of manufacturer will be subject to a revision in price to reflect additional costs.
4. Use of materials, parts or equipment furnished by Buyer will subject the order to termination without any liability on the part of Seller if the said materials, parts or equipment are defective or will not perform to Seller's requirements. However, Buyer shall be liable to pay Seller's costs and expenses through date of termination.

PATENTS AND TRADEMARKS

Seller shall indemnify the Buyer against liability for infringement of any United States Letters Patent arising out of the manufacture, sale or use of any of Seller's goods furnished, provided that the Buyer shall promptly notify Seller of any such claim and give Seller the opportunity to defend against such claim. The Buyer shall be responsible for all such loss when a particular process or system, or the goods of a particular manufacturer or manufacturers is specified, or when infringement is incurred by employing the furnished Seller's goods in combination with other parts or goods. All drawings and data furnished by Seller shall remain its property and shall be returned to Seller upon request.

DEVELOPMENT CHANGES, DESIGN AND SPECIFICATIONS

1. Changes in design or specifications may be made at Seller's discretion and Seller has no obligation to incorporate such changes in goods manufactured prior to the change.
2. Seller may furnish Buyer with goods which have been subject to changes in design or specifications provided such changes do not adversely affect price, delivery, or any guaranteed performance of the goods or make unusable or obsolete any other item of goods furnished to Buyer under this contract.
3. All drawings, instructions and/or technical and engineering services which Seller may furnish with respect to installation or use of the goods are furnished solely for the review and approval of the Buyer. Seller makes no representation or warranty with respect to the accuracy or sufficiency of any such information and disclaims all liability in connection with their use or application.
4. Seller reserves the right to correct any factory, engineering, clerical or stenographic errors or omissions which may appear upon review and verification of data referred to in Seller's quotation, or Buyer's order.

COMPLIANCE WITH LAWS

No representation or claim is made regarding compliance with the Occupational Safety and Health Act of 1970, or its amendments, or any other federal, state or local laws, ordinances, codes, rules or regulations which may apply to the goods or their installation.

GOVERNING LAW AND SEVERABILITY

1. This agreement shall be governed in all respects by the law of Illinois.
2. This contract shall be binding upon and shall inure to the benefit of the parties, their successor and assigns.
3. If any provision or term herein is found to be invalid or unenforceable as a matter of law or by public policy, it shall be considered to be severed from the remainder of the terms and conditions which shall remain in full force and effect.

A CHECK IN THE APPROPRIATE SQUARE INDICATES THE TYPE OF BEARINGS USED IN THE MOTOR POWERING THIS EQUIPMENT

GENERAL INSTRUCTIONS FOR FAN MOTORS

☐ RELUBRICATABLE BALL BEARINGS - An instruction tag from the manufacturer is included with the motor and the recommendations contained therein should be followed.

☐ SEALED BALL BEARINGS - The bearings are factory-packed with a general purpose bearing lubricant and require no further attention. The life of the grease is dependent upon the number of operating hours and temperature. Under normal conditions of operation (8 hours per day, 5 days per week and average ambient temperature of 80 deg. F) the expected grease-life will be approximately seven years. The life may be greater or less depending upon the enclosure of the motor, RPM, type of mounting, variation in ambient temperature and operating duty cycle. In terms of hours of operation, expected life may be stated as approximately 30,000 hours for open motors and 20,000 hours for enclosed motors when working in an average ambient temperature of 80 deg. F.

☐ SEALED SLEEVE BEARINGS - Bearings of this type are provided with a large lubricant reservoir and require no attention. Because of the extremely light loads on motors with this type of bearing, the life will compare favorably with larger motors having sealed ball bearings.

☐ RELUBRICATABLE SLEEVE BEARINGS - The bearing is essentially the same as the sealed sleeve bearing with the exception that it may be relubricated to secure extended life. To obtain maximum life, 5 or 6 drops of SAE20 Motor Oil or Electric Motor Bearing Oil should be added after every 1,000 hours of operation.

NOTE: THE STATEMENTS REGARDING EXPECTED LIFE DO NOT CONSTITUTE A GUARANTEE, EXPRESSED OR IMPLIED - BUT SERVE ONLY AS AN INDICATION OF WHAT MAY BE EXPECTED OF THE EQUIPMENT. (REFER TO STANDARD TERMS AND CONDITIONS OF SALE.)

GENERAL NOTES REGARDING FAN EQUIPMENT

1. OVERLOAD PROTECTION - Some motors are provided with built-in overload protection. This fact is so noted on the Motor Rating Plate. If the motor does not contain built-in overload protection, it is mandatory that this protection be provided by starters in the motor circuit. The starters are to be equipped with overload protection devices of a rating suitable for the current rating of the motor.
2. PERIODIC CLEANING - Periodic cleaning of all fan equipment is strongly recommended. Dirt and grease accumulations on the impeller cause vibration which greatly increases stresses and loads on the motor bearings. A program of preventive maintenance will greatly increase fan and motor life.
3. CHECKING DIRECTION OF ROTATION - Care should be taken to insure the proper direction of rotation. This is particularly true in the case of centrifugal type roof ventilators. This type of equipment will deliver air when running in either direction; however, the load is greatly increased when operation is in the wrong rotation. This is a very common cause of overload tripping in centrifugal type roof ventilators. When this trouble is experienced, try reversing fan rotation before increasing the size of the overload protection.
4. MOTOR OVERLOAD - Forward-curve and radial-bladed fans consume maximum horsepower at 0 in. Static Pressure. Some fans of this type are powered so that operation at 0 in. Static Pressure will overload the motor. Check Catalog Ratings to determine minimum Static Pressure operation if overloading is experienced with this type of equipment.
5. CHECKING RUNNING CLEARANCE - To achieve maximum performance and efficiency, fans are precision-built machines. Upon occasion, parts will shift slightly due to mishandling in shipment. This can cause binding of the rotating assembly. Before placing any fan in operation, the impeller should be turned by hand to ensure that no binding or interference is present.

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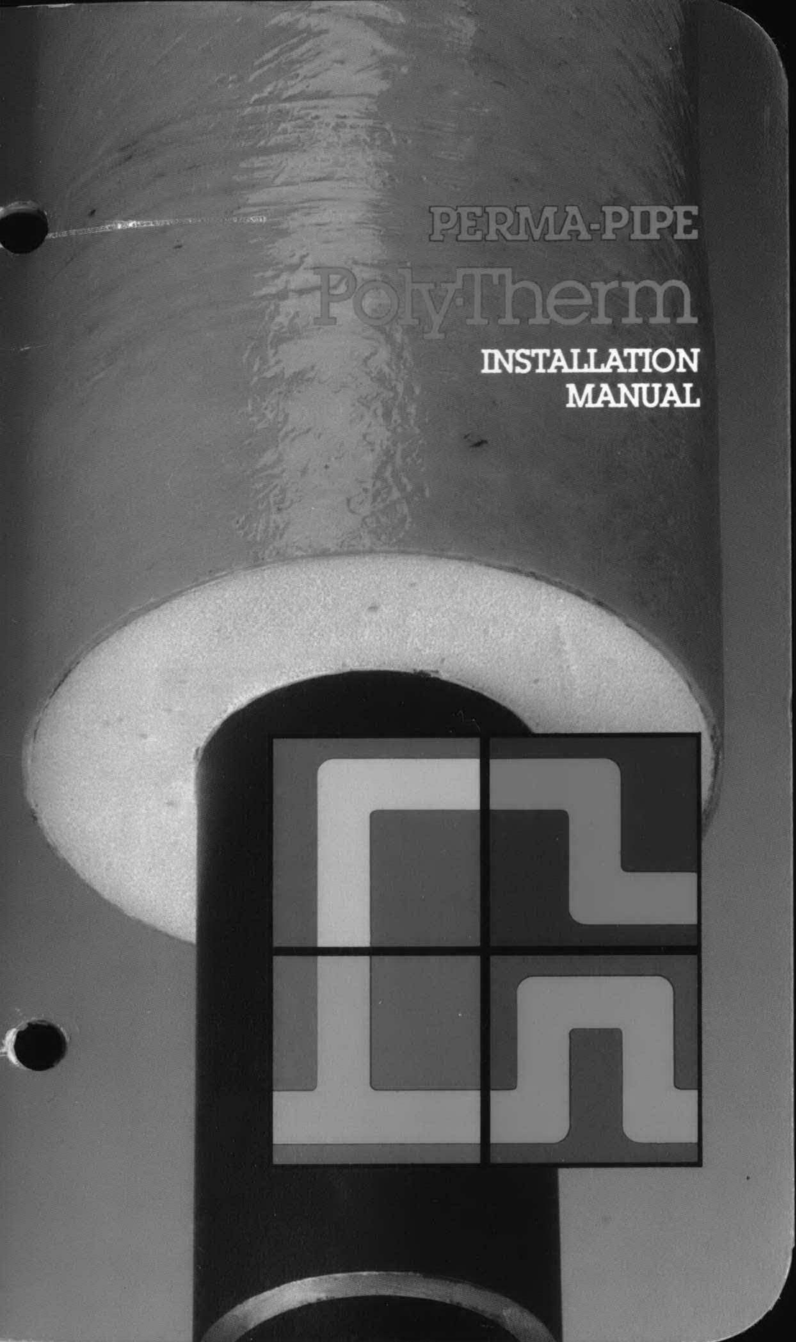
PERMA-PIPE

PolyTherm

INSTALLATION MANUAL



Poly-Therm Installation Manual

IMP 031185

February, 1985

PREFACE

The consulting engineer has been provided with information on what to expect from the PERMA-PIPE Poly-Therm system once it is installed. However, the true operating success of the system is greatly dependent upon the proper installation. PERMA-PIPE is committed to providing a complete system of the highest possible quality, including clear and concise installation instructions and expert field supervision.

The objective of this text is to guide the installer and provide both the engineer and installer with additional technical information on the installation. In order to satisfy this dual role, the installation manual has been divided into two sections.

SECTION I is a set of step-by-step instructions which will guide you through the installation process. The instructions are supported by close to 100 illustrations. These illustrations will help to visualize a procedure before actually doing it. Section I is further divided into the five phases of installation for easy reference.

SECTION II offers the reader a more detailed description and a technical explanation of the installation. The design of our system is also explained to help the consulting engineer and the installer understand the reasons behind our recommendations. This section will answer many questions about the "critical" periods of installation and can prove to be a useful guide when comparing the installation and key features of our product with that of another manufacturer.

CONTENTS

CONTENTS

SECTION II
TECHNICAL SUPPLEMENT

INTRODUCTION

Poly-Therm brings versatility to preinsulated fluid transportation systems. Complete application flexibility is enhanced by Perma-Pipe's totally integrated, engineered system design. Typical applications include collection and distribution of hot and chilled water, cryogenic liquids, fuel oil, and chemicals.

Providing exceptional reliability in all climates and environments, Poly-Therm's fiberglass reinforced plastic (FRP) jacket is completely non-corrosive and resists installation abuse. Excellent thermal efficiency is also standard with Poly-Therm's void-free poly-urethane foam spray process.

The optional PermAlert leak detection system is capable of constant monitoring of the pipeline for service pipe or jacket leaks.

The Poly-Therm system has been designed with the installer in mind. Poly-Therm arrives at the project site virtually assembled. Our in-plant fabrication means less field work and fewer complications. This significantly reduces the installation cost, and at the same time maintains the integrity of the system.

The features that make Poly-Therm unique extend beyond the product itself. An experienced field service staff will assist you to help assure a quick and smooth installation.

Our expert project design staff tailors each system to the customers' needs. PERMA-PIPE's use of computers for system design is unequaled in the industry. You can also be sure that Poly-Therm has been engineered to the high standards found in all products bearing the PERMA-PIPE label.

When installed according to the recommended practices of this manual and PERMA-PIPE Field Service, Poly-Therm will give you the performance you require.

We are sure you will complete a successful installation and join our growing list of satisfied customers.

INSTALLATION INSTRUCTIONS

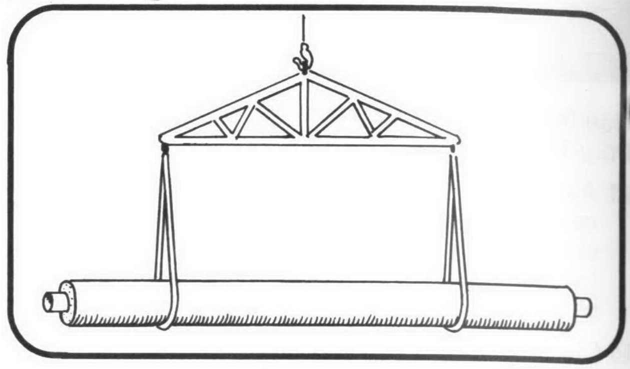
SECTION I

Inspection

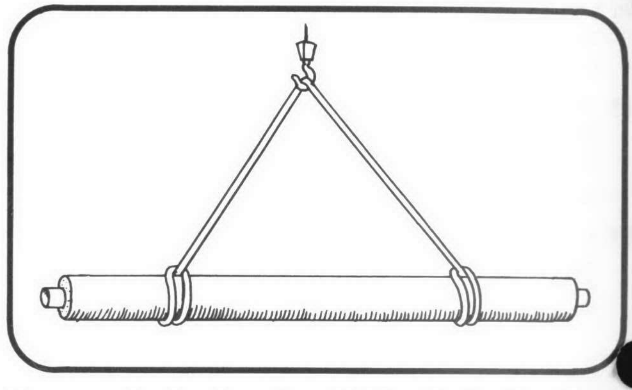
Use the following check list when receiving each Poly-Therm shipment:

- ☑ As soon as you are contacted by the common carrier, notify your PERMA-PIPE representative of delivery time. Your PERMA-PIPE representative must be present during receiving of each shipment.
- ☑ Check all shipped materials against the packing slip for shortages.
- ☑ Visually inspect the shipment as it is unloaded:
  1. Poly-Therm assemblies
  2. Field joint closure materials
  3. Fittings and accessories
- ☑ List all damages and/or shortages on the packing slip and the bill of lading. These claims should be submitted to the common carrier.
- ☑ Notify your PERMA-PIPE representative of these claims if assistance is required. PERMA-PIPE terms are F.O.B. our plant, full freight allowed to project site.
- ☑ Locate the part drawing layout (PDL). A PDL is included with each shipment.

Unloading

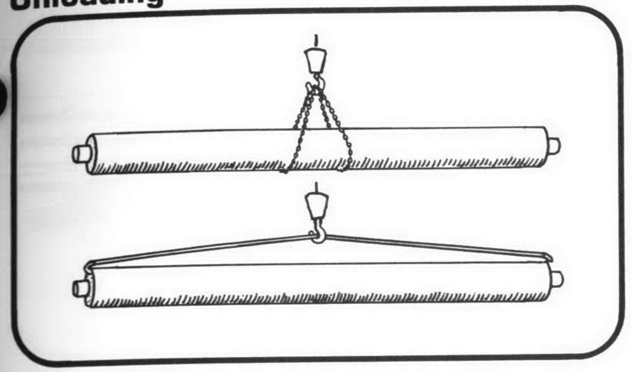


Support each Poly-Therm assembly with **two nylon slings.** Space the slings about 20 feet apart. PERMA-PIPE recommends using a spreader bar.

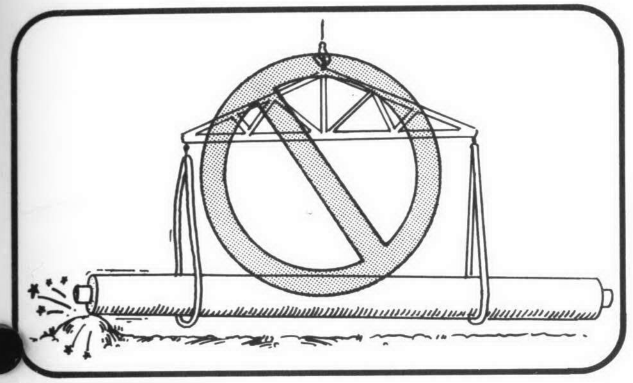


If a spreader bar is not available, choke the slings together as shown.

Unloading



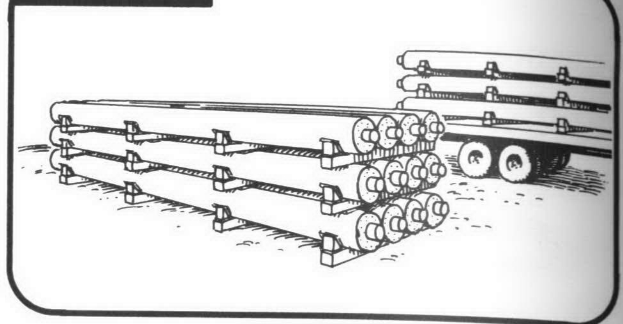
Do not use steel cables or chains for handling any Poly-Therm assemblies.



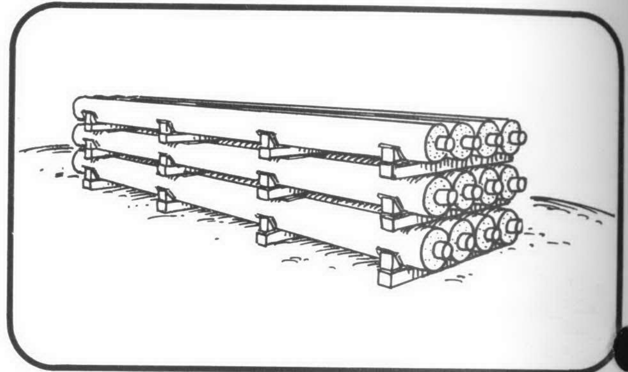
Do not drop the Poly-Therm assemblies or strike against hard surfaces at any time.

Storage

ASSEMBLIES



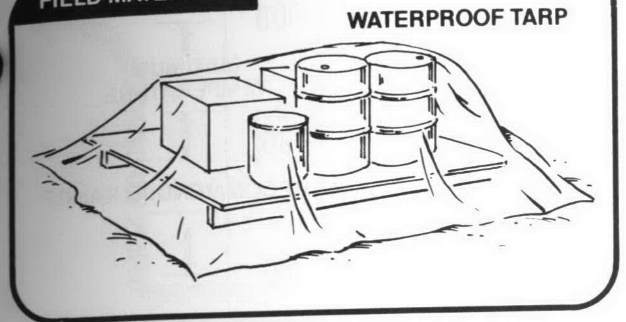
When storing the Poly-Therm assemblies, restack them in the same fashion they were received. For **long term** storage of Poly-Therm, see Section II-page 56.



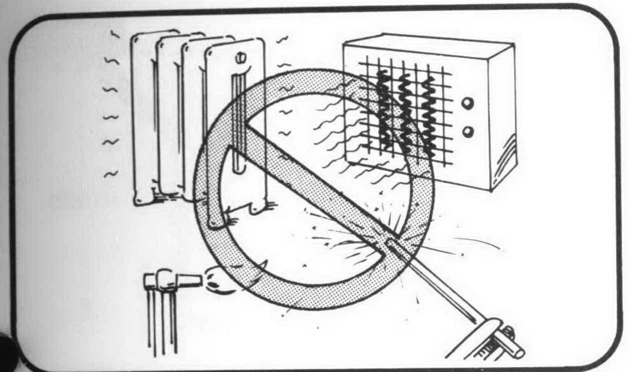
Stacking Poly-Therm:
- ☑ Stack on the wooden shipping braces.
- ☑ Use foam or other padding between layers.
- ☑ Locate the Poly-Therm on **high ground.**

Storage

FIELD MATERIALS

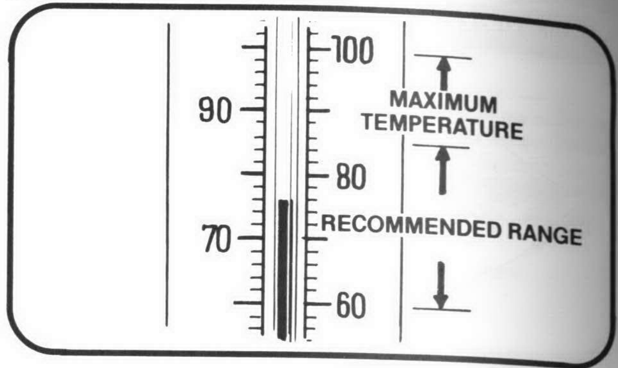


Keep all field materials in their shipping containers. Store the materials in a trailer or mechanical room. Stack the field materials off the ground, covered with a waterproof tarp.



CAUTION: Store all field materials away from extreme heat, flames, or sparks. The resin, catalyst, and insulation components are highly flammable. Wear proper safety clothing when handling the field materials, see Section II-page 71.

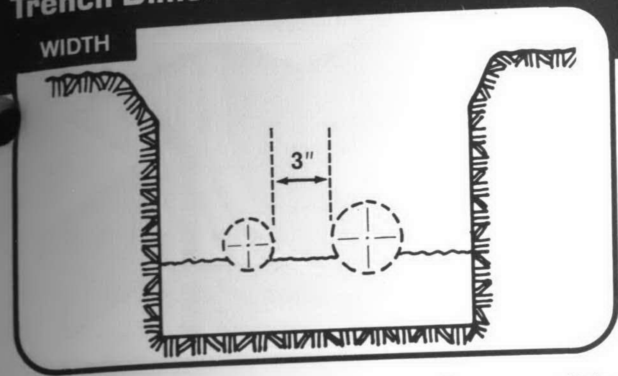
Storage



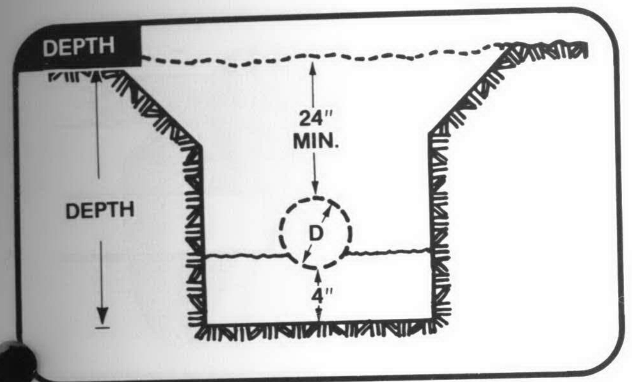
Store the **resin** and **catalyst** at 60°-85°F.

CAUTION: Do not store the resin, catalyst, or insulation components above 100°F.

Trench Dimensions



Minimize the trench width as much as possible. Allow at least 3'' between adjacent assemblies.

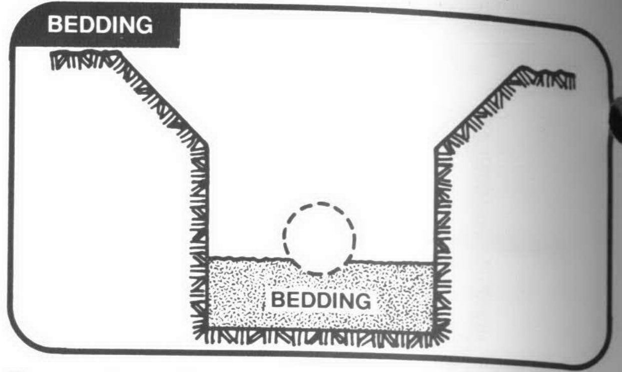


The total trench depth must allow for a 4" bedding, the assembly diameter, and a **minimum** 24" coverage above the assembly.

Check the project drawings for burial depths. For depths less than 24," see Section II-page 58.

EXCAVATION

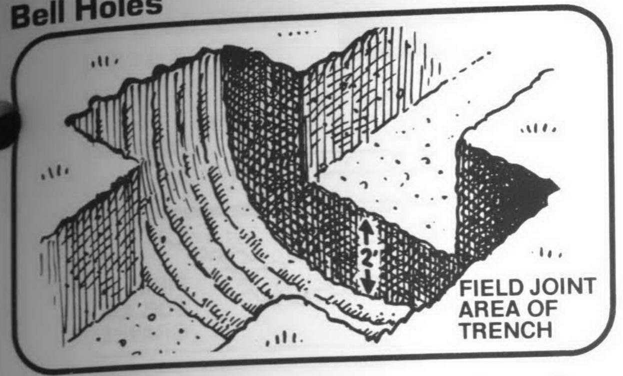
Trench Dimensions



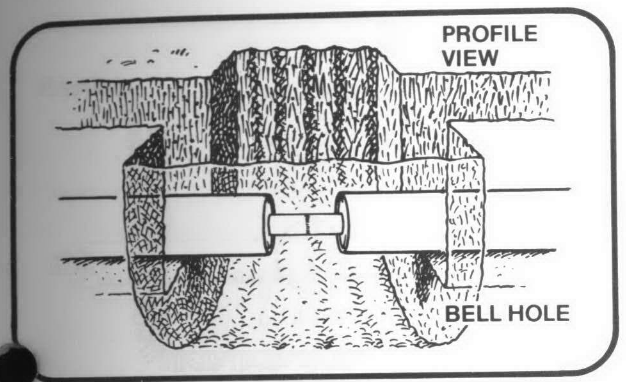
Compact a minumum 4" bedding evenly along the entire length of the run.

Use bedding soil that fits the soil description on page 49.

Bell Holes

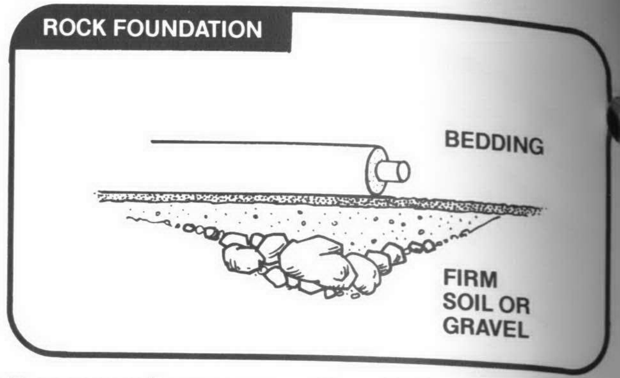


Digging **bell holes** at field joint locations allows room for welding, field joint closure, and testing. Field joint locations are marked on the part drawing layout (PDL).

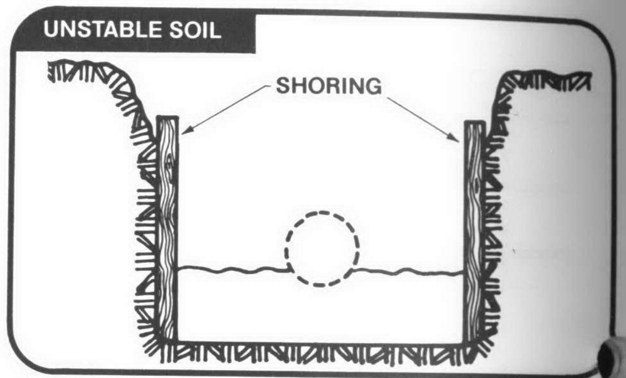


A common way to dig bell holes is to cut across the trench with a backhoe. Cut into the side of the trench and 1½—2 feet below the system grade. Dig the bell holes before lowering Poly-Therm into the trench.

Trench Conditions

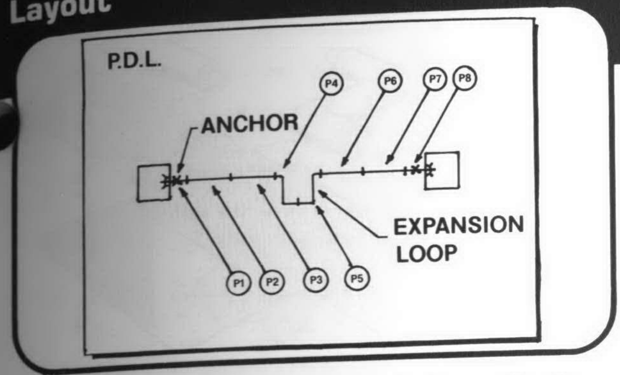


Cover a rocky or uneven foundation with firm soil or gravel before the bedding is laid.

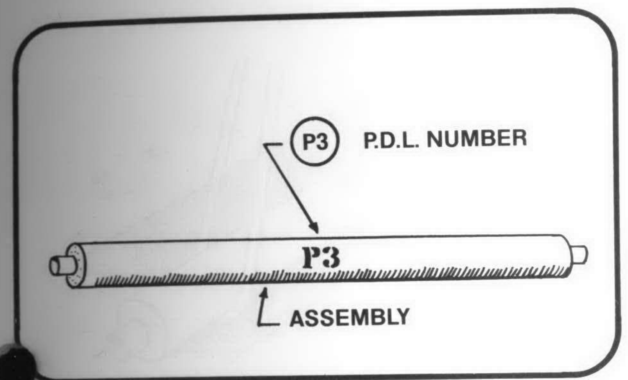


When excavating in unstable soil shore up the trench walls. Do not lower any Poly-Therm assemblies into the trench until the walls are stabilized.

Layout



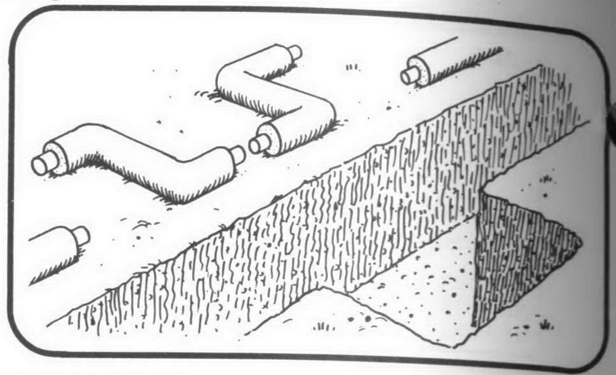
The Part Drawing Layout (PDL) shows the location for each Poly-Therm assembly.



Each assembly is marked with a number that matches a number on the PDL.

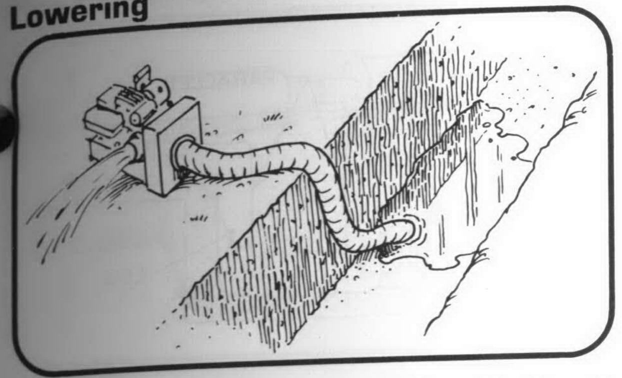
ASSEMBLY

Layout

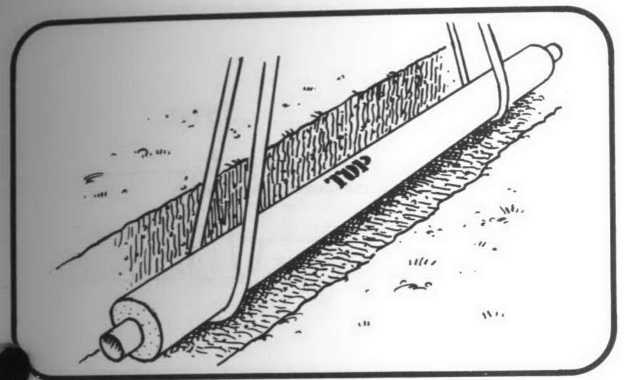


PERMA-PIPE recommends laying assemblies in order next to the trench for easier installation.

Lowering

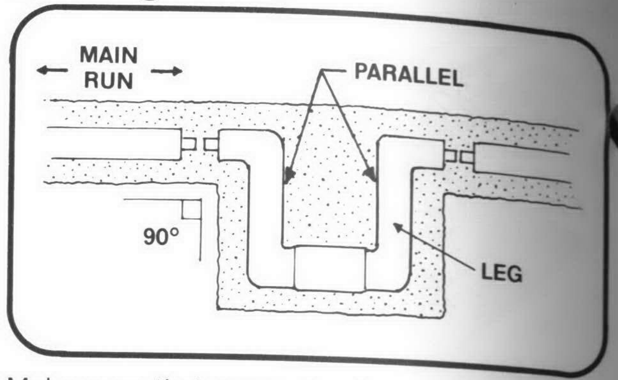


Remove all free standing water from the trench before lowering any Poly-Therm assemblies into it.



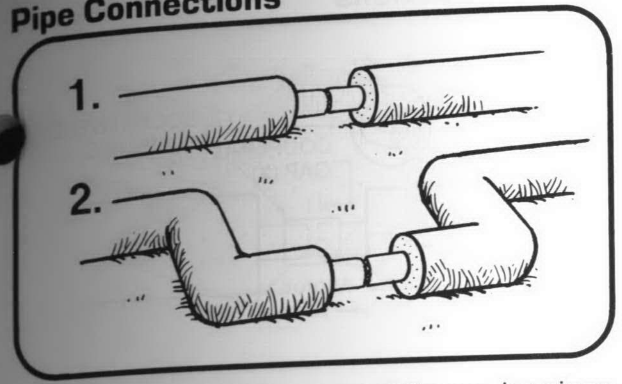
Follow the handling guidelines on pages 2-3 for all moving and lowering of the Poly-Therm assemblies.

Lowering



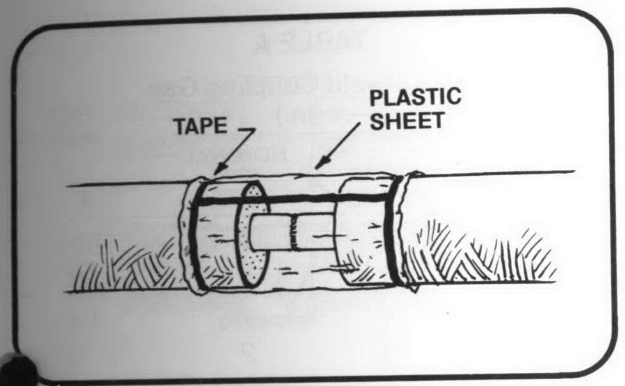
Make sure that expansion loop and elbow legs are perpendicular to the main run and that the loop legs are **parallel** to each other.

Pipe Connections



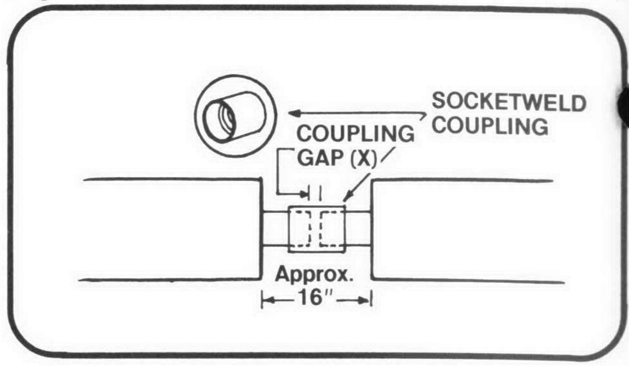
When you are ready to connect the carrier pipes, complete the following steps in order:

1. Weld all straight assembly joints.
2. Weld all non-straight assembly joints.



PERMA-PIPE **strongly** recommends covering any open field joints. Wrap plastic sheeting around the open joint. Seal both the edges and the seam with heavy, water-proof tape.

Pipe Connections



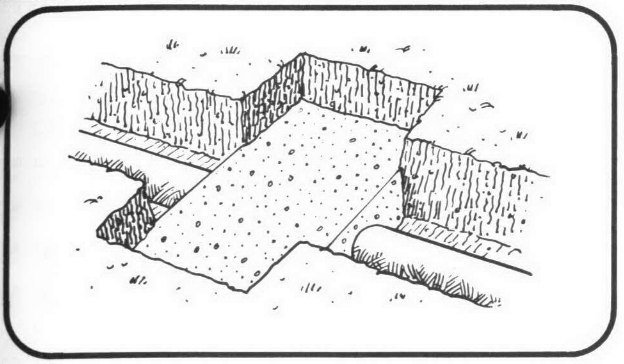
Socketweld couplings are required at field joints for steel pipe, 2" and smaller. The couplings are supplied by others. Table A gives the required gap between service pipes when using socketweld couplings.

TABLE A

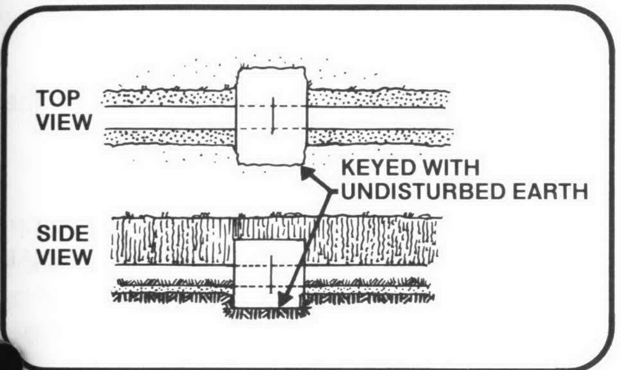
Socketweld Coupling Gap x (In.)

NOMINAL PIPE SIZE	x	NOMINAL PIPE SIZE	x
¼	¼	1	½
⅜	¼	1¼	½
½	⅜	1½	1½
¾	⅜	2	¾

Anchor Blocks

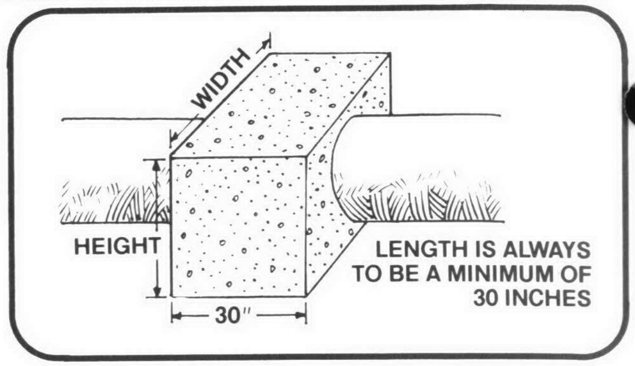


Pour concrete blocks at each anchor location.



The concrete anchor blocks should extend into **undisturbed** earth in the trench walls or beneath the bedding material into the foundation.

Anchor Blocks



Minimum Anchor Block Dimensions

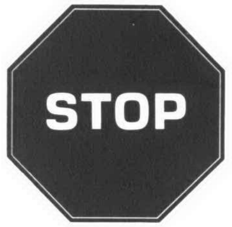
The following are the recommended dimensions for concrete anchor blocks.

Single pipe:
Length: 30"
Height: NOMINAL CASING SIZE* + 14"
Width: Same as Height
*NOMINAL CASING SIZE: Outer diameter of the Poly-Therm assembly in inches.

For more than one pipe in a trench:
Height: Largest NOMINAL CASING SIZE + 14"
Width: For each additional pipe add its NOMINAL CASING SIZE + 3"

Hydrostatic Test

- ☑ After the service pipes are welded, connect pipe test caps at the end of the run. Pipe test caps are supplied by others.
- ☑ Set all valves so the entire line can be tested.
- ☑ Fill the pipe completely with water.
- ☑ Vent the service pipe of all air.
- ☑ Pressurize the service pipe to 1½ times the operating pressure, unless otherwise stated.
- ☑ Maintain the pressure for two hours, allowing for temperature change, unless otherwise stated.
- ☑ Repair and retest any faulty welds.



If the Leak Detection option is being used, go to the PERMALERT I Installation Supplement.

Field Closure

After the service pipes have been welded and hydrostatically tested, a field closure is required.

The field closure is completed in two parts:

A. Insulating
B. Hand Lay-up

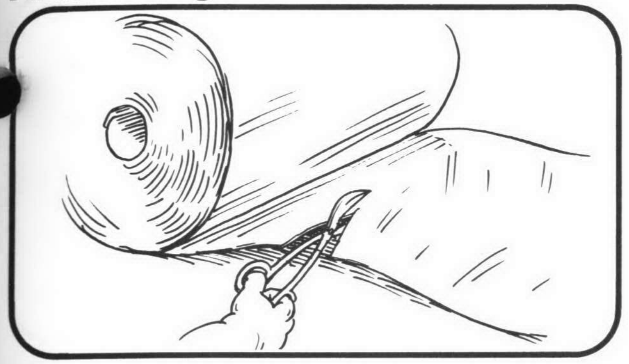
PERMA-PIPE furnishes:

☑ Insulation components A & B
☑ Metal mold
☑ Fiberglass bi-ply
☑ Pre-promoted resin
☑ 6'' wide laminating roller
☑ Catalyst

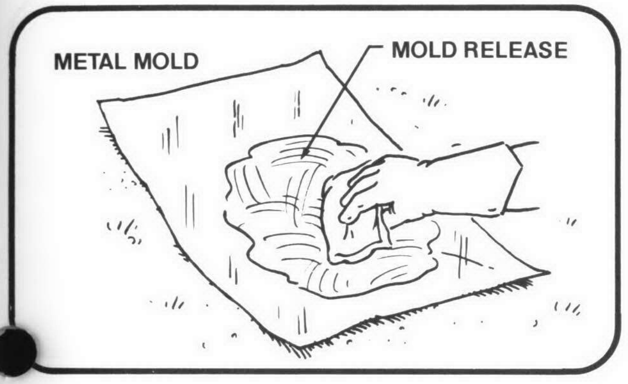
The customer furnishes:

☑ Disposable paper mixing pails (see page 63)
☑ Acetone (1 pint/field closure)
☑ Heavy-duty rubber gloves
☑ Wooden mixing paddles
☑ 60 grit sandpaper
☑ Dry rags
☑ Plastic drop cloths (5 mil minimum)
☑ Sheet of plywood
☑ Paintbrushes (3")
☑ Banding wire or rope
☑ Mold release (see page 61)
☑ Cardboard
☑ Safety clothing (see page 71)
☑ Tin snips
☑ Shears

A. Insulating



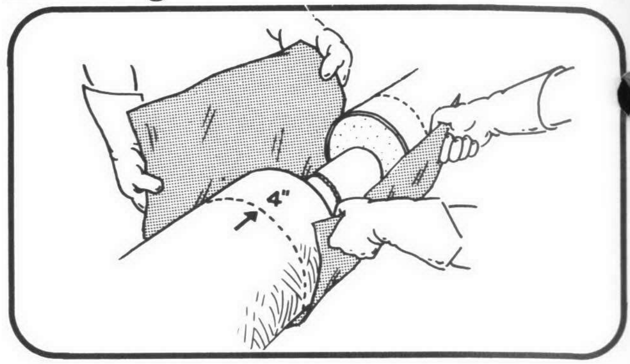
Using tin snips, cut the metal mold material to the length given in Table B.



Clean off any dirt or foam from the inside of the mold.

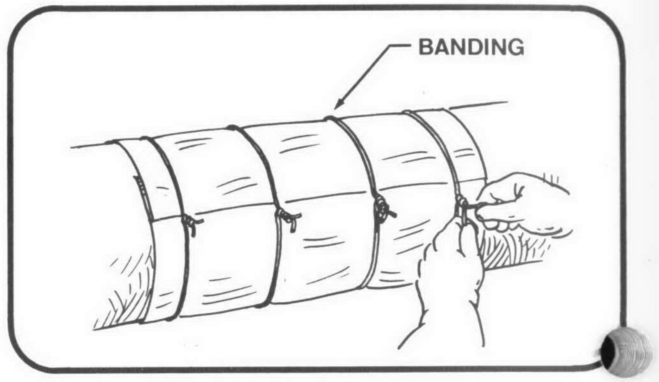
Apply mold release to the entire inside surface of the mold.

Insulating



Spread the mold apart and center it around the field joint.

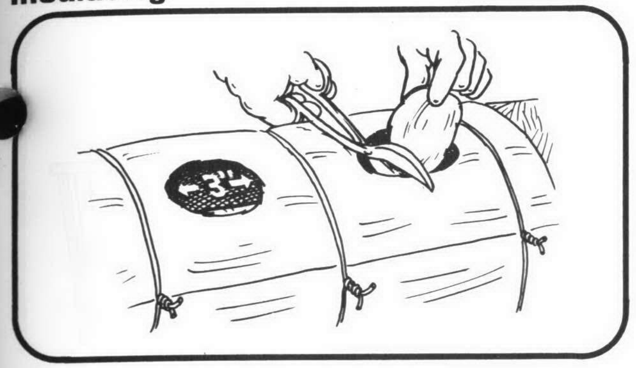
The mold should extend 4" past each edge of the field joint.



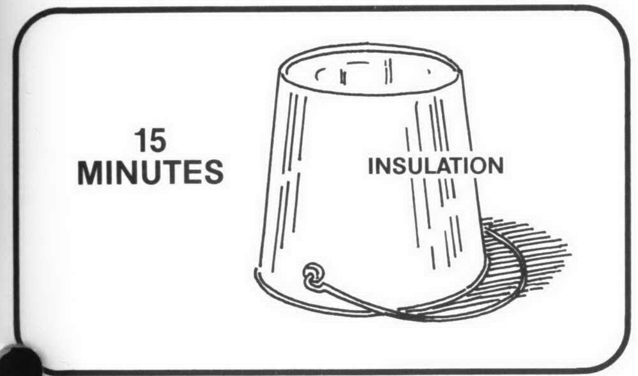
Tie a wire or rope band around the mold 2" from each edge.

Use two more bands in the middle, evenly spaced from the first two.

Insulating



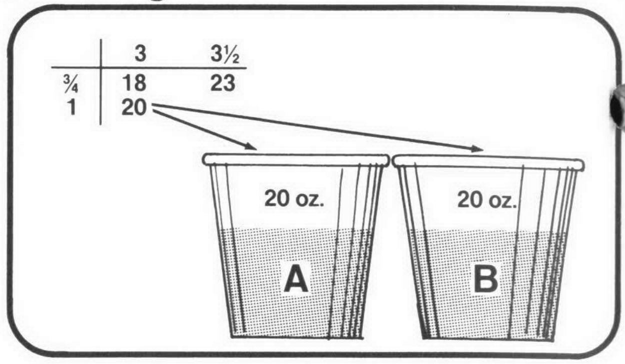
Using tin snips, cut 3 holes in the top of the mold between the banding. Make each hole about 3" in diameter.



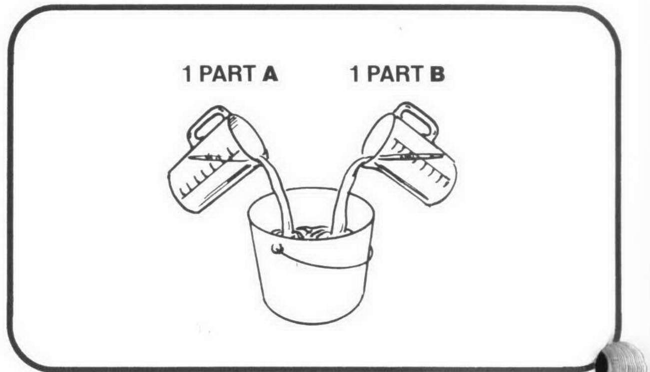
Keep the insulating components at a minimum 60°F for several hours before using.

Turn the shipping containers upside down for about 15 min. before each day's use.

Insulating

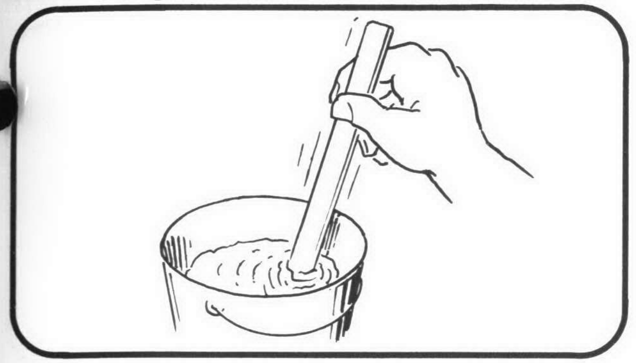


Refer to Table C for the insulation component amounts. Use a 1:1 mixing ratio. For example, if the amount given is 20 oz., the mixture requires 20 oz. of Type A and 20 oz. of Type B.

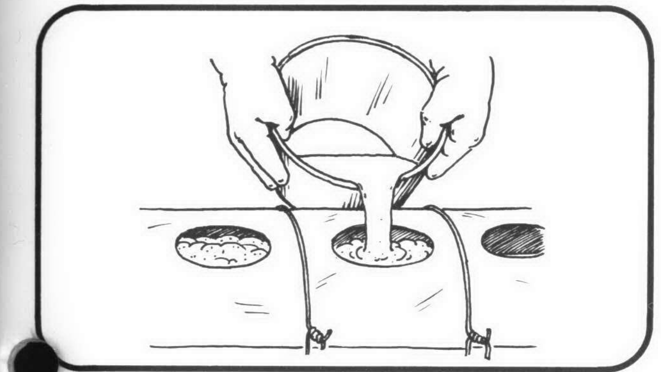


Pour the required amount of Type A into a measuring cup. Pour an equal amount of Type B into a second measuring cup. Combine the contents of both measuring cups into a mixing pail.

Insulating



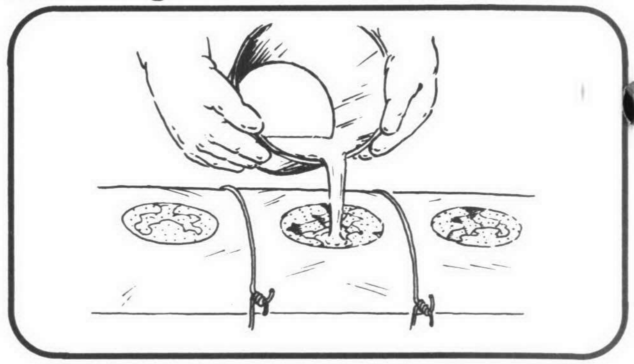
Immediately begin stirring the mixture. Stir vigorously for about 15 seconds. The insulation will begin rising in 15-30 seconds.



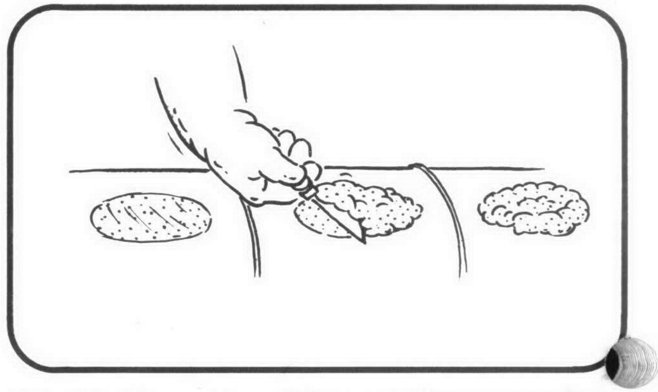
After 15 seconds of stirring, pour the mixture into the three holes at the top of the mold.

The mixture will turn to foam and rise to the top filling the entire mold.

Insulating



The excess foam will push out through the top holes. If the mold does not fill completely, remix small amounts of foam until it does. Also, adjust the amount for the remaining field closures of that particular size.

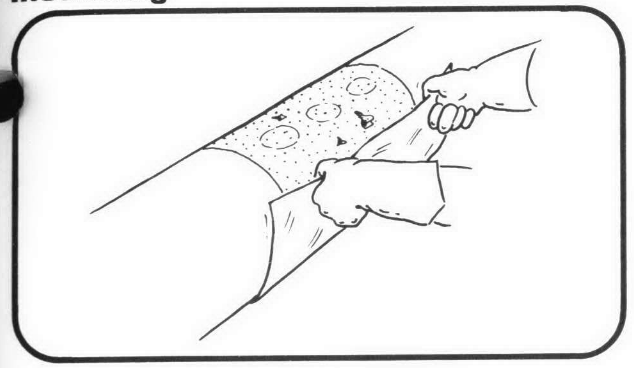


After the foam stops rising, cut the excess foam from the top of the mold.

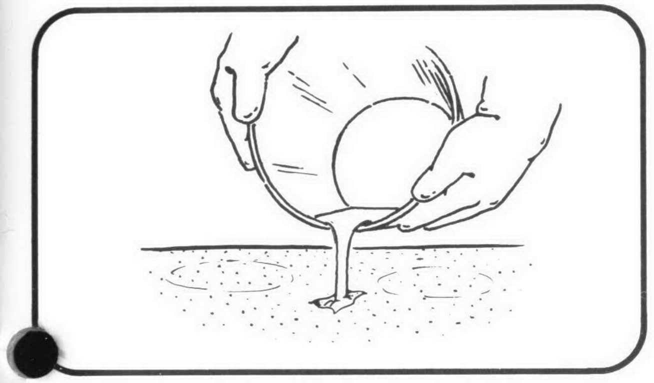
Discard the paper mixing pail.

Let the mold cool for several minutes.

Insulating



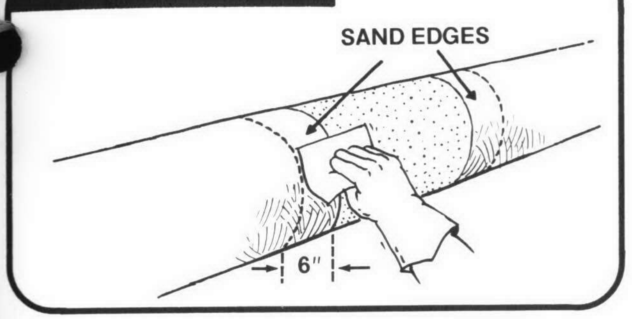
Remove the banding and carefully peel the mold off the insulation. Tearing the mold off may rip the insulation and require a repair procedure.



Patch any voids in the surface of the insulation by mixing another small batch of foam. As soon as it begins to rise in the container, apply to the void areas.

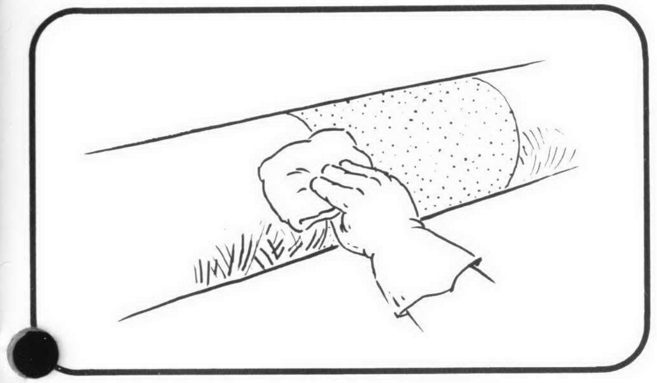
B. Hand Lay-up

SURFACE PREPARATION



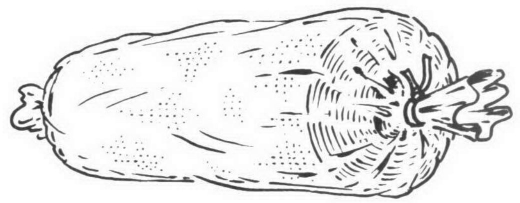
Sand the ends of the Poly-Therm jacket.

Lightly sand down any insulation that is not level with the top of the jacket.



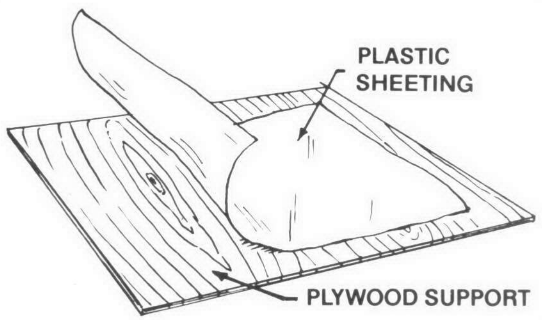
Wipe off any rain, dew or other moisture from the ends of the jacket. These surfaces must remain dry during the fiberglass hand lay-up.

Hand Lay-up



PERMA-PIPE provides the **fiberglass bi-ply** in covered rolls. Do not remove the bi-ply from the plastic bag, until you are ready to use it.

Do not use **wet** glass.



A plastic sheet, 36" wide and 12" longer than the bi-ply, is needed for the field closure. Place a piece of plywood larger than the sheet, near the field joint and lay the sheet on it.

Insulating

TABLE B
Metal Mold Length Per Field Joint

BI-PLY LENGTH IS THE SAME AS THE MOLD LENGTH

If the NOMINAL CASING SIZE is:

LESS THAN	5	USE	1½	FEET
	5¾		1¾	
	6½		2	
	7¼		2½	
	8		2½	
	9		2¾	
	9-5		3	
	10½		3¼	
	11¼		3½	
	12		3¾	
	12¾		4	
	14½		4½	
	16		5	
	17½		5½	
	19¼		6	
	20¾		6½	
	22½		7	
	24		7½	
	25½		8	
	27¼		8½	
	28¾		9	
	30¼		9½	
	32		10	
	33½		10½	
	35		11	

TABLE C
Insulation Quantities (oz.) per Component

NOMINAL PIPE SIZE	INSULATION SIZE (IN) 1	1½	2	2½
¾	4	7	10	14
1	5	7	11	15
1¼	5	8	12	16
1½	6	9	13	17
2	6	10	14	19
2½	7	11	15	21
3	8	12	17	23
4	10	15	20	26
5	12	17	23	30
6	13	20	26	34
8	16	24	32	41
10	20	29	39	49
12	23	33	44	56
14	25	36	48	60
16	28	41	54	68
18	32	45	60	75
20	35	50	66	82
22	38	54	71	89
24	41	59	77	96
26	45	64	83	103
28	48	68	89	111
30	51	73	95	118
32	54	77	101	125

TABLE C (Cont.)
Insulation Quantities (oz.) per Component

NOMINAL PIPE SIZE	INSULATION SIZE (IN) 3	3½	4	4½
¾	18	23	29	36
1	20	25	31	38
1¼	21	27	33	40
1½	22	28	35	42
2	24	30	37	45
2½	26	33	40	48
3	29	36	43	52
4	33	41	49	58
5	38	46	55	64
6	42	51	61	71
8	51	61	72	83
10	60	71	84	96
12	68	81	95	109
14	74	87	102	117
16	82	97	113	129
18	90	107	124	141
20	99	117	135	154
22	107	126	146	166
24	116	136	157	179
26	124	146	168	191
28	133	156	179	203
30	141	165	190	216
32	150	175	201	228

TABLE D
Resin Quantities per Hand Lay-up

If the NOMINAL CASING SIZE is:

LESS THAN	USE	
5	1	QUART(S)
7½	1½	
10	2	
12½	2½	
15	3	
17½	3½	
20	4	
22½	4½	
25½	5	
28	5½	
30½	6	
33	6½	
35½	7	
38	7½	
40½	8	

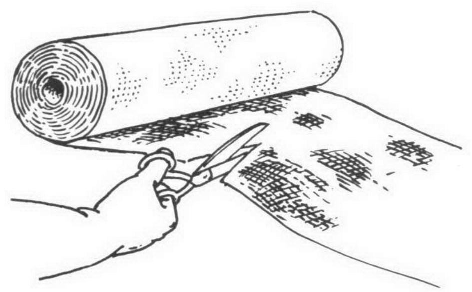
The NOMINAL CASING SIZE is the outer diameter of the Poly-Therm assembly in inches.

For sizes greater than 40½, special instructions will be provided.

TABLE E
Catalyst Quantities

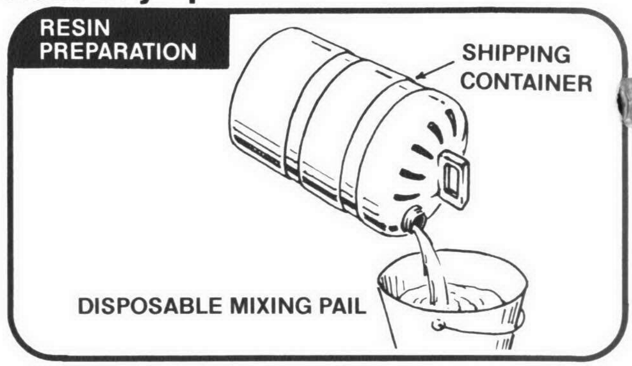
TBSP. OF CATALYST/QUART OF RESIN

AMBIENT TEMPERATURE (DEG. F)			
60	70	80	90
8	6	4	2



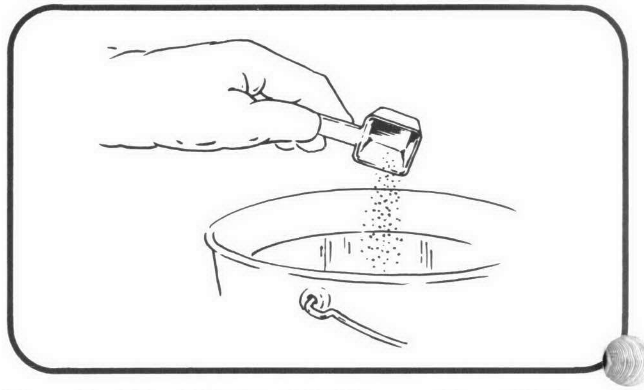
Using shears, cut the bi-ply material to the length given in Table B.

Hand Lay-up



Pour resin from the shipping container into a disposable mixing pail. The quantity required is given in Table D.

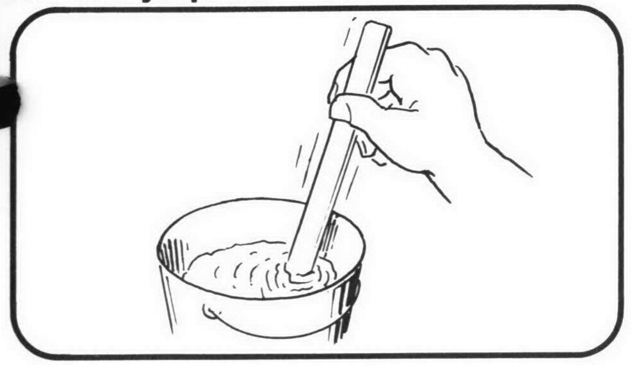
NOTE: Keep the resin at a minimum of 60°F for several hours before use.



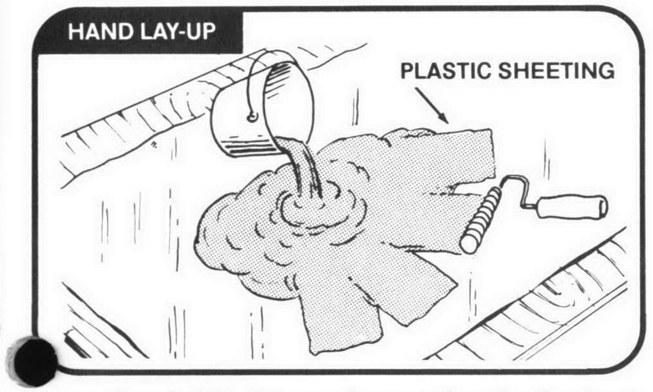
Do not add catalyst until after you have followed the instructions on pages 32-35.

Add the catalyst quantity given in Table E to the resin, see page 35. Use a standard measuring spoon.

Hand Lay-up



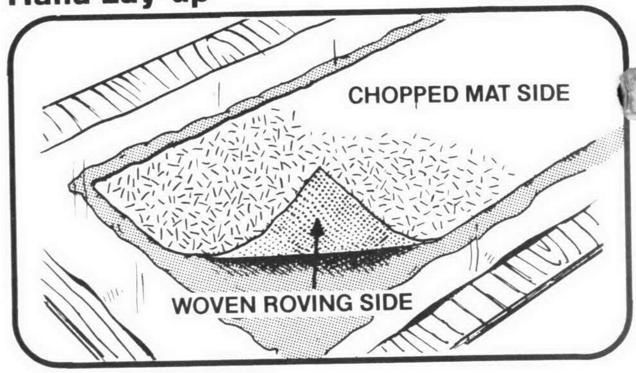
Begin stirring the mixture **immediately.** Stir until the white specks of catalyst disappear (approx. 30 seconds).



Pour a fourth (¼) of the resin onto the plastic sheet.

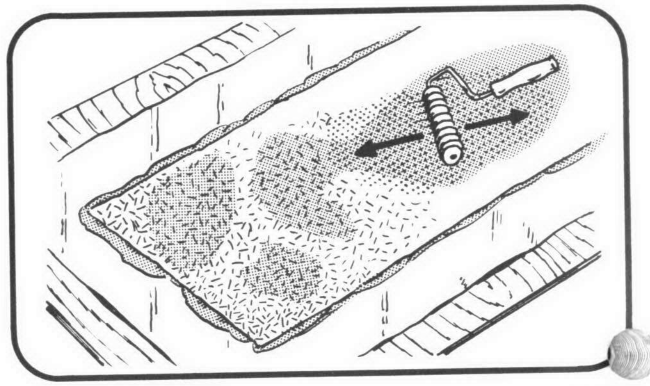
Spread the resin over the entire sheet with a roller or brush.

Hand Lay-up



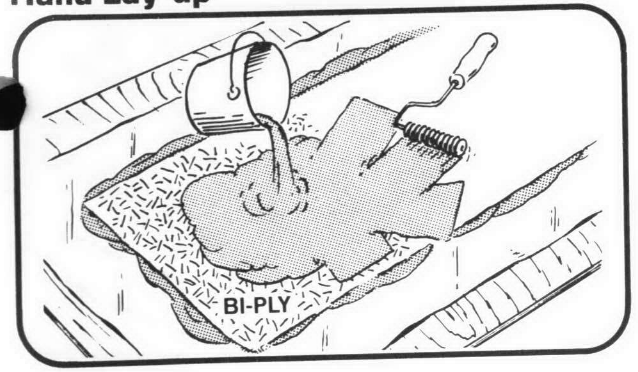
Lay a piece of bi-ply onto the sheet, with the woven roving side facing down.

Center the bi-ply on the sheet.



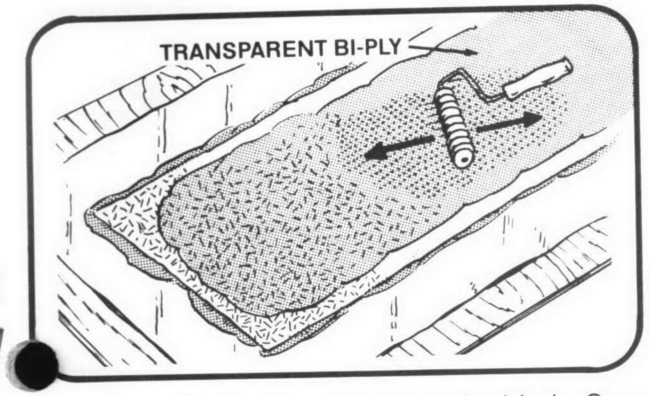
Move the metal roller back and forth on the bi-ply until most of the resin is absorbed. Use **only** a finned, metal roller.

Hand Lay-up



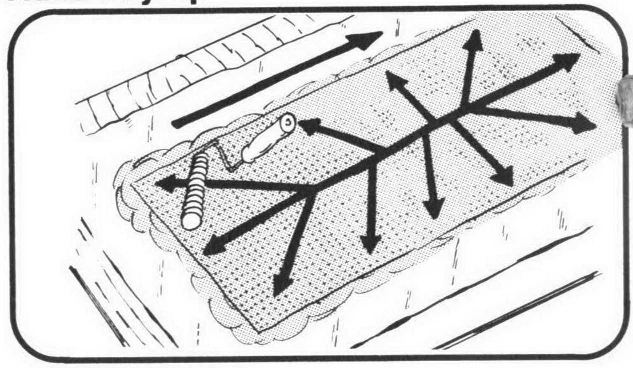
Pour the remaining resin onto the bi-ply.

Spread the resin over the entire bi-ply surface using the metal roller.



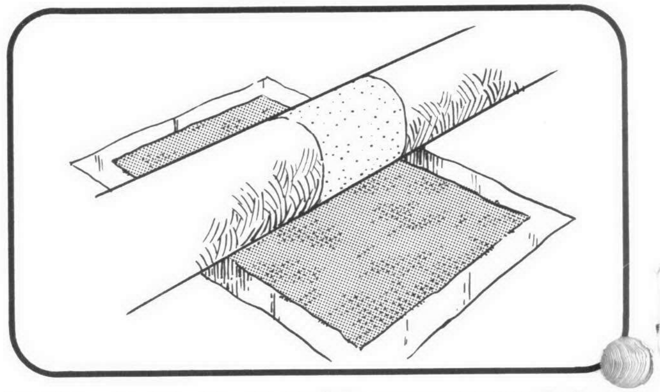
Move the roller back and forth on the bi-ply. Continue until the bi-ply appears transparent.

Hand Lay-up



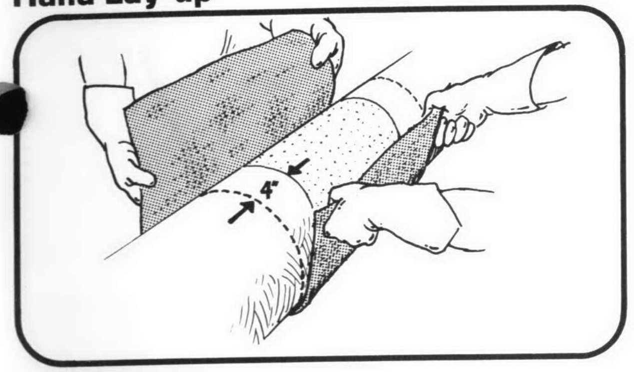
Roll out the excess resin. Push the resin from the middle of the bi-ply out over the edges.

Begin rolling at one end and gradually move to the other end, making sure all excess resin is removed.

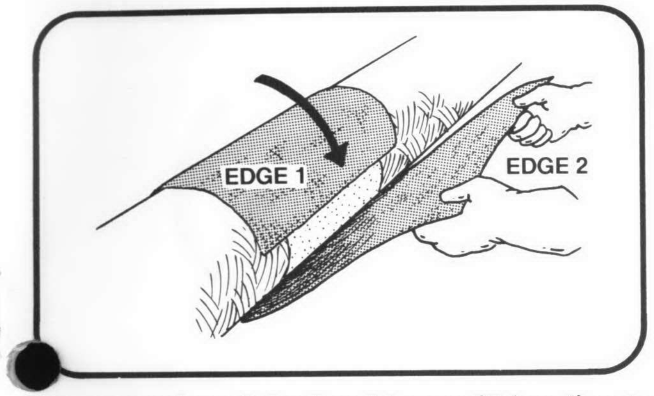


Lift the plastic sheet at all four corners and place it under the field closure. Use two people when lifting the hand lay-up.

Hand Lay-up



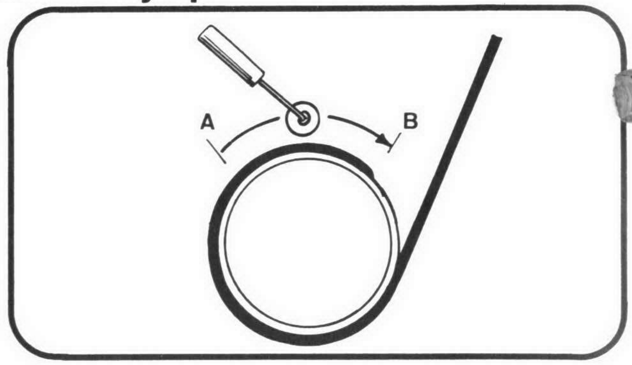
Peel the corners of the hand lay-up off the sheet. Lift the hand lay-up at all four corners and center it about the field joint. The hand lay-up should extend 4" past each jacket edge.



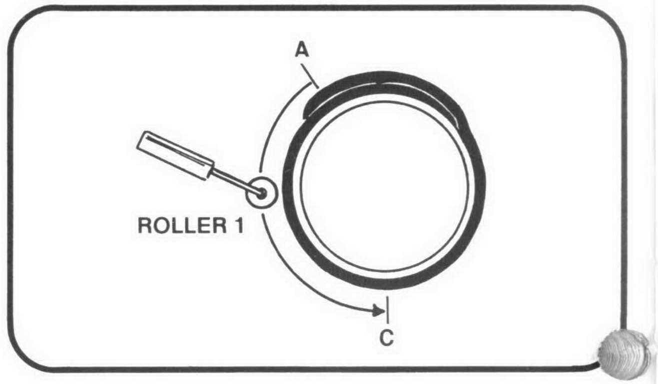
Lay one edge of the hand lay-up (Edge 1) onto the field joint surface.

Continue to hold the other edge (Edge 2) in place.

Hand Lay-up



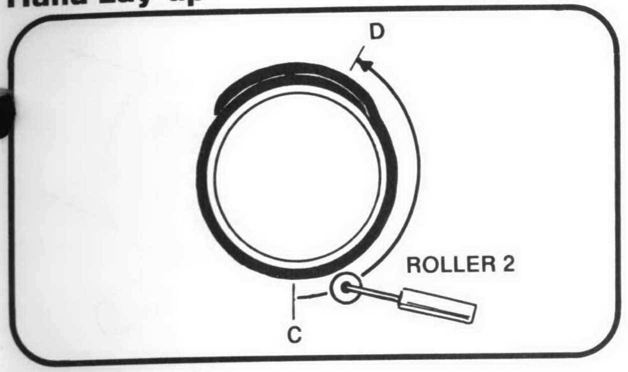
Move the roller (Roller 1) along the hand lay-up from Point A to B pushing out any trapped air. Repeat from A to B along the entire hand lay-up width.



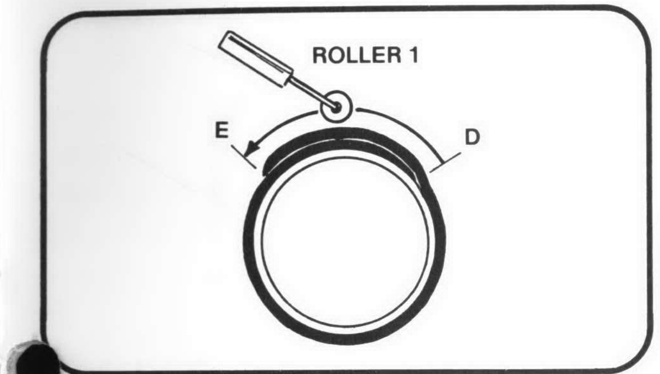
Lay down Edge 2, overlapping Edge 1.

Move Roller 1 down along the hand lay-up from Point A to C pushing any air to the bottom.

Hand Lay-up

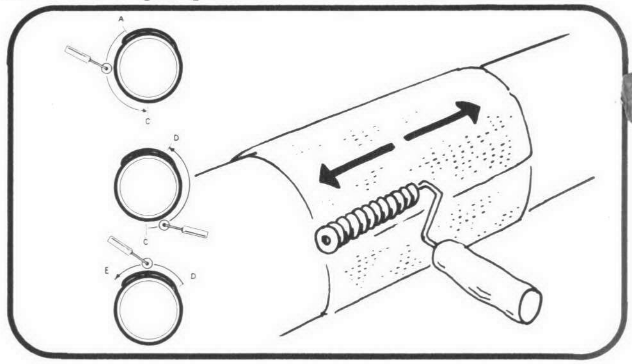


The other person moves Roller 2 up from Point C to D pulling any air to the top.

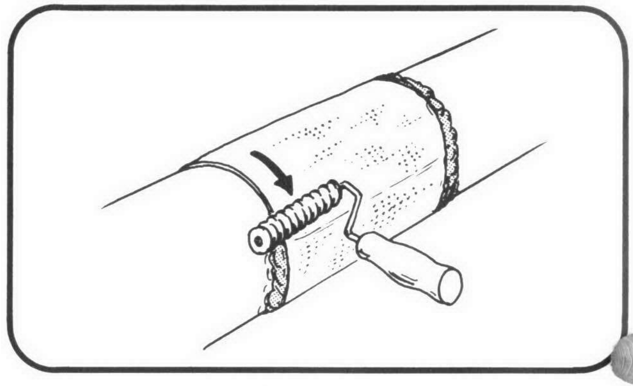


Move Roller 1 from Point D to E pulling any air out of the hand lay-up.

Hand Lay-up

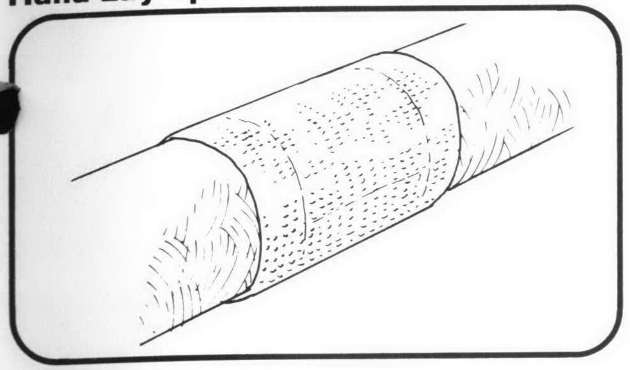


Repeat the last three steps along the entire width of the hand lay-up. Begin in the middle and move out to the side edges.



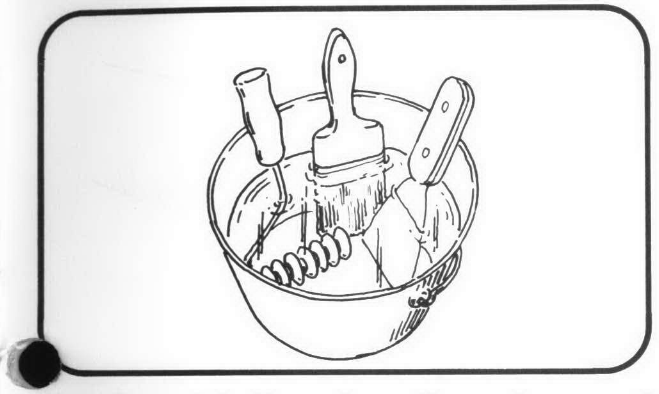
Remove any remaining air bubbles using the same procedure. Roll any excess resin off the side edges of the hand lay-up.

Hand Lay-up



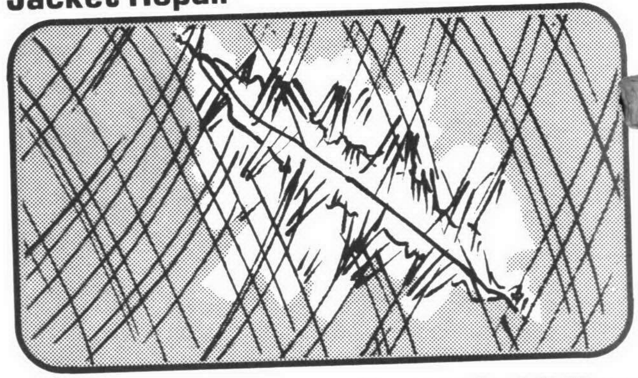
Let the hand lay-up cure for at least 24 hours before backfilling.

Contact your PERMA-PIPE representative about any field joint closure problems.



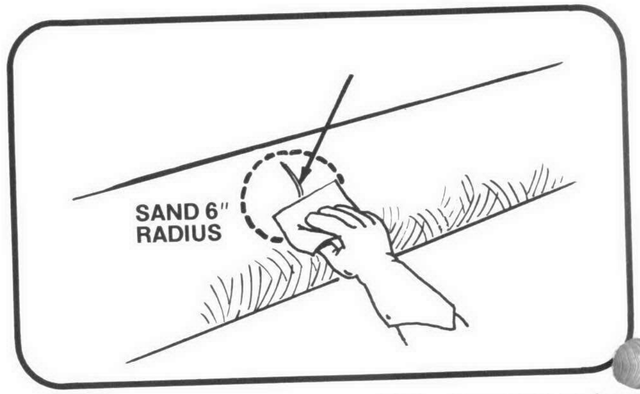
Place the metal roller and any other resin-covered tools in a pail of acetone after each field joint closure. Clean the tools thoroughly at the end of the day.

Jacket Repair



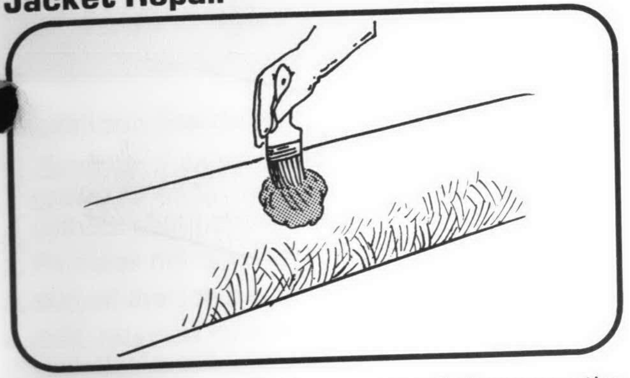
A casing has been **severely scratched** if fiber-glass strands are exposed or the casing wall has been chipped or penetrated.

Consult your PERMA-PIPE representative and perform the following repair procedure if necessary.



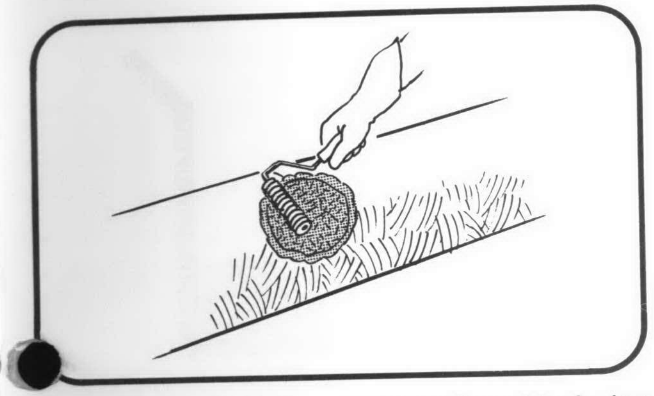
Sand a 6" radius area around the damage, using sandpaper or emery cloth. Wipe the area clean with acetone.

Jacket Repair



Cut a piece of bi-ply large enough to cover the repair area.

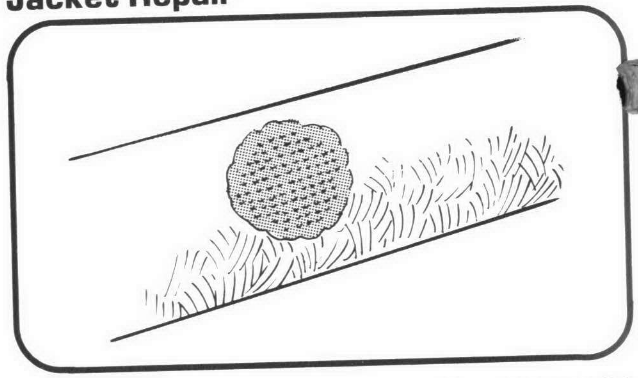
Prepare one quart of resin, see page 34. Pour a fourth (¼) of the resin onto the repair area and spread with a brush.



Lay a piece of bi-ply, woven roving side facing down, onto the repair area.

Pour the remaining resin onto the bi-ply. Roll out the bi-ply until it appears transparent.

Jacket Repair

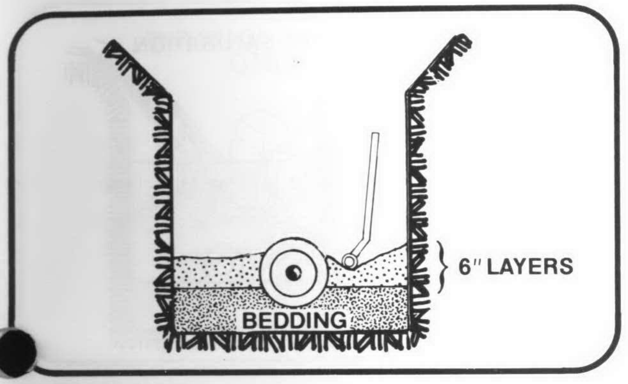


Let the hand lay-up repair cure for at least 24 hours before backfilling.

1st Stage

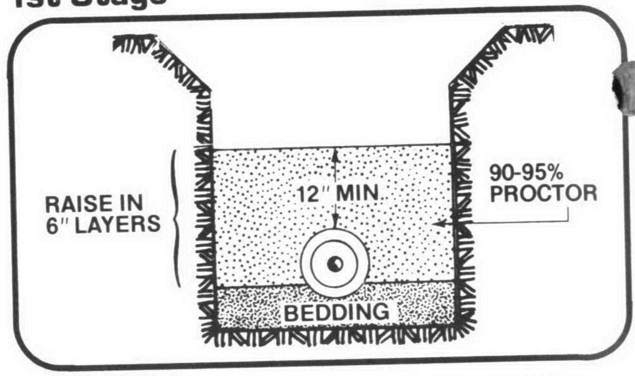
Backfill soil description:

1. Sand or a sand-gravel mixture in which the gravel is either pea gravel or crushed stone without sharp edges.
2. Particles not larger than ½."
3. 90% of the soil passing a No. 4 sieve.
4. 90% retained by a No. 200 sieve. Separate all unsuitable soil from the backfill soil.



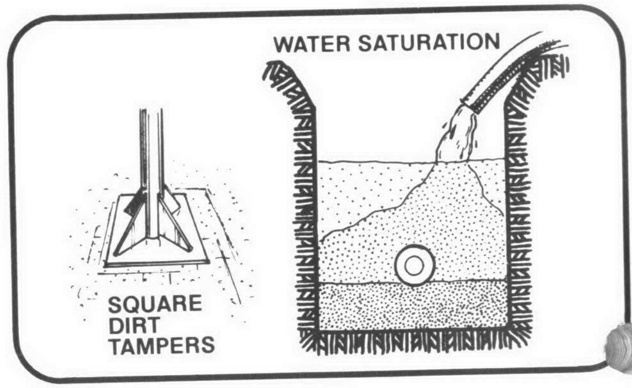
Remove any foreign material like shoring, braces or support blocks. Carefully compact the area around the pipe in 6" layers.

1st Stage



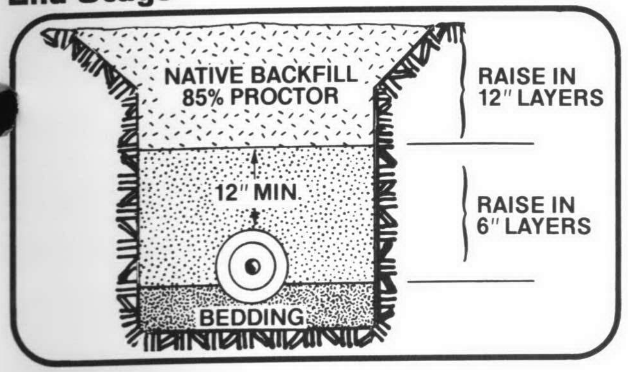
Use the described backfill soil to **at least** 12" above the top of the pipe. Compact in 6" layers to 90-95% modified proctor density.

If there are **surface loading** conditions, backfill to surface grade in this manner.

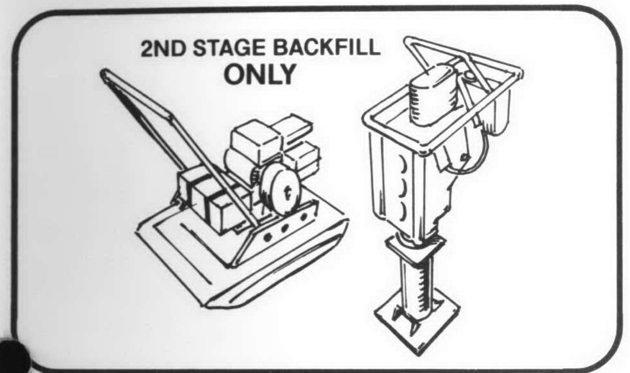


Hand tamping and/or water saturation is recommended for compaction. Contact your PERMA-PIPE representative for approval of any other methods.

2nd Stage



If there are no surface loading conditions over the system, backfill to grade and compact to 85% modified proctor density. Native soil can be used.



PERMA-PIPE recommends using mechanical compaction equipment to complete the **2nd Stage** of backfill.

Do not use mechanical compactors until the pipe is covered with **at least** 12" of firmly compacted soil.

TECHNICAL SUPPLEMENT

SECTION II

RECEIVING

Unloading

Visually inspect each Poly-Therm assembly for damage during unloading. Your PERMA-PIPE representative must be present during receiving of each shipment.

Poly-Therm assemblies must be handled carefully during installation to avoid damaging the corrosion-proof fiberglass jacket.

PERMA-PIPE's unique fiberglass Poly-Therm is designed to be impervious to corrosion and strong enough to withstand heavy soil loads and system pressures. The FRP jacket is extremely durable, however, if damage does occur due to improper handling the jacket must be either repaired or replaced at the customer's expense. Proper handling, as described in this manual, will result in a successful installation at a minimal cost.

Support each Poly-Therm assembly with **two nylon slings** during all phases of handling. The nylon slings serve two important purposes. First, they prevent severe scratching and/or chipping of the jacket. Steel cables or chains are not acceptable because they tend to cause this type of damage. Nylon slings are loaned free of charge by PERMA-PIPE.

Secondly, the use of **two** slings provides much more control of the pipe movement. A 40 foot section of pipe suspended by a single line is extremely likely to swing out of control. This greatly increases the chances of damaging the pipe against trucks, buildings, and equipment.

PERMA-PIPE recommends that even more control be exercised by choking the slings around the pipe or using a spreader bar if one is available. These practices are shown in Section I—pages 2-3, and should be used for all the handling phases.

Storage

If the storage of the Poly-Therm assemblies requires field stacking, stack the assemblies in the same fashion that they were received.

Poly-Therm assemblies can be considerably damaged from improper storage.

If the Poly-Therm assemblies will be stored outdoors longer than 6 months, cover them with a dark tarp as a shade against the sun.

Store all field materials in a dry area. Stack the materials on wooden pallets, covered with a tarp to prevent water contamination from flooding or rain.

Keep the field materials in their shipping containers. Store the resin, catalyst, and insulation components in a cool location. Separate the resin and catalyst by several feet to prevent any chemical interaction.

Keep all chemicals away from heat, flames and sparks. Sprinklers should be provided in storage areas. Have fire extinguishers and water readily available. See Page 71 for further information.

Recommended Storage Temperature
60-85°F (18-29°C)

Maximum Storage Temperature
100°F (38°C)

Do not use fiberglass bi-ply that has been wet, even if attempts are made to dry it out. Water can never be fully removed from the bi-ply. Using dried out bi-ply will usually result in a defective hand lay-up.

In addition, water affects the proper curing of the resin. Resin that has been contaminated by rain, oil or any other foreign substance **must not** be used. Contact your PERMA-PIPE representative about purchasing additional resin.

EXCAVATION

All types of flexible pipe derive some of their strength from the passive soil resistance on the sides of the pipe. Therefore, the proper excavation of the trench is very important to ensure a structurally sound system.

Usually the centerline dimensions for the placement of the pipe in the trench can be found in the submittal drawings.

Poly-Therm pipe is designed to handle normal soil and H-20 loading. If PERMA-PIPE's recommended procedures are followed, a minimum burial depth of 2 feet is allowed. Note that shallower burial depths increase heat losses slightly.

Special analysis of minimum burial depths is required at taxiways, runways, railroads, and other areas of high surface loading conditions. It is recommended that the customer contact both PERMA-PIPE and the local authority for more specific instructions.

PERMA-PIPE recommends that the trench width be minimized as much as possible, leaving only enough room to position the pipe.

The trench should be considerably wider at field joint locations to allow room for welding and field joint closure. Additional room should be provided by digging bell holes. Bell holes are simply small ditches dug in the base of the trench at field joint locations. Experience shows that bell holes about 3 ft. across and 1½-2 ft. below grade permit the most freedom at a minimum additional excavation cost. After completing the field closure, fill the bell holes and compact the soil to a 90-95% modified proctor density.

The trench floor should be completely cleared of stones and rocks and covered with a 4″ bedding. The bedding soil should correspond with the soil description in Section I—page 49.

An unstable soil condition is occasionally encountered during excavation, usually with deep burials. Shore the trench walls before lowering any Poly-Therm assemblies into the trench.

State and Federal regulations for shoring should be followed where applicable. As the shoring is removed, it should be replaced with backfill soil.

Organic soils or plastic clays and silts with high liquid limits may be encountered that are incapable of supporting the pipe. Remove the poor soil and replace it with the proper bedding soil to a depth that will provide a firm stable foundation.

ASSEMBLY

Layout

After excavation is complete, the Poly-Therm should be distributed along the trench. Installation can be simplified by laying the assemblies in order along the trench according to the P.D.L.

If the project includes PermAlert, consult the **PermAlert Installation Supplement.**

Lowering

Poly-Therm field joint closures must not be fabricated before the assemblies are in their final position in the trench. Even if the lowering equipment is sufficient to lift more than one section, PERMA-PIPE cannot certify a system installed in this manner. Contact your PERMA-PIPE representative if a special problem arises.

Pipe Connections

Before continuing, check to see if the legs of the expansion loops are perpendicular to the rest of the run and parallel to each other. If the legs of the loop are not positioned correctly, it may affect the length of the run.

Field Closure

PERMA-PIPE provides enough materials to complete the field joint closures under normal work conditions. Using more than the prescribed quantities or excessive waste might result in shortages on the overall project. If you feel you are running short of materials, contact your PERMA-PIPE representative for the purchase of additional materials.

Insulating

The metal molds provided by PERMA-PIPE can be used in insulating at least ten field joints given proper maintenance. Prior to each use the mold must be coated with Mold Release. This is commonly found in fiberglass supply houses. Non-stick coating sprays such as PAM™ can also be used.

The entire inside surface of the mold must be coated. Insulation tends to stick to uncoated portions of the mold and will damage both the insulation and the mold upon removal from the joint.

After each use clean the inside of the mold with acetone or a similar cleaning solvent to remove any dirt or insulation.

It is important to fasten the mold tightly around the field joint. Gaps between the mold and the FRP jacket will allow some of the rising insulation to escape. This could result in an incomplete pour and require mixing another small batch of insulation.

Each day before using a shipping container, turn it upside down for about 15 minutes. This ensures that each component is properly mixed prior to being used.

Table C lists the quantity for each insulation component. Two containers, each large enough to hold the given quantity are required. Mark one of the containers **A** and the other **B**. Pour the given quantity into **each** container. DO NOT combine the two mixtures until you are ready to begin insulating the field joint.

Once the components have been combined it is extremely important to **mix them well.** If they are not mixed well enough the resulting foam will not expand at its specified rate and the field joint will not fill completely. This requires mixing an additional batch. Experience with one or two pours and assistance from our representative should solve any problems.

A small amount of foam will expand in the bottom of the pail after a pour, requiring disposal of the pail. It is recommended to use **disposable** paper pails large enough to accommodate both component volumes.

Let the mold cool for about five minutes after the foam rises out the top holes. The mold will be **extremely hot.** After removing the banding, peel the mold carefully off the insulation. If this is not done, the mold and the insulation will probably get damaged. It the mold sticks repeatedly, use more mold release.

If the fiberglass hand lay-up is not completed immediately after either the service pipe connection or insulating, plastic sheeting should be sealed around the field joint. If any of the insulation in the field joint or preinsulated assembly becomes wet it must be removed and replaced. Water contaminated insulation cannot be dried out. This may require replacement of the entire assembly at the customer's expense.

Hand Lay-up

CATALYST

It is very important to use exactly the correct amount of catalyst for each hand lay-up. Heat controls the reaction of the catalyzed fiberglass hand lay-up. The catalyst quantities given in Table E are based on specific temperatures. The temperature of a hand lay-up varies considerably, depending on the amount of sunlight, the humidity level, and the work surface.

If the field joints are not cured in 30 minutes, add an additional 1/4 tablespoon of catalyst for every quart of resin used. Subtract 1/4 per quart of resin if the curing takes less than 30 minutes. Adjust this amount depending on the weather conditions.

Avoid adding too much catalyst to the resin. Trying to achieve a gel time faster than the recommended 30 minutes will result in a cracked and unreliable field closure.

CAUTION: Over-catalyzation can result in an explosive reaction with the resin.

ROLLING OUT
PERMA-PIPE provides a finned, metal laminating roller for rolling out the hand lay-ups. The fins are designed to allow air to escape. This roller is made specifically for this type of application. It does a very good job of impregnating the bi-ply with resin. Consult your PERMA-PIPE representative if any other types of rollers will be used.

Make sure that the entire bi-ply surface appears clear after rolling it out on the supported plastic sheet. This indicates a properly wetted-out hand lay-up. Once it is fully wetted out, all the excess resin must be removed. Leaving excess resin on the hand lay-up may make it sag when wrapped around the conduit.

Position the hand lay-up onto the jacket as described in Section I. If for some reason the hand lay-up is put on incorrectly, carefully peel it off and re-wrap it while it is still wet.

When rolling out the hand lay-up on the jacket, it is extremely important to follow the step-by-step pattern described in Section I. This pattern is designed to remove all the air from underneath the hand lay-up. Most air pockets will be visible through the hand lay-up if it has been properly wetted out. The rolling pattern moves any air around the conduit and out the top in a systematic way.

When the hand lay-up is dry, inspect if for loose strands (especially the bottom). Trim the strands and repaint the areas with catalyzed resin.

Field Alterations

All field modifications to the Poly-Therm system must be cleared with PERMA-PIPE. Changing the length or direction of the system may result in a faulty installation requiring costly repairs in the future.

Every installation should have field verification of the submittal drawings. This will eliminate most dimension problems and will also allow PERMA-PIPE time to re-engineer the system if needed.

Even with field verification, there will occasionally be an installation that does not run true to plan. If additional materials are required, contact your PERMA-PIPE representative immediately.

If it is necessary to lengthen or shorten a run, your PERMA-PIPE representative will specify where to make the modifications. The position of the modification will depend on the nature and location of the problem.

You must also contact your PERMA-PIPE representative before modifying the direction of a run. Written authorization is required or PERMA-PIPE's warranty may be void.

Jacket Repair

In some rare cases, severe mishandling of the Poly-Therm assemblies may result in a scratch or chip in the FRP jacket. Following the guidelines in this manual should prevent most mishaps. If damage is found on the surface of the jacket, contact your PERMA-PIPE representative.

If the jacket is determined to be **severely scratched,** it will be necessary to perform a simple, quick repair, see Section I—page 46.

The repair follows essentially the same procedure as the hand lay-up. A repair hand lay-up uses a piece of bi-ply, but is wetted out directly on the jacket instead of a plastic sheet. Roll out the hand lay-up to conform to the repair surface. If the repair is on the lower half of the jacket, keep rolling it out until it begins to harden.

PERMA-PIPE provides enough material to make one repair for every ten assemblies shipped.

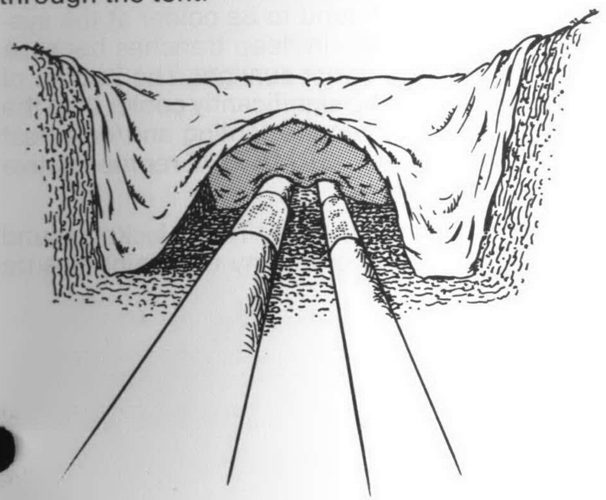
Weather Effects

COLD WEATHER

As with most plastics, a low ambient temperature will adversely affect the expansion of the insulation and the curing of the resin.

Use the following tenting procedure in cold weather.

Fabricate a tent around each field joint. It should be large enough to enclose two men and the entire working area needed to fabricate the field closure. Tie down the tent so that cold drafts don't flow through the tent.



Field Closure Tent

Heat the tent to a minimum temperature of 60°F using a heat source at one end of the tent. If a flame type heat source is used, it is recommended to mount it outside the trench. Duct work should be placed to direct the heat into the tent.

Provide ventilation in the tent to remove any fumes given off by the insulation or resin.

The insulation required increases as the ambient temperature is lowered. Shortages on joints insulated at temperatures below 60°F. will be replaced at the customer's expense.

The amount of catalyst may need to be increased depending on the ambient temperature and wind chill. The jacket will tend to be colder at the system grade, especially in deep trenches because of the shade from direct sunlight. The bottom of the jacket can also be significantly cooler than the top side. This may require tenting and/or a heat source. Contact your PERMA-PIPE representative if any problems arise.

Wipe off any frost on the Poly-Therm jacket around the field joint area before any field joint closure fabrication.

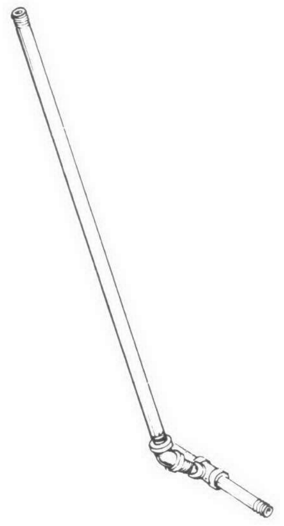
RAIN AND SNOW

If insulating or hand lay-ups are done during rain, it is extremely important to keep the field joint and materials completely dry. PERMA-PIPE does not recommend any insulating or hand lay-ups in a wet environment since even the smallest amount of water contamination will damage the materials.

Insulated field joints soaked with water are considered damaged and must be replaced. If an uncovered field joint becomes soaked with water it may be necessary to replace any damaged prefabricated sections of pipe.

BACKFILL

The most crucial part of the backfill process is the compaction of soil underneath and alongside of the pipe. A hand tamping device can be constructed easily and economically by joining small diameter pipe. This tool will compact the soil firmly and evenly around the pipe. It should be used in place of mechanical tampers when compacting around the pipe to prevent damage to it.



Compaction Tool

CHEMICAL SAFETY

Insulation

(Part A) Diisocyanate
(Part B) blowing agent

CAUTION—Flammable Liquids

FIRE: Keep away from heat, open flame, and sparks. No smoking is permitted around this material. Fight fire with CO_2, water, dry chemical, or foam extinguishers. Never use welding equipment or a cutting torch near any insulation containers. Excessive heat may produce pressures that will rupture shipping containers.

WARNING: Harmful if inhaled. Avoid breathing vapors. Use a NIOSH approved respirator and have adequate ventilation. Harmful if swallowed. Do not store near food or drink. Do not get in eyes or on skin. Wear chemical splash goggles and rubber gloves.

FIRST AID:
EYE—Immediately flush with plenty of water for at least 15 minutes. See a physician immediately.

SWALLOWING—Immediately contact a physician. Refer physician to local poison control center or 213/664-2121 or 617/232-2120, day or night.

SKIN—Flush with soap and water.

INHALATION—Remove to fresh air and contact a physician if discomfort persists.

Catalyst

BENZOYL PEROXIDE (BFF-60)

CAUTION—Flammable Solid

FIRE: Keep away from heat, open flame, and sparks. No smoking is permitted around this material. Fight fire with water, dry chemical or foam extinguishers. Never use welding equipment or a cutting torch near any catalyst containers.

WARNING: Harmful if inhaled. Avoid breathing dust. Use a NIOSH approved respirator and have adequate ventilation. Harmful if swallowed. Do not store near food or drink. Do not get in eyes or on skin. Wear chemical splash goggles and rubber gloves.

FIRST AID:
EYE—Immediately flush with plenty of water for at least 15 minutes. See a physician immediately.

SWALLOWING—Induce vomiting. Immediately contact a physician. Refer physician to local poison control center or 213/664-2121 or 617/232-2120 day or night.

SKIN—Flush with soap and water.

INHALATION—Remove to fresh air and contact a physician if discomfort persists.

This information is intended for First Aid only and patients must contact a physician for treatment.

SPILLS OR LEAKS: Cover with sand or earth. Transfer to waste container. Flush residue with water. Dispose of, consistent with Federal, State and Local regulations.

Resin

THERMOSETTING RESIN

CAUTION—Flammable Liquid

FIRE: Keep away from heat, open flame, and sparks. No smoking is permitted around this material. Fight fire with water, dry chemical or foam extinguishers. Vapors are heavier than air and may travel along the ground. Never use welding equipment or a cutting torch near any resin pails or containers (even if empty).

Flashpoint—73-100°F (23-38°C).

WARNING: Harmful if inhaled. Avoid breathing vapors. Use a NIOSH approved respirator and have adequate ventilation. Do not get in eyes or on skin. Wear chemical splash goggles and rubber gloves.

FIRST AID:
EYE—Immediately flush with plenty of water for at least 15 minutes. See a physician immediately.

SWALLOWING—Do not induce vomiting. Immediately contact a physician. Refer physician to local poison control center or 213/664-2121 or 617/232-2120 day or night.

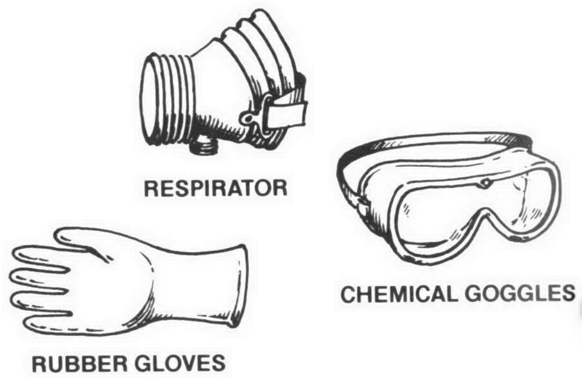
SKIN—Remove contaminated clothes, wash with soap and water for at least 15 minutes. Wash contaminated clothing before reuse.

INHALATION—Remove to fresh air and contact a physician if discomfort persists.

This information is intended for First Aid only and patients must contact a physician for treatment.

SPILLS OR LEAKS: Cover with sand or earth. Transfer to waste container. Flush residue with water. Dispose of, consistent with Federal, State and Local regulations.

EMPTY CONTAINERS: Resin containers when empty will contain vapors, liquids, or solid residue that may be hazardous. Keep all containers away from heat, sparks, and flames.



Safety Equipment

GLOSSARY

Anchor A metal plate, factory joined to both the service pipe and casing to arrest movement of the pipe.

Anchor Blocks Concrete poured around the anchors.

Assembly A preinsulated piece of Poly-Therm.

Bell Hole A hole dug out at field joint locations to enlarge the work area.

Bi-ply A fiberglass material consisting of woven roving and chopped mat that provides the structural strength to the hand lay-up.

Carrier Pipe The service pipe.

Casing The FRP outer jacket protecting the insulated pipe line.

Catalyst A chemical which starts the reaction between the resin and the bi-ply.

Coupling Gap The extra space needed between two service pipes when welding with a socketweld coupling.

Critical Period An installation period requiring supervision by your PERMA-PIPE representative.

Elbow (ell) A mitered fitting which produces a change in direction.

Expansion Loop A U-shaped assembly which allows for thermal expansion of the pipe.

Gel Time The time it takes for the catalyzed resin or hand lay-up to harden.

Gravel A coarse grained soil with 50% or more of coarse fraction retained on a #4 sieve. ASTM D 2487.

Hand Lay-up Manually combining resin and fiberglass and applying it to the field joint closure or repair area.

Hydrostatic Test A water pressure test of the service pipe welds.

Modified Proctor A density scale of soil compaction.

Mold Release A grease which prevents the pour foam insulation from sticking to the metal mold.

"Must" Indicates that a provision is mandatory if the system is to be installed properly.

Natural Angle of Repose The slope at which soil rests without artificial support.

Nominal Casing Size Outer diameter of Poly-Therm assembly in inches.

PDL The Part Drawing Layout is a diagram indicating the relative positions of the assemblies.

Preinsulated All possible work is done in the Perma-Pipe factory, leaving only field connections of assemblies.

Resin The liquid which combines with the bi-ply to form a reinforced plastic jacket.

Sand A coarse grained soil with more than 50% of coarse fraction passing on a #4 sieve. ASTM D 2487.

"Should" or "it is recommended" indicates that a provision is not mandatory, but considered good practice.

Socketweld Coupling A coupling used in welding small diameter pipe (2 in. or less).

Wetted Out The state in which the bi-ply and resin have been properly combined.

NOTES

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Perma-Pipe
America's Performance Piping Systems
PERMA-PIPE
Division of Midwesco Inc.
7720 Lehigh Avenue
Niles, Illinois 60648
312/966-2150 TWX 910/223-0825

PERMA-PIPE

EsCon-A

INSTALLATION
MANUAL

EsCon-A Installation Manual

INTRODUCTION

EsCon-A arrives at your job-site virtually assembled. Our in-plant fabrication means less field work and fewer complications at the job-site. This installation manual is designed to make the field work as easy as possible. The manual is divided into two sections for your convenience.

Section I is a set of step-by-step instructions supported by helpful illustrations which will guide you through completion in a straightforward manner.

Section II offers the reader a more detailed description of our product. This section will also answer many questions about the "crucial" periods of installation. Section II serves as an aid, not only to the contractor, but to the consulting engineer as well.

EsCon-A comes complete with experienced field service, assuring you a quick and smooth installation. Calling our convenient hot line connects you directly to one of our trained field servicemen — 312/966-2150.

EsCon-A is a fully engineered system. Our expert project design staff has tailored the system to your needs. If required, our entire engineering staff is prepared to work through field service to ensure the best possible technical assistance.

If installed using the recommended practices of this manual and the field service of Perma-Pipe, you can be sure that EsCon-A will give you the performance you require.

We're sure you'll complete a successful installation and join our growing list of satisfied customers.

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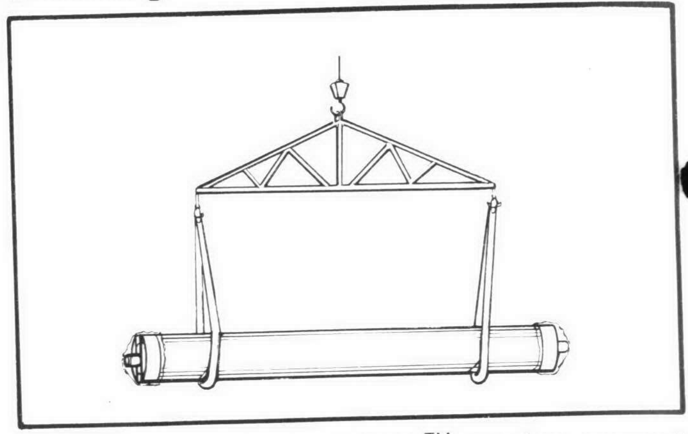
INSTALLATION INSTRUCTIONS

SECTION I

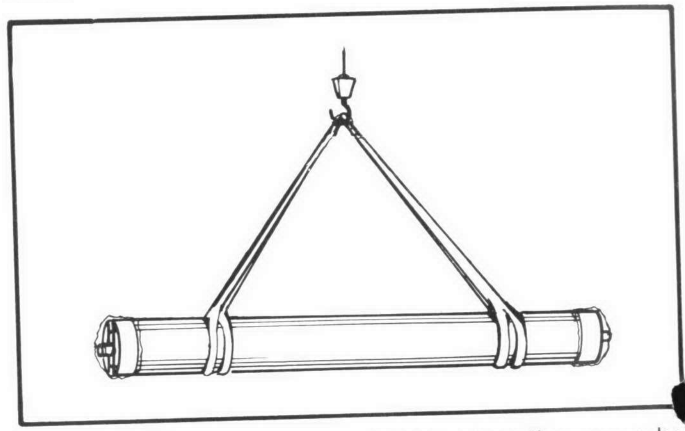
The following checklist should be used by the contractor when receiving the shipments:

- ☑ Our local field representative is to be present when shipment arrives and is unloaded.
- ☑ Check all shipped materials against the packing list for shortages.
- ☑ Inspect the EsCon-A as it is unloaded:
  1. EsCon-A pipe
  2. Boxes of insulation
  3. Repair materials
  4. Fittings and accessories
- ☑ List on the freight receipt all damages or shortages; otherwise claims cannot be accepted by the freight company.
- ☑ The subject of these claims should be brought to the attention of the Perma-Pipe field representative.
- ☑ Visually inspect all assemblies as they are unloaded and holiday test any coating areas that appear damaged.
- ☑ Locate the part drawing layout (P.D.L.) packed with each shipment.

Unloading

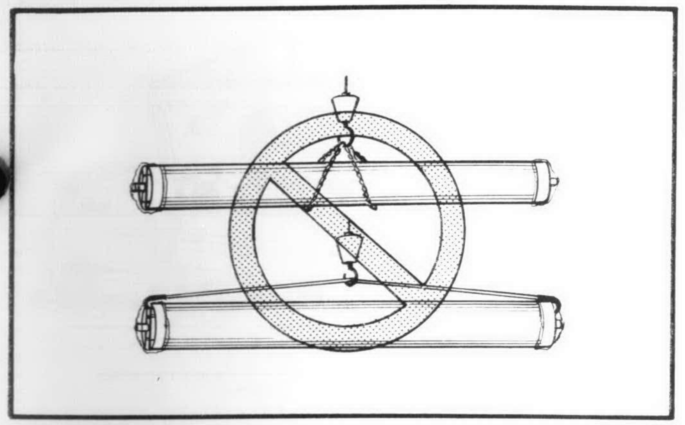


To protect the Elephant Hide™ coating, support each straight section of EsCon-A with the nylon slings provided. The slings should be spaced about 20 ft. apart. A spreader bar is recommended for this task.

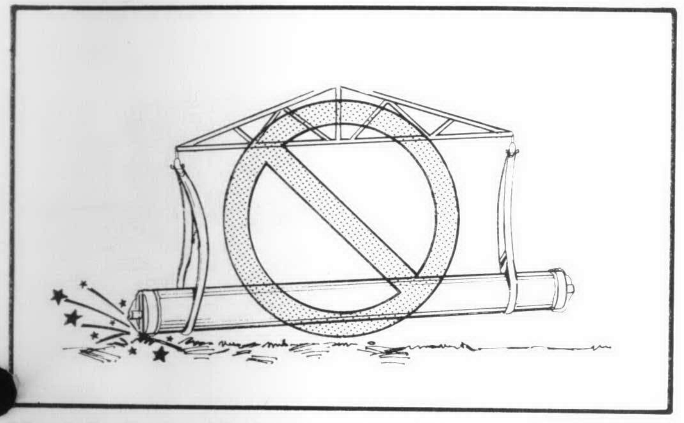


If a spreader bar is not available, the slings can be choked together as shown.

Unloading

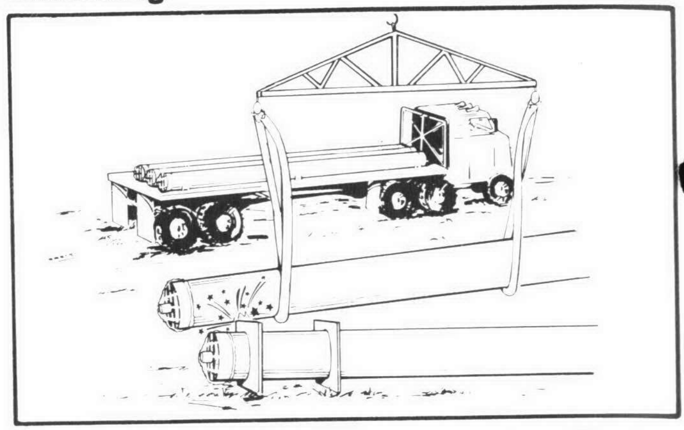


Steel cables or chains **must not** be used.



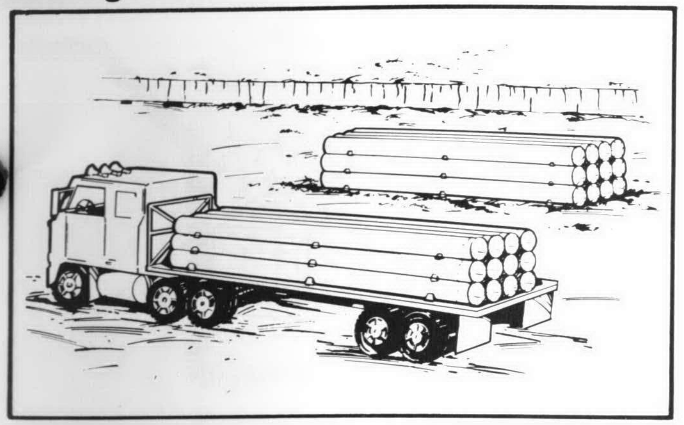
Hard drops or side bangs **must** be prevented.

Unloading

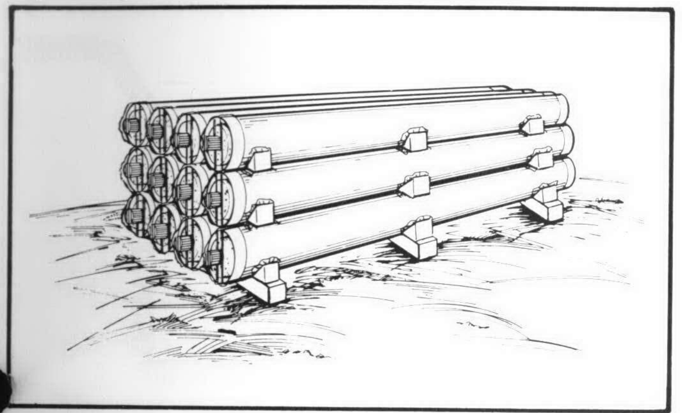


If accidental abuse occurs, inspect the Elephant Hide™ coating for damage. Repair if necessary.

Storage

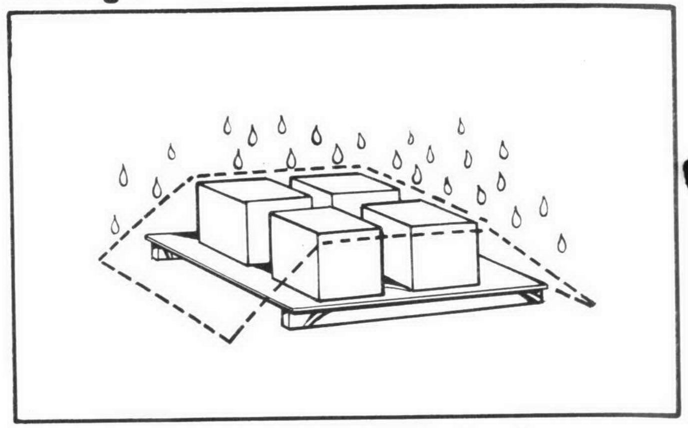


When stacking the EsCon-A for storage, restack it in the same fashion that it was received.
FOR PROLONGED STORAGE of EsCon-A, consult the Technical Supplement.

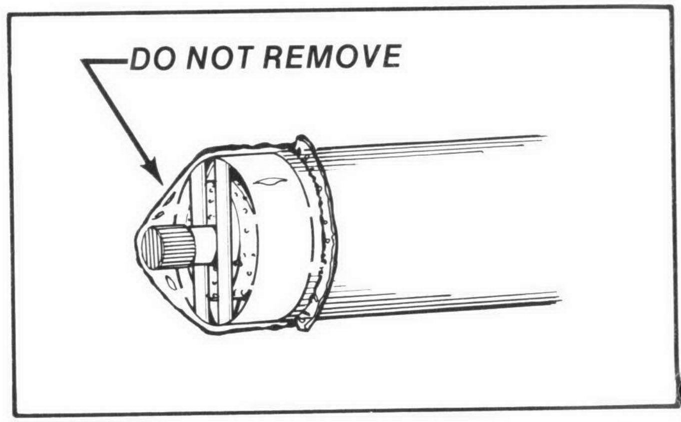


Storing EsCon-A for future use:
- ☑ Stack on the wooden shipping braces.
- ☑ Use foam or other padding between layers.
- ☑ Stacks should be located on high ground.

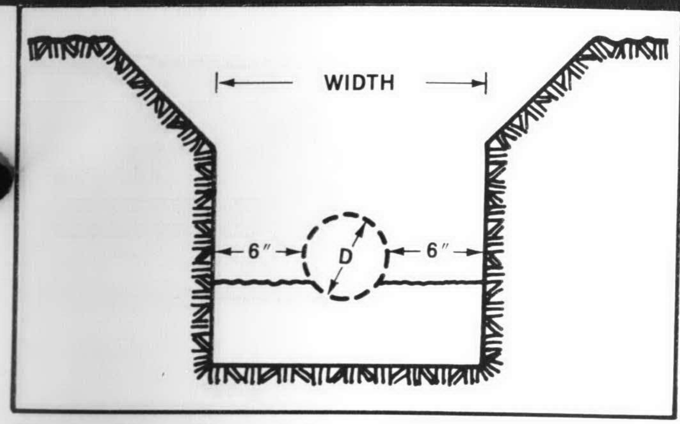
Storage



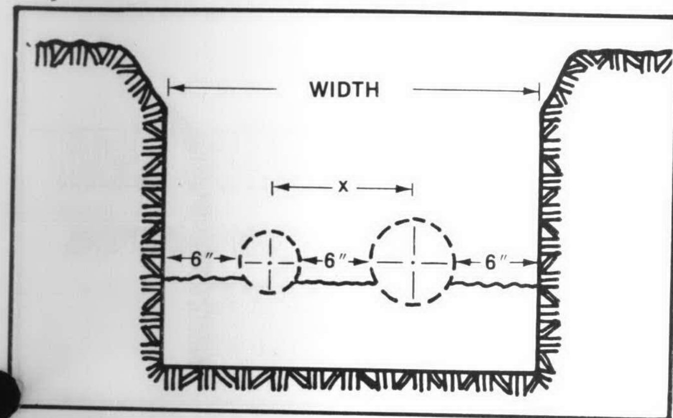
Store all field joint materials in a dry place.



Do not remove plastic coverings or end caps from the EsCon-A.



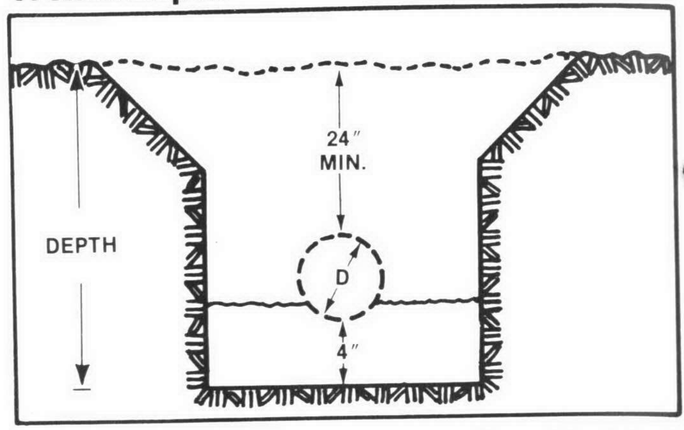
Single Pipe. The minimum recommended trench width for single pipe is 12″ plus the diameter of the conduit.



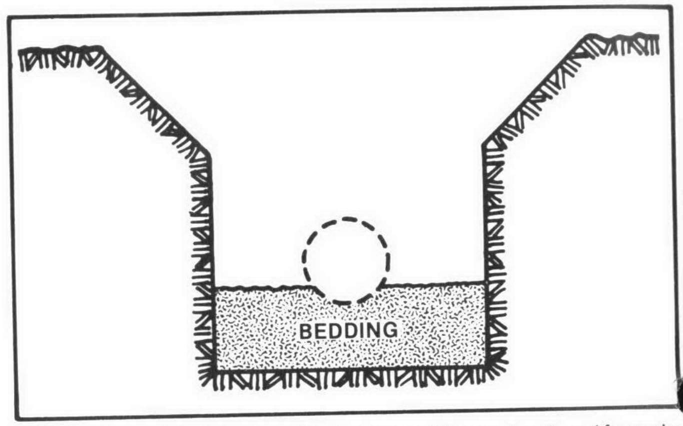
Multi-pipe. Centerline dimensions can usually be found in the submittal drawings. If centerline dimensions are not specified in the drawings, Perma-Pipe's standard recommendations can be found in Tables D and E in Section II. The center-to-center distance "x" for various combinations of EsCon-A is listed in Table E.

EXCAVATION

Trench Depth

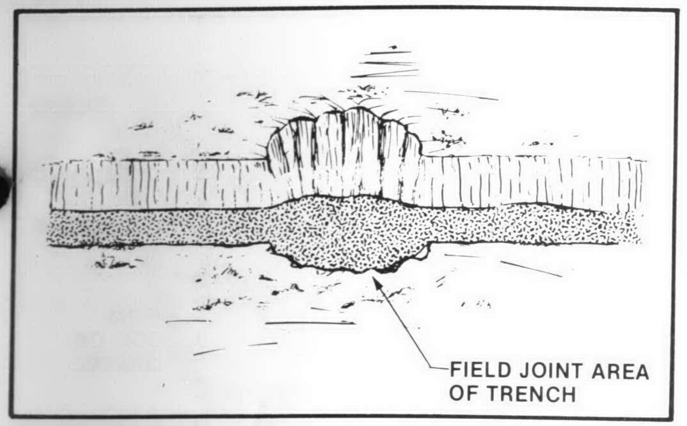


The total trench depth should allow for a 4-inch bedding, the pipe diameter, and a minimum 24″ cover depth above the pipe. See contract drawings for specific pipe burial depths.

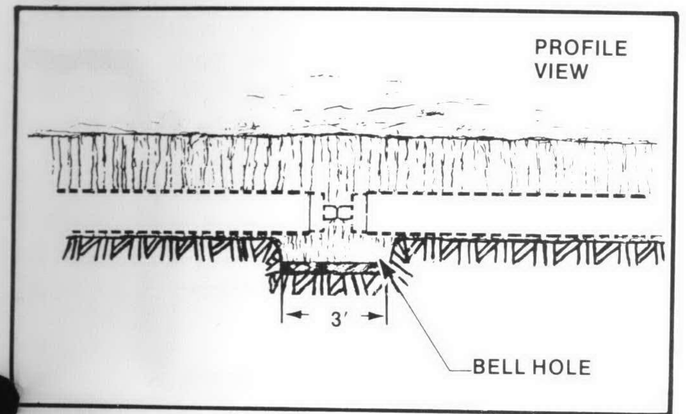


A minimum bedding of 4 in. must be raked uniformly along the entire length of the run. The bed of the run must be graded to a minimum slope of 1 in. per 40 ft. The bedding material should conform with the recommendations in ***Backfill.***

Bell Holes

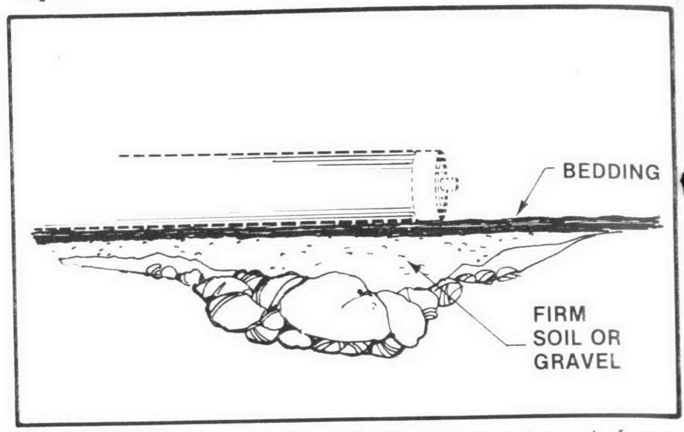


The trench should be made slightly wider at field joint locations, to allow for welding and testing.

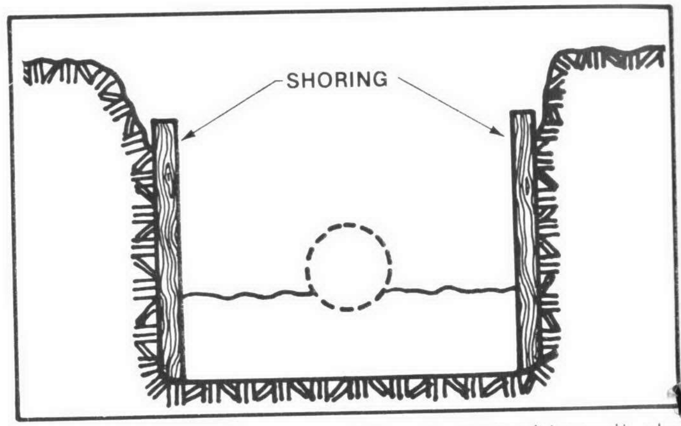


Bell holes approximately 3 ft. across should be dug at every field joint location before the EsCon-A is placed in the trench. For field joint locations, see the Part Drawing Layout. It may also be necessary to enlarge the trench at concrete anchor block locations, see page 20.

Special Trench Conditions

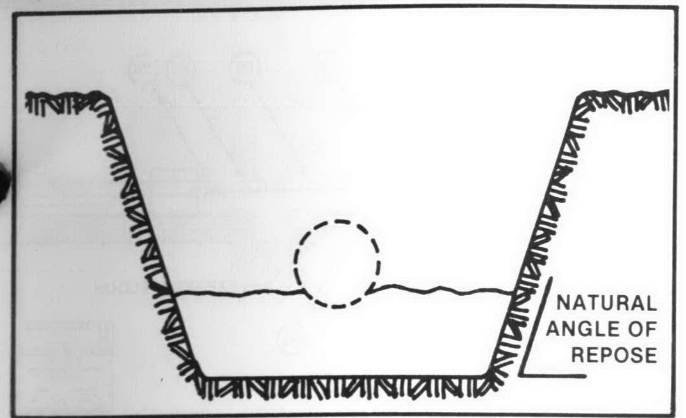


Rock bottom trench: A rocky or uneven trench foundation should be covered with a firm soil or gravel before the bedding is constructed.



Unstable soil: When trenching in unstable soil, do not lay any EsCon-A until the trench walls are stabilized with staybracing or shoring. Replace and compact the soil as the shoring is removed.

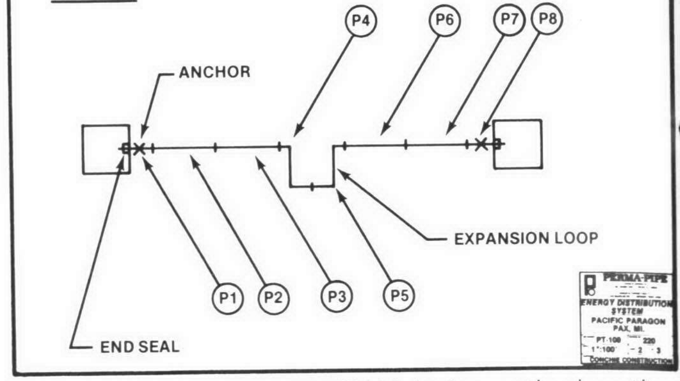
Special Trench Conditions



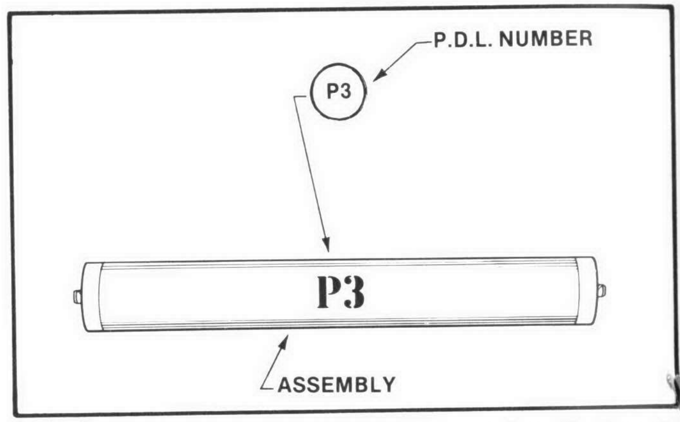
Granular soil: In granular soil, the trench wall should be sloped at the natural angle of repose.

Over-excavation: Any accidental over-excavation should be filled with bedding material and compacted to 90-95% modified proctor.

P.D.L.

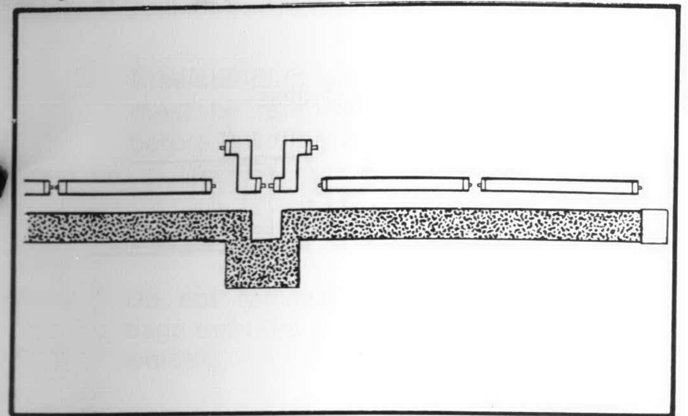


The part drawing layout (P.D.L.) shows the location for each EsCon-A assembly.

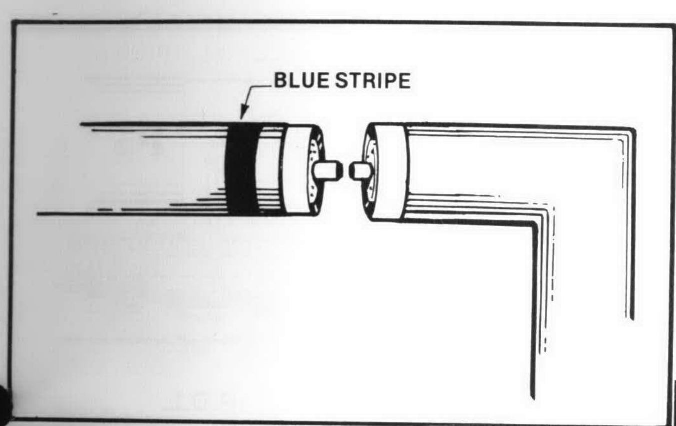


Each assembly is marked with a number that matches a number on the P.D.L. drawing.

Layout

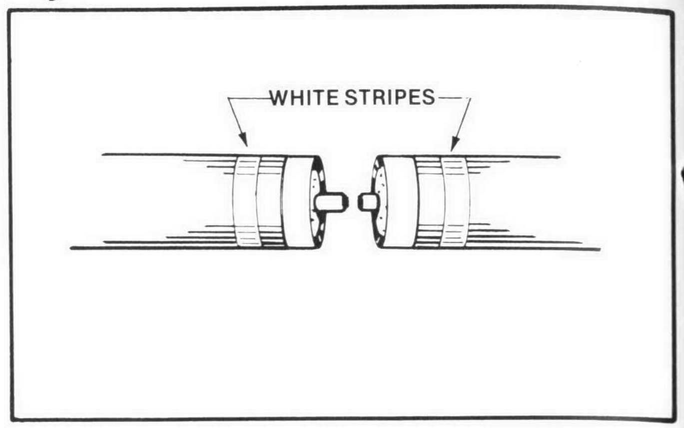


Laying assemblies in order next to the trench may simplify installation.

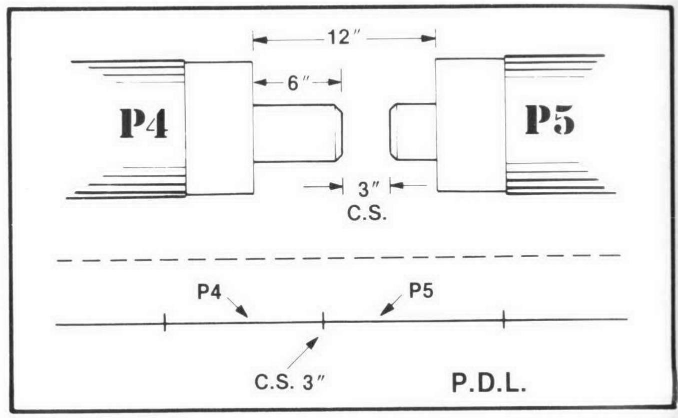


Straight run assemblies with a blue stripe on the end must be placed with that end toward the adjacent elbow.

Layout



Adjacent assemblies with white stripes should be positioned with the striped ends together.

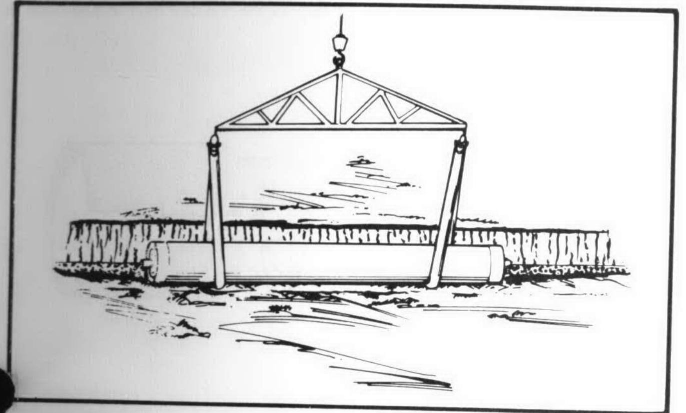


The white stripes show that this is a cold-spring location. This is also shown on the P.D.L. as "C.S." **Do not** connect these pipes until these instructions say to do so. It is important to maintain a 12″ gap between all adjacent outer casings.

Lowering

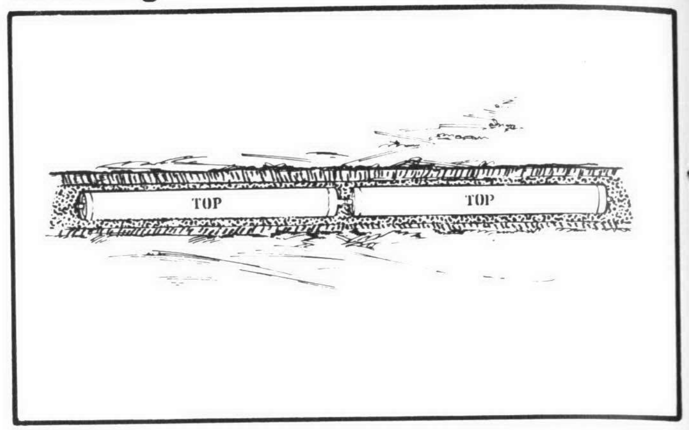
Free-standing water in the trench must be removed and disposed of before lowering assemblies.

Do not remove the protective end bags until the carrier pipes are to be welded.



Lowering EsCon-A should follow the same handling guidelines discussed in ***Unloading.***

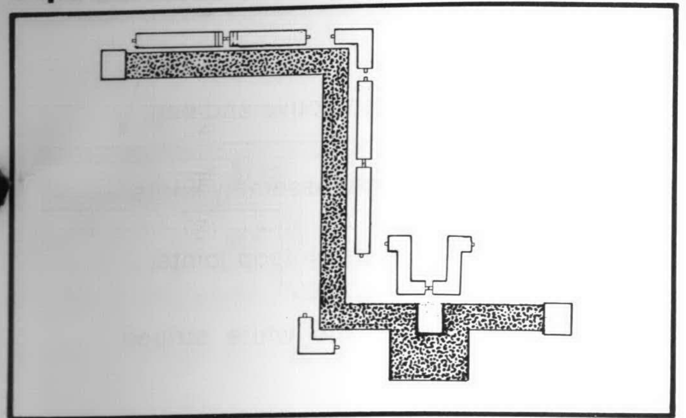
Lowering



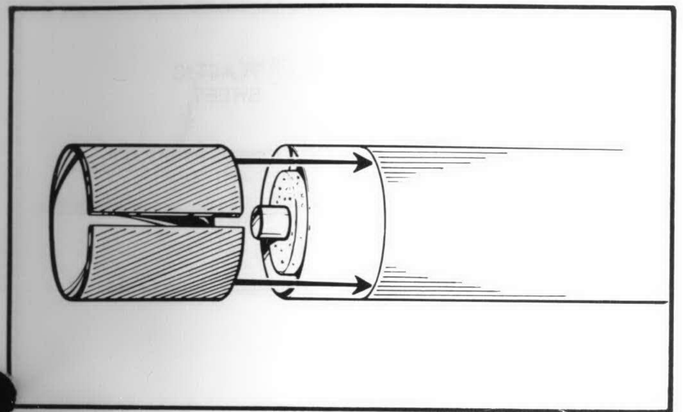
Each assembly should be positioned with the **TOP** side facing up in exactly the 12 o'clock position.

Since holiday testing is required after assemblies are in the trench, it is recommended to support the assemblies with sandbags.

Pipe Connections

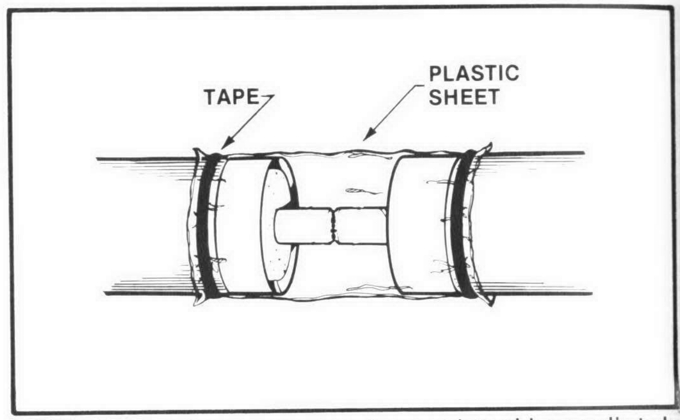


If sufficient lowering equipment is available, it may be easier to complete some field joints above the trench.

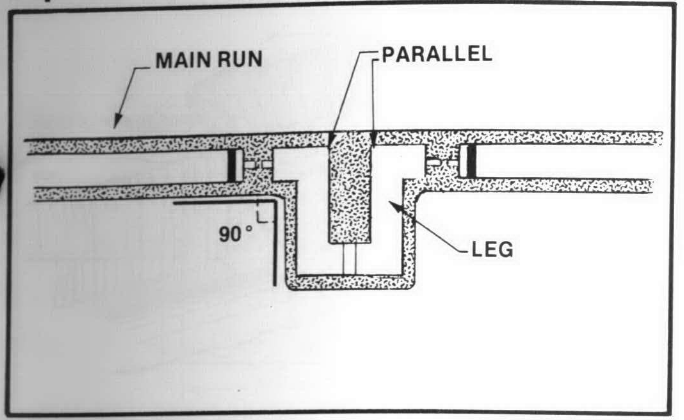


The closure sleeve **must** be around the conduit before welding the carrier pipe.

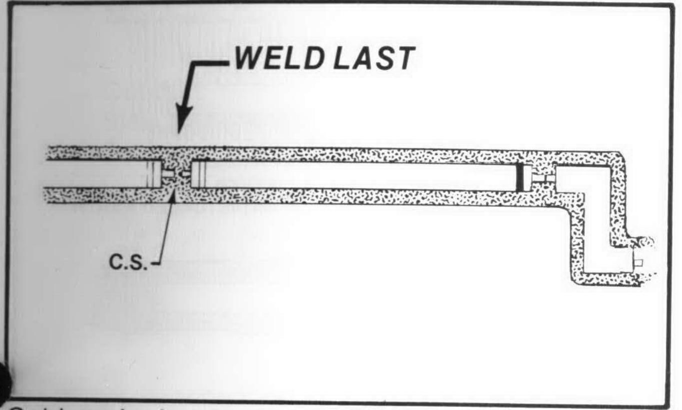
- ☑ Remove the protective end bag.
- ☑ Weld all straight assembly joints.
- ☑ Weld all expansion loop joints.
- ☑ **Do not** weld the white striped joints.
- ☑ Remove shipping bars.



If field joint closures are not completed immediately after the carrier pipe connections, it is recommended to use a temporary covering such as plastic sheeting and seal it with tape to keep out moisture, rain and dirt.

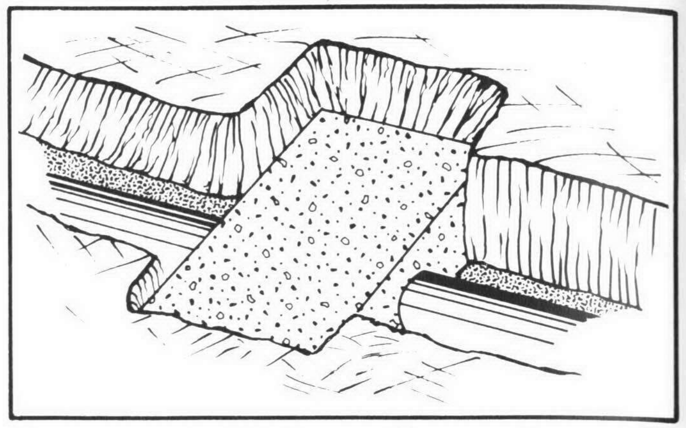


Loop and elbow legs **must** be perpendicular to the main run, and loop legs **must** be parallel to each other.

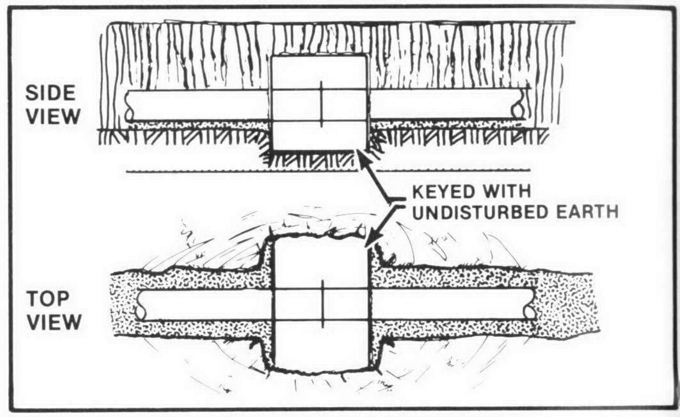


Cold springing is to be done only after all other welds are completed and concrete anchor blocks are in place.

Concrete Anchor Blocks

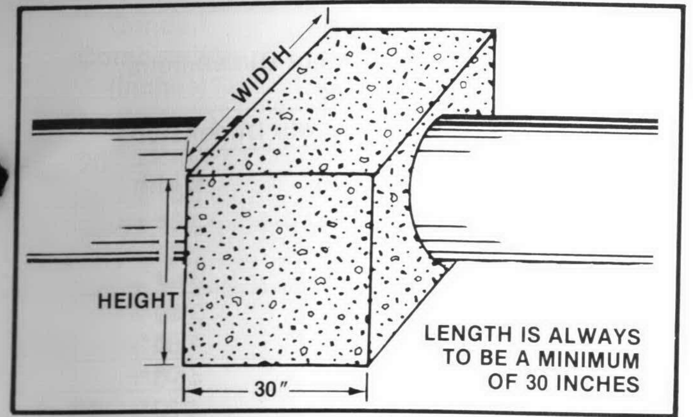


Concrete anchor blocks **must be** poured at each anchor point. Do not cold spring unless the run is solidly fixed at both ends.



The concrete anchor **must be** poured through the bedding material into **undisturbed** earth in the foundation or trench walls.

Concrete Anchor Blocks



Refer to Table A & B for the recommended concrete anchor block dimensions. If you need further information, consult page 74 in Section II.

TABLE A
Minimum Concrete Anchor Dimensions
Single Pipe

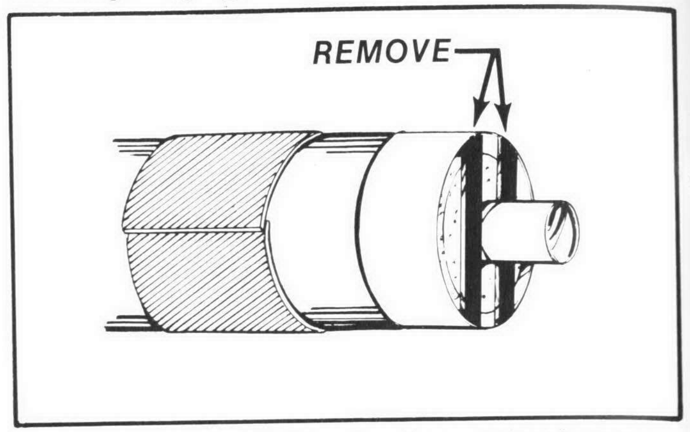
Conduit Size (Inches)	Concrete Dimensions	
	Height	Width
6⅝	2' 3"	2' 7"
8⅝	2' 5"	2' 9"
10¾	2' 7"	2'11"
12¾	2' 9"	3' 1"
14	2'10"	3' 2"
16	3' 0"	3' 4"
18	3' 2"	3' 6"
20	3' 4"	3' 8"
22	3' 6"	4'10"
24	3' 8"	4' 0"

TABLE B
Minimum Concrete Anchor Dimensions
Multi-pipe

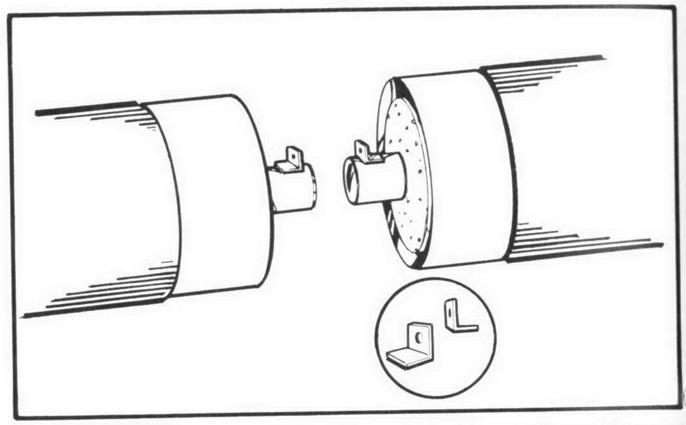
Conduit Combination (Inches)	Concrete Dimensions	
	Height	Width
6⅝ + 6⅝	2′ 2″	3′ 8″
8⅝ + 6⅝	2′4″	3′10″
+ 8¾		4′ 0″
10¾ + 6¾	2′6″	4′ 0″
+ 8⅝		4′ 2″
+ 10¾		4′ 4″
12¾ + 6⅝	2′8″	4′ 2″
+ 8⅝		4′ 4″
+ 10¾		4′ 6″
+ 12¾		4′ 8″
14 + 6⅝	2′10″	4′ 4″
+ 8⅝		4′ 6″
+ 10¾		4′ 8″
+ 12¾		4′10″
+ 14		5′ 0″
16 + 6⅝	3′0″	4′ 6″
+ 8⅝		4′ 8″
+ 10¾		4′10″
+ 12¾		5′ 0″
+ 14		5′ 2″
+ 16		5′ 4″
18 + 6⅝	3′2″	4′ 8″
+ 8⅝		3′10″
+ 10¾		5′ 0″
+ 12¾		5′ 2″
+ 14		5′ 4″
+ 16		5′ 6″
+ 18		5′ 8″

Conduit Combination (Inches)	Concrete Dimensions	
	Height	Width
20 + 6⅝	3′ 4″	4′10″
+ 8⅝		5′ 0″
+ 10¾		5′ 2″
+ 12¾		5′ 4″
+ 14		5′ 6″
+ 16		5′ 8″
+ 18		5′10″
+ 20		6′ 0″
22 + 6⅝	3′ 6″	5′ 0″
+ 8⅝		5′ 2″
+ 10¾		5′ 4″
+ 12¾		5′ 6″
+ 14		5′ 8″
+ 16		5′10″
+ 18		6′ 0″
+ 20		6′ 2″
24 + 6⅝	3′ 8″	5′ 2″
+ 8⅝		5′ 4″
+ 10¾		5′ 6″
+ 12¾		5′ 8″
+ 14		5′10″
+ 16		6′ 0″
+ 18		6′ 2″
+ 20		6′ 4″
+ 22		6′ 6″
+ 24		6′ 8″

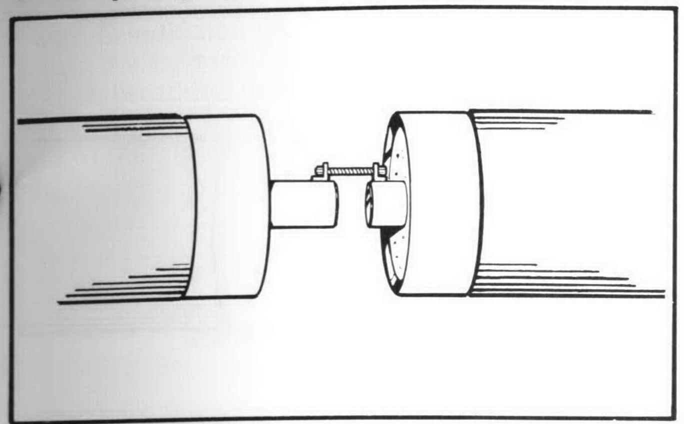
NOTE: For other combinations of conduit:
Height: Use the height value in Table A of your largest conduit size.
Width: For each additional conduit, add 6″ plus the conduit diameter.



With the use of a cutting torch, completely remove the shipping bars from all EsCon-A assemblies. Any damage to the conduit or pipe must be repaired. Remove the weld scale.

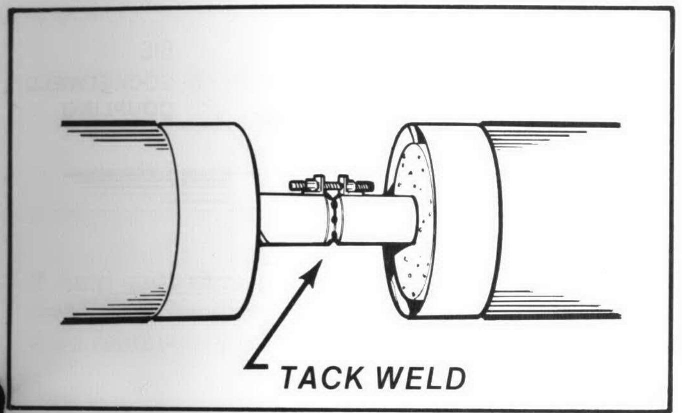


Tack weld angles ½ in. from the top edge of each carrier pipe. Angles are supplied by the contractor.



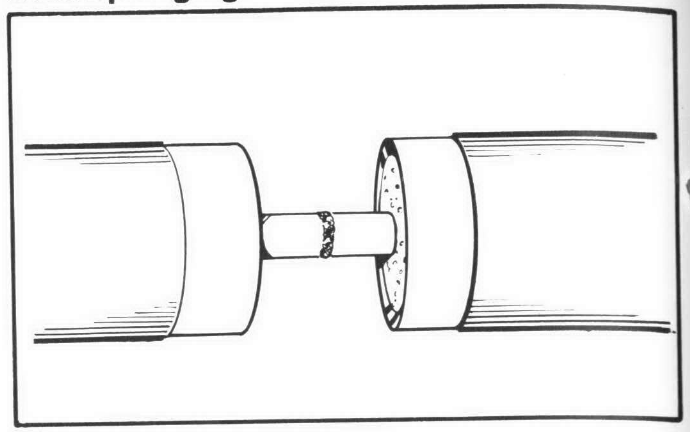
Insert a bolt through the two angles.

Place the nut on the bolt and tighten until the two pipes come together.



Tack weld the pipe joint.

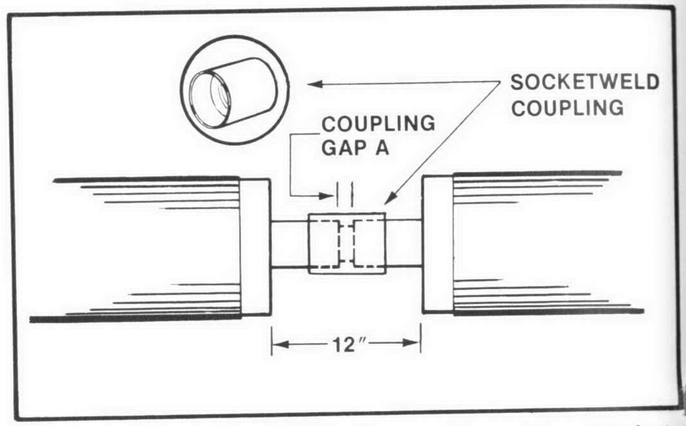
Cold Springing



Remove the angles.

Butt weld the pipe joint.

Inspect the surface for damage. Repair if necessary.



For 2 in. diameter steel pipe and smaller, socketweld couplings and fittings are required at the field joints. The couplings are supplied by others. Refer to Table C for required coupling gap.

Cold Springing

Table C indicates the required gap between carrier pipes. If a field joint also has a cold-springing gap, it should be added to the coupling gap (A). Before doing a cold spring, the coupling should be welded to one of the pipes.

TABLE C

Socketweld Coupling Gap (inches)

Nom. Pipe Size	A	Nom. Pipe Size	A
1/4	1/4	1	1/2
3/8	1/4	1 1/4	1/2
1/2	3/8	1 1/2	1/2
3/4	3/8	2	3/4

If field problems are encountered while doing the prescribed cold-springing procedures, consult your field representative.

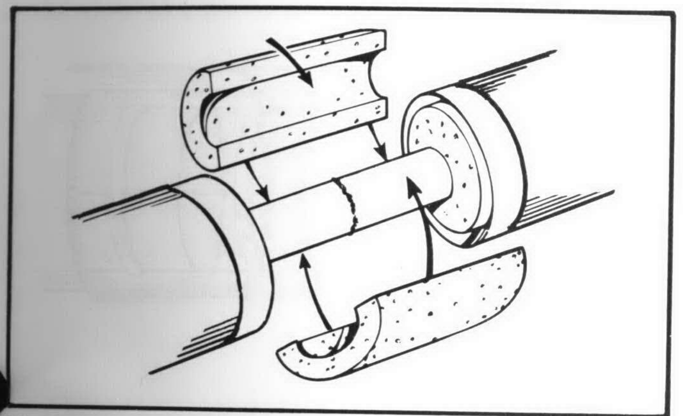
Hydrostatic Test

- After the carrier pipes are welded together, connect test caps at the ends of the run.
- All valves should be set so the entire line can be tested.
- The pipe should be completely filled with water.
- All air should be vented so that the carrier pipe is void of air.
- The pipe section should be brought up to 1½ times the operating pressure unless otherwise stated.
- The pressure should be maintained for a minimum of two hours allowing for temperature unless otherwise stated.
- Any faulty weld should be repaired and retested.

Field Joint Closure

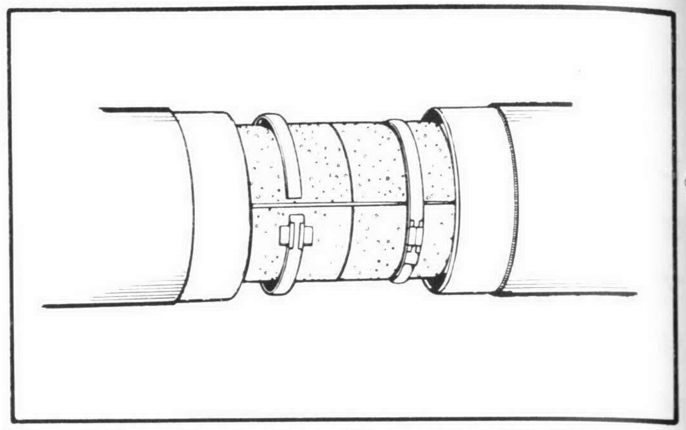
After the pipes have been welded and hydrostatically tested, a field closure is required. Perma-Pipe provides the following materials for field joint closure:

- Pipe insulation
- Stainless steel banding and fasteners
- Closure sleeves
- Shrink sleeves
- Propane torch (fittings and tank not included)



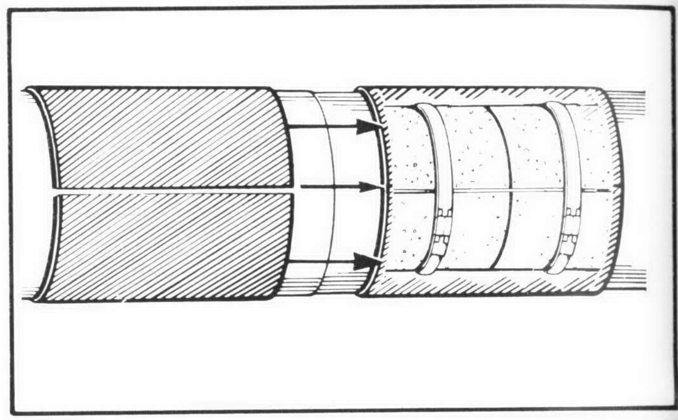
Half round pieces of insulation must be cut for use at each field closure. Press two halves firmly together onto the bare pipe to provide the required insulation around the field joint.
NOTE: More than two pieces may be required.

Field Joint Closure



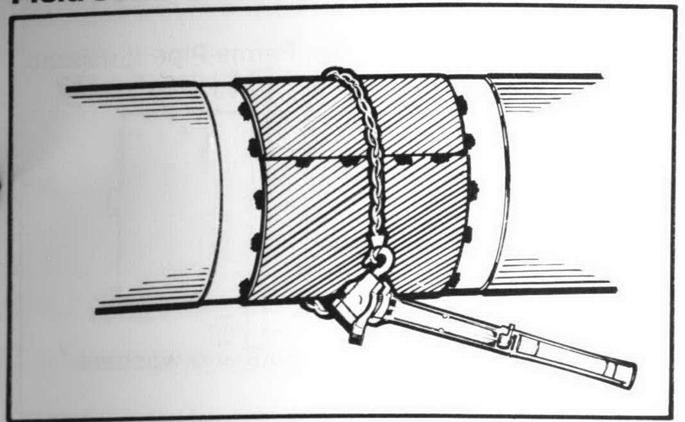
The strips of steel banding must be tightened around the halves of insulation and secured with the metal fasteners.

NOTE: One strip of steel banding is required for every two pieces of insulation.



Slide the closure sleeve over the field joint and center it.

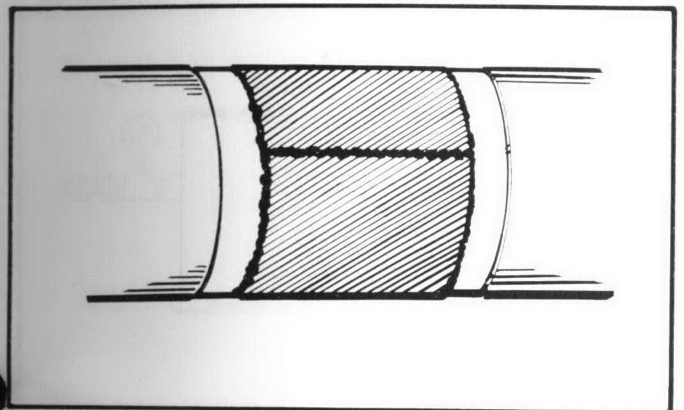
Field Joint Closure



Use a come-along or comparable tool to draw the closure sleeve tightly around the conduit. Exert constant pressure while doing this.

Tack weld the closure sleeve.

Remove the come-along.



Lap weld the closure sleeve along the seam and edges. These welds must withstand the conduit air test.

Conduit Air Test

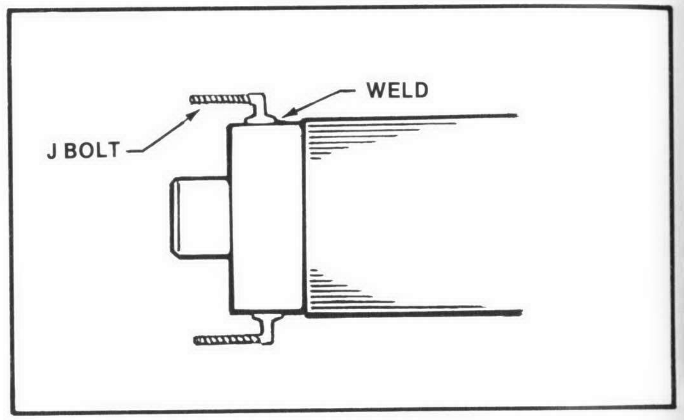
To perform a conduit air test, Perma-Pipe furnishes:

- Test cap
- Rubber gasket

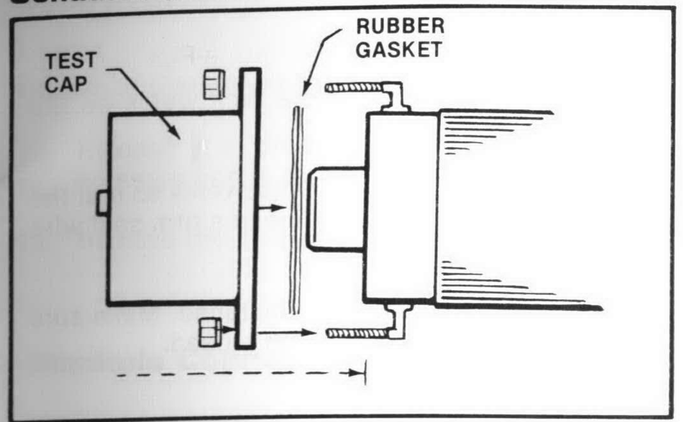
The contractor furnishes:

- Pressure gauge
- J bolts or threaded rod, nuts and washers

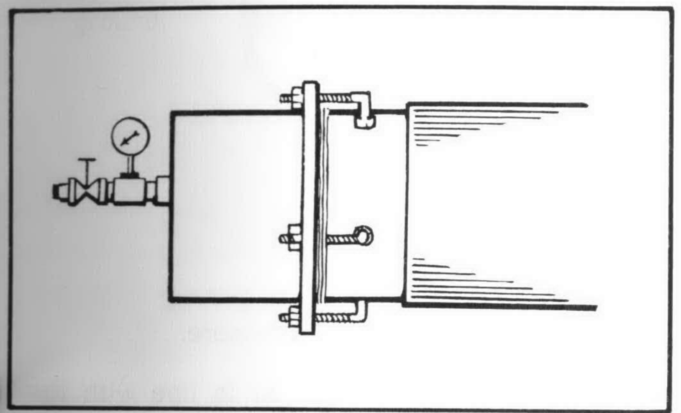
If the end seals are connected, no test caps are needed. Follow steps 7 through 11.



1. Tack weld the head of a J bolt to the edge of the conduit. Tack weld the head of a similar bolt to the opposite side of the conduit. Leave enough thread extending past the conduit for the pressure cap to fit on.

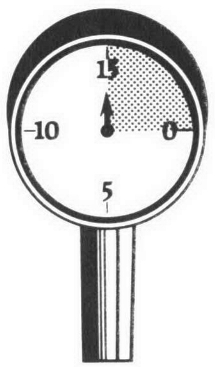


2. Place the gasket over the open end of the pressure cap and lift the cap onto the bolts. Apply the nuts and washers. Tighten by hand.



3. Weld the other bolts onto the conduit to match the pressure cap holes. Place the nuts and washers on the bolts. Tighten.

4. Make a firm weld over the tack welds on the first two bolts.
5. Tighten all nuts carefully and evenly so that the pressure cap and gasket make a firm seal with the conduit.
6. Be sure the cap is tightly fastened. Make sure the drain and vent plugs are closed.
7. Build up the test pressure in the system.



8. **Do not** exceed 15 PSI air pressure.
9. **Do not** stand in front of or in line with the pressure cap while the pressure is on.
10. Maintain test pressure for a minimum of 1 hour, allowing for fluctuations in temperature.

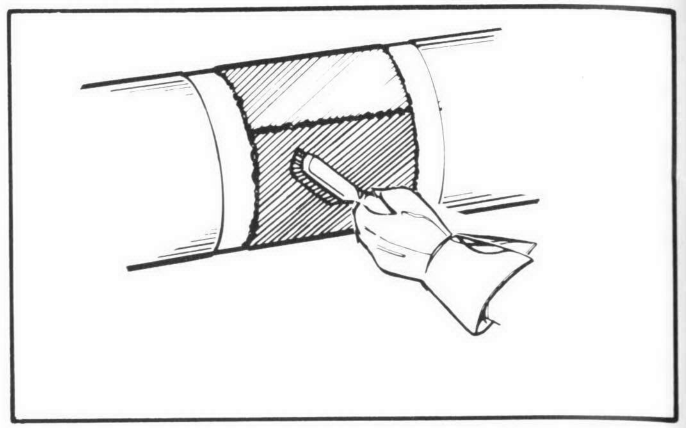
11. Soap test all welds to indicate pin hole leaks.
12. Release air pressure before removing the pressure cap or loosening the bolts.
13. Remove the J bolts and all rough weld edges.

Manhole Connections

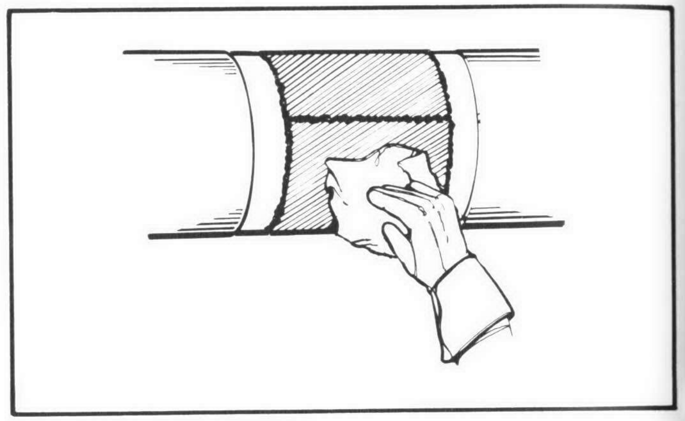
If the run ends at a manhole, it is necessary to do the following:

- ☑ Plug the drain (lower hole) on the end plate.
- ☑ Tell-tale the end plate vent (upper hole) above ground.

Shrink Sleeve

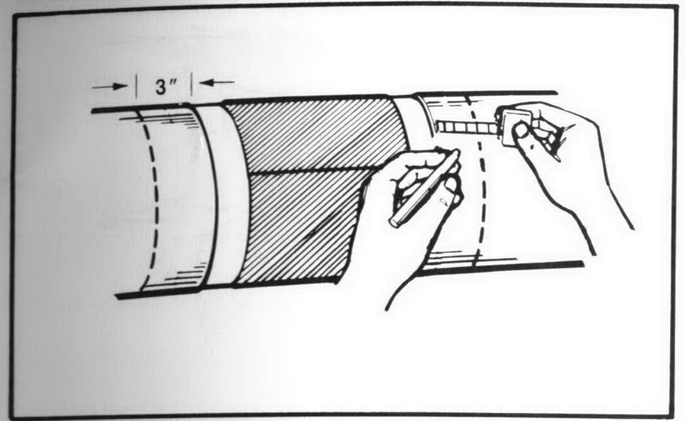


Before applying the shrink sleeve, all bare metal at the field joint must be wire-brushed clean of scale and dirt.

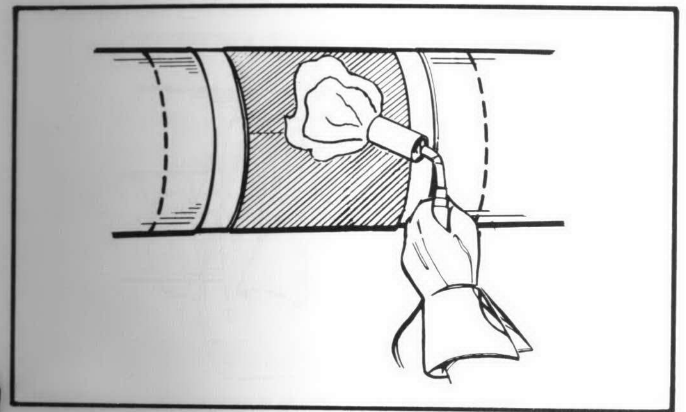


Wipe off the field joint area.

Shrink Sleeve

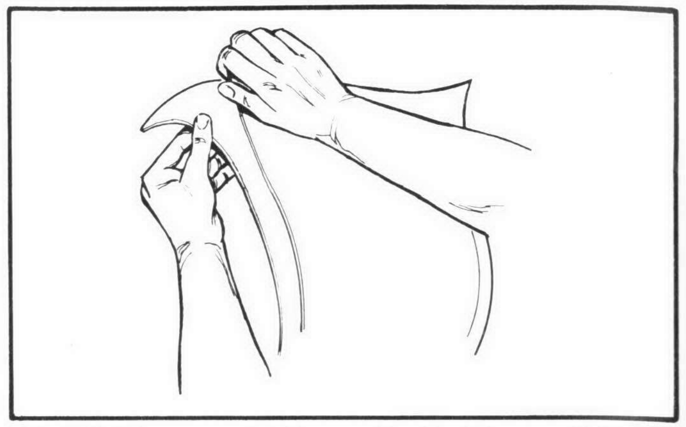


With a measuring tape, chalk mark a guideline on the coating 3 in. from each edge of the Elephant Hide™ coating.

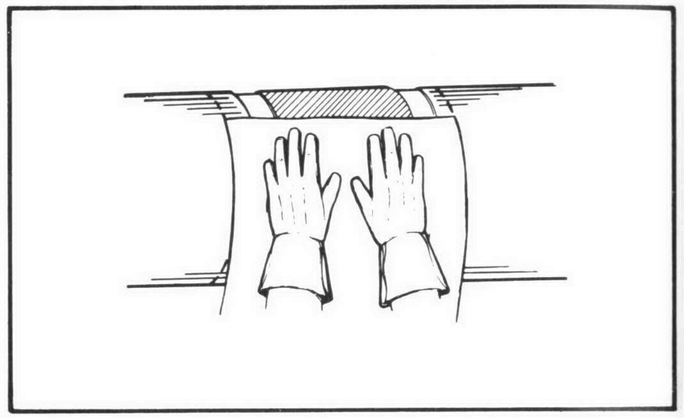


Preheat all bare metal at the entire field joint area until it is warm to the touch (approximately 130 °F).

Shrink Sleeve

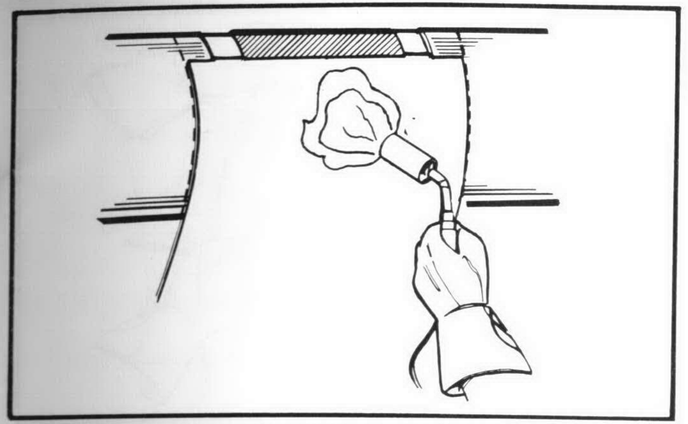


Identify the correct sleeve size by the conduit size label on the backing material. One edge will measure 24″. Hold this starting edge up and remove the first 6-10″ of backing material.

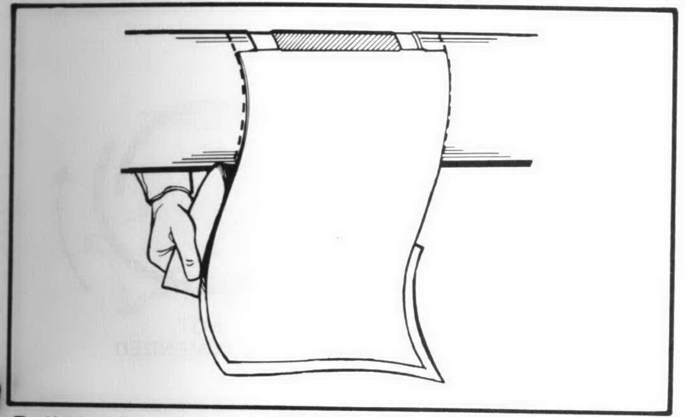


Continue to hold the shrink sleeve right side up. Press the top edge into place just below the top of the conduit so that the sleeve is centered between the chalk lines.

Shrink Sleeve

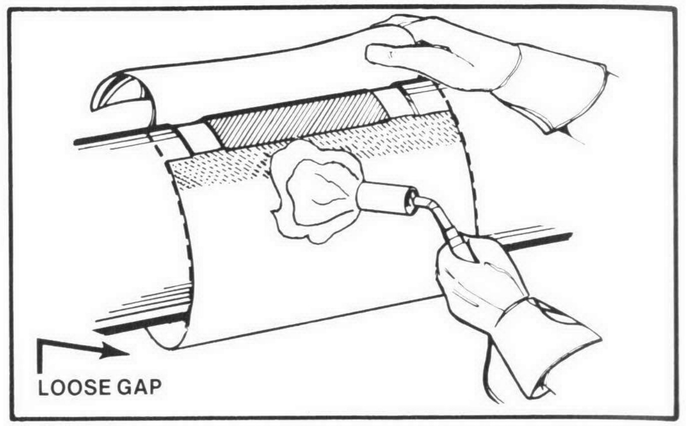


Heat the top 2 in. of the sleeve with a torch until it becomes soft and adheres to the metal. Use only the provided torch or an approved substitute.

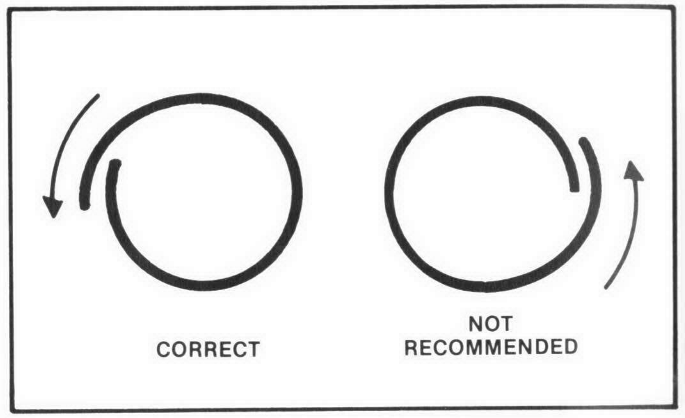


Pull the backing material off as the sleeve is wrapped around the conduit.

Shrink Sleeve

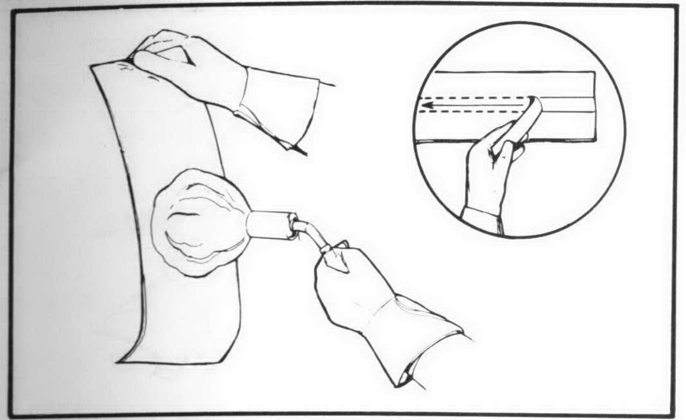


Wrap the sleeve around the conduit so that the lower portion hangs loose about an inch from the bottom of the conduit. Stay within the chalk guidelines. Reheat the top 2 in. of the sleeve before overlapping.



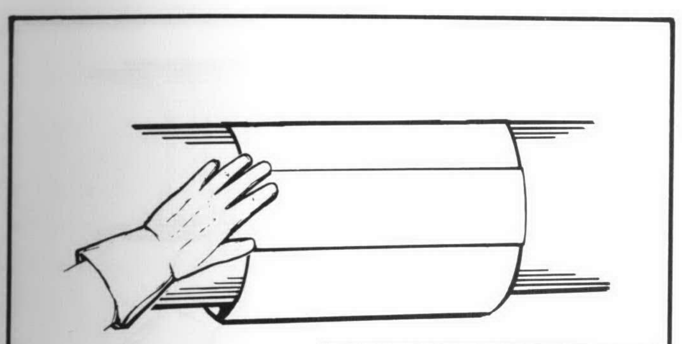
Be sure to overlap downward.

Shrink Sleeve



Peel the back strip off the closure tape.

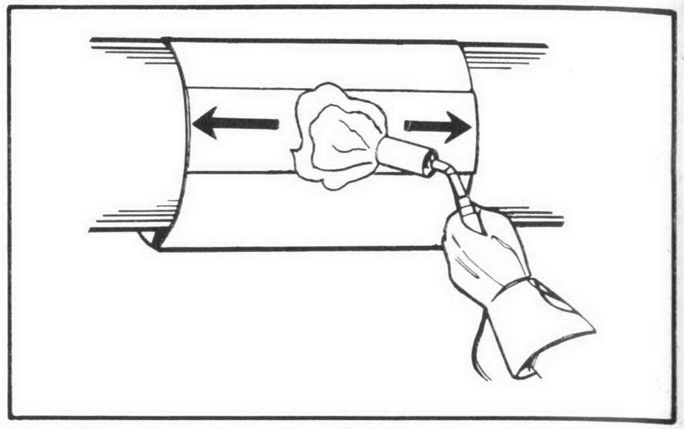
Preheat the tape until it is limp. **Do not** heat longer than 5 seconds.



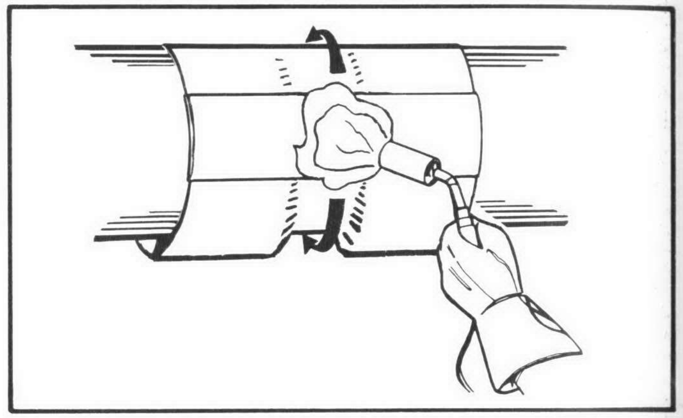
Note: Conduit larger than 16 in. may require two torches.

Apply the tape across the seam made by the overlap. The sticky back strip should be face down.

Shrink Sleeve

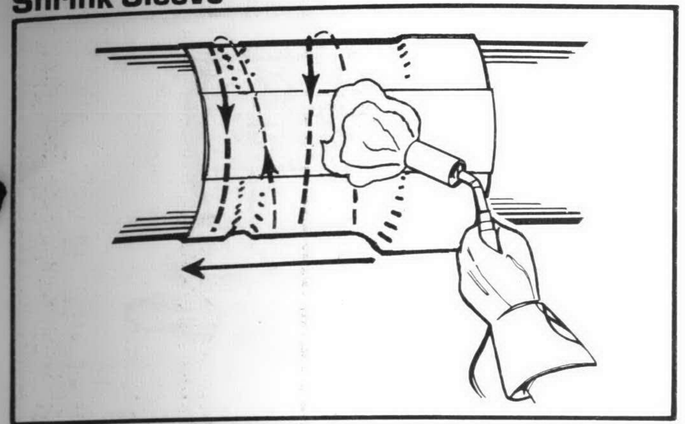


Heat the closure tape with a torch until it sticks to the rest of the sleeve. Pat the tape down with a hand for a good bond.

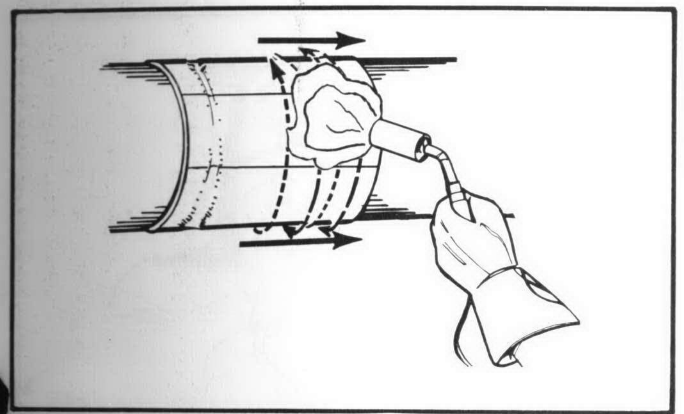


Heat the **center** section of the sleeve all the way around until it shrinks. Keep the torch in constant motion. Do not burn the surface.

Shrink Sleeve

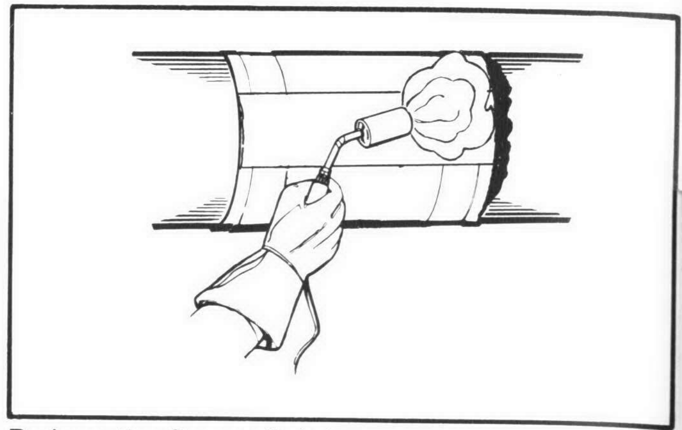


When the center of the sleeve has shrunk, begin to move the torch with an up-and-down spiral motion around the sleeve toward the left edge.

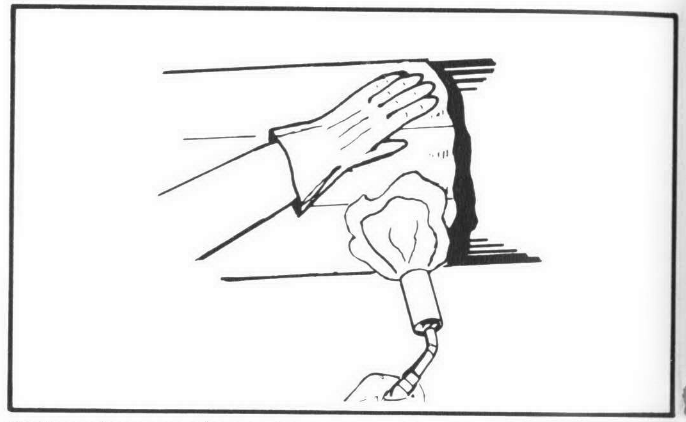


When left side has shrunk, heat the right side in the same up-and-down spiral manner.

Shrink Sleeve

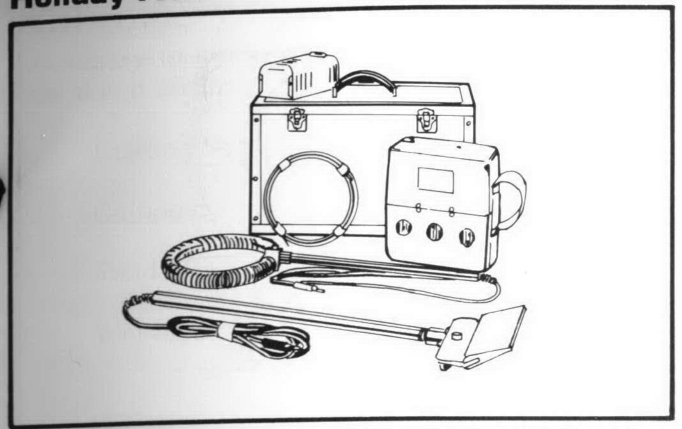


Reduce the flame slightly and shrink the edges of the sleeve onto the pipe. Black adhesive escaping at the edges indicates a good bond.

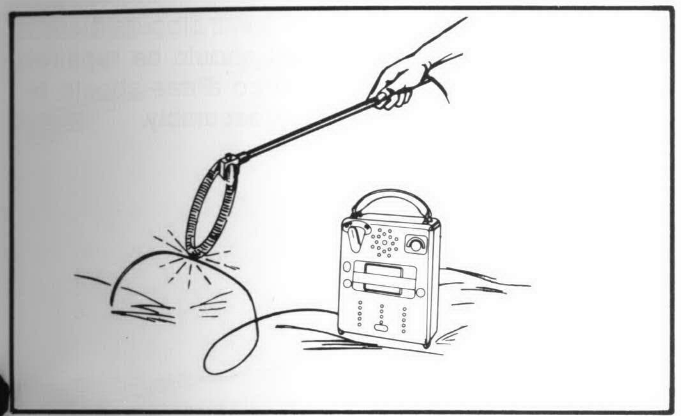


If the sleeve edge raises up, reheat and press down firmly.

Holiday Test

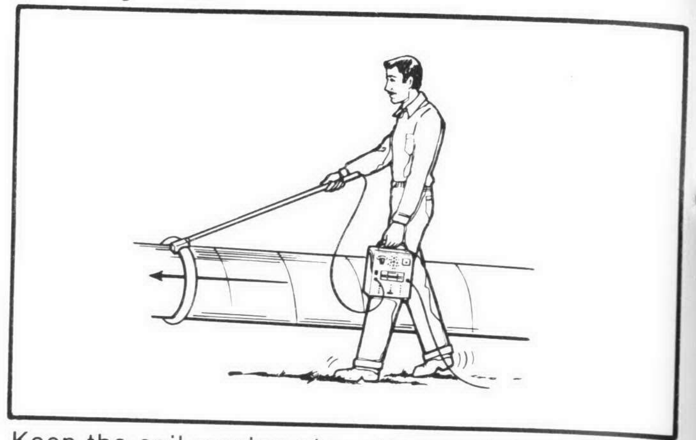


The Perma-Pipe field representative will supply a holiday testing kit and demonstrate its operation. The holiday detector will be set at the required voltage. Consult your field representative if you have questions.



Check the detector by passing it over the bare metal at the end of the conduit or by touching the coil or the rake directly to the ground wire.

Holiday Test



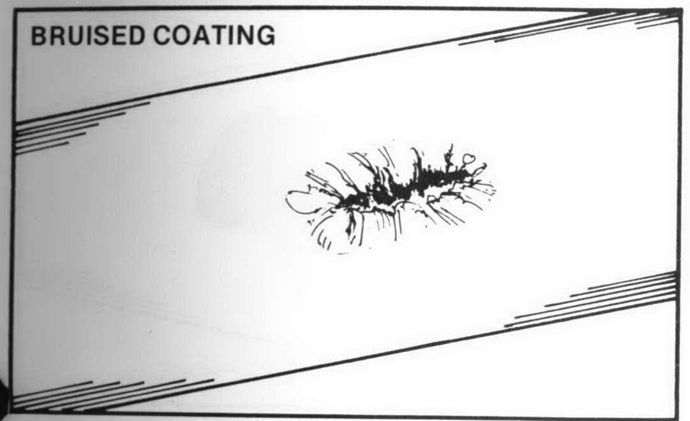
Keep the coil moving along the conduit at a steady pace. If the rake is used, keep the rake moving around the conduit in smooth circular motions. Stay close to the surface. Do not rest the rake on the conduit as this can damage the coal tar coating.

Test every assembly and field joint closure before backfilling. Areas failing the test should be repaired and retested, but only the repaired areas should be retested. **Do not** retest the entire assembly.

This section of the manual discusses steps necessary to correct certain installation problems that could occur:

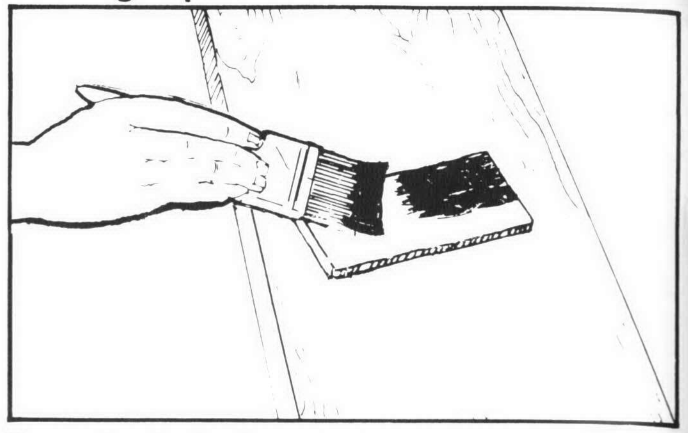
1. Coating Repair
2. Cathodic Protection
3. Field Alterations
4. Wet Insulation

Coating Repair

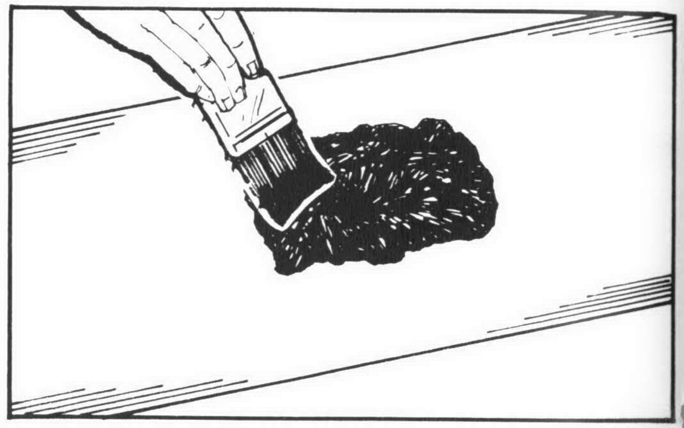


The coating is bruised if the felt is torn, exposing the coal tar. Bare metal is **not** showing.

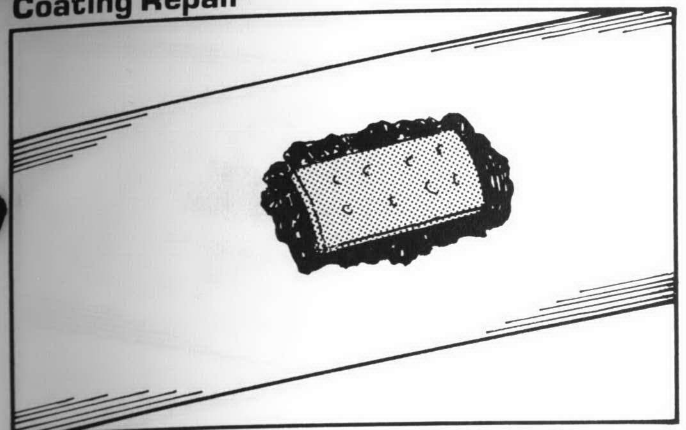
Coating Repair



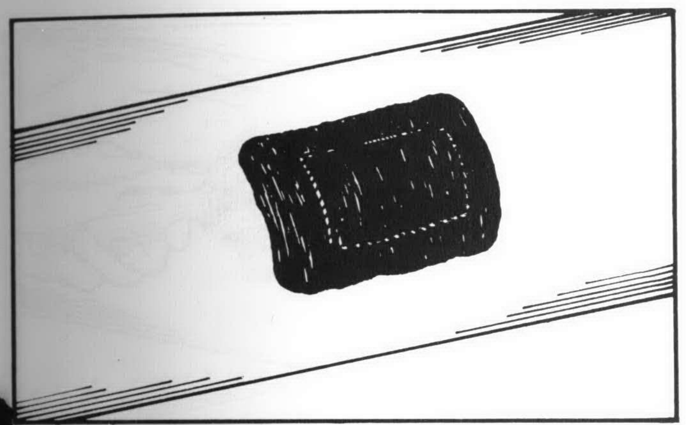
To repair a bruised area, cut a piece of Perma-Tape large enough to **cover** the repair area. Apply Perma-Kote to the smooth side of the Perma-Tape.



Apply a layer of Perma-Kote inside and around the repair area. Let dry until tacky.

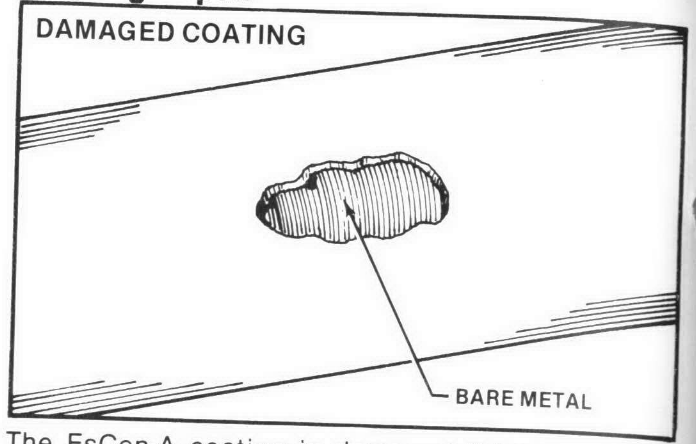


Position the Perma-Tape **over** the repair area coated side down. Press firmly into place and work out air bubbles.

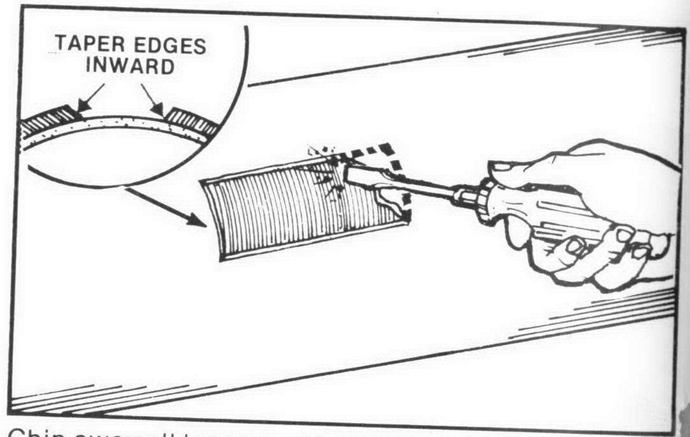


Apply a heavy layer of Perma-Kote over and around the Perma-Tape. Let dry for 30 min.

Coating Repair



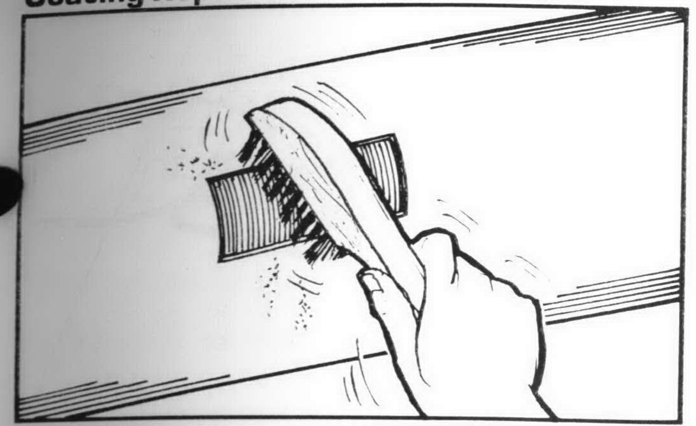
The EsCon-A coating is damaged if bare metal is showing.



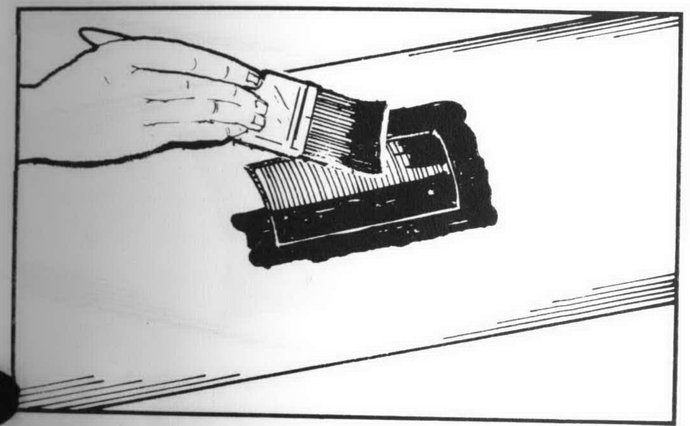
Chip away all loose coating material from the area to be repaired.

Taper the coating edges for a smooth transition between the coating and the metal surface.

Coating Repair

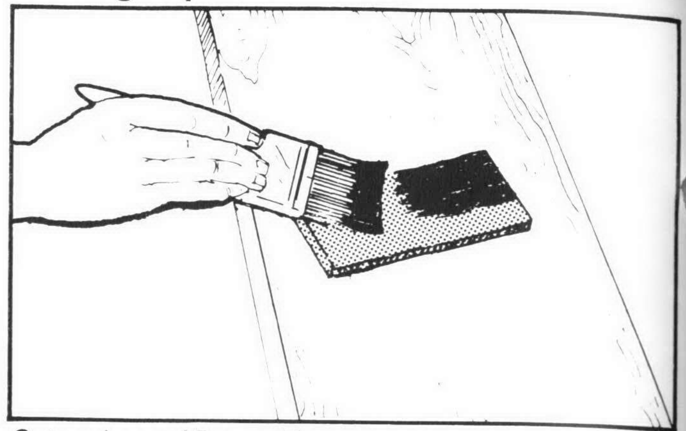


Use a wire brush to remove any remaining loose particles and rough up the surface that needs repair.

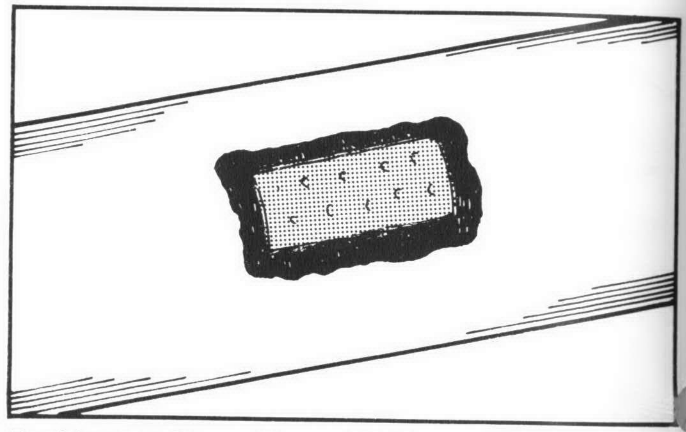


Apply a layer of Perma Kote within and around the repair area. Let dry until tacky.

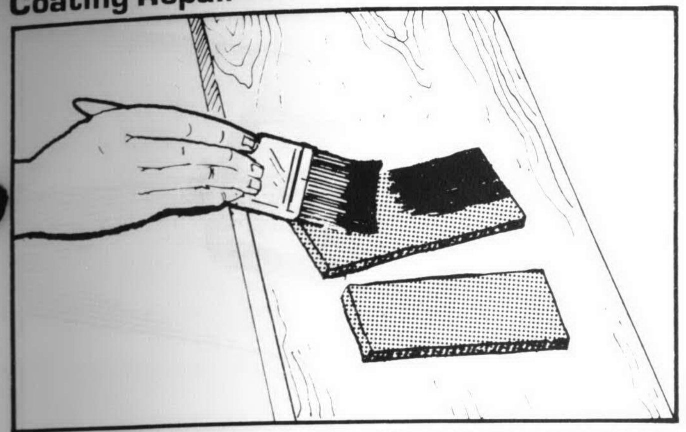
Coating Repair



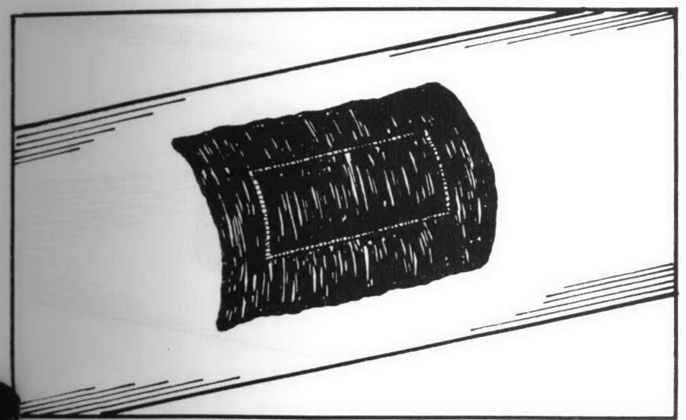
Cut a piece of Perma-Tape the size of the metal area. Apply Perma-Kote to the smooth side of the tape.



Position the Perma-Tape with the coated side down. Press firmly into place and work out the air bubbles.

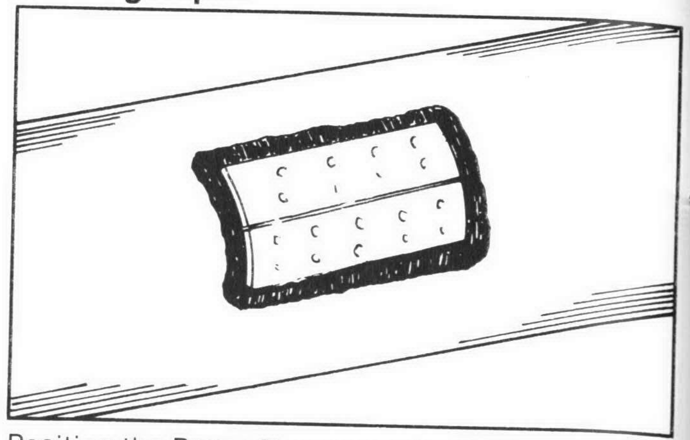


Cut another piece of Perma-Tape large enough to **cover** the repair area. Apply Perma-Kote to the smooth side of the tape.

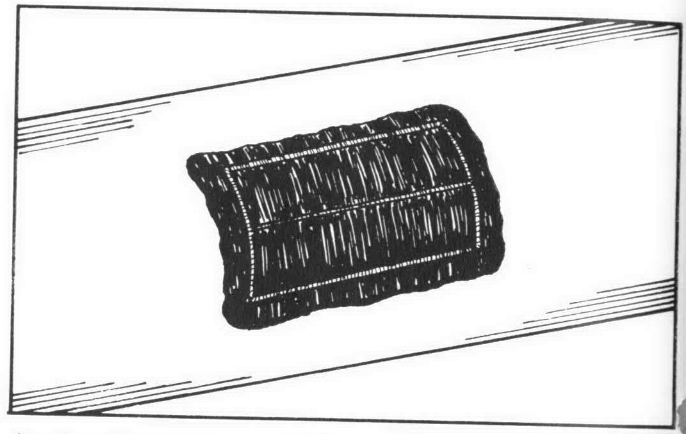


Apply a layer of Perma-Kote over and around the area to be repaired. Let dry until tacky.

Coating Repair

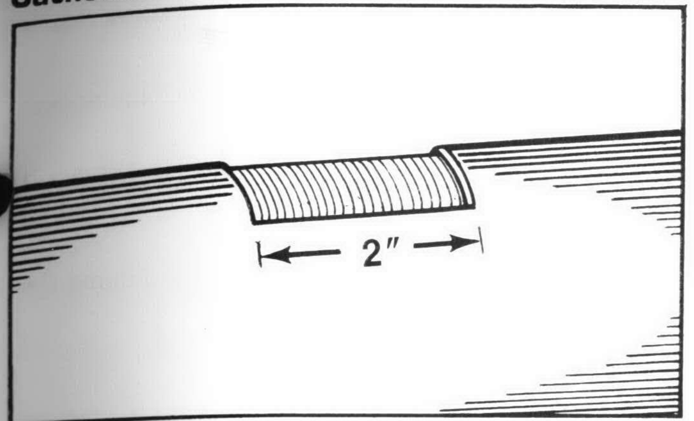


Position the Perma-Tape coated side down over the repair area. Press firmly into place and work out the air bubbles.



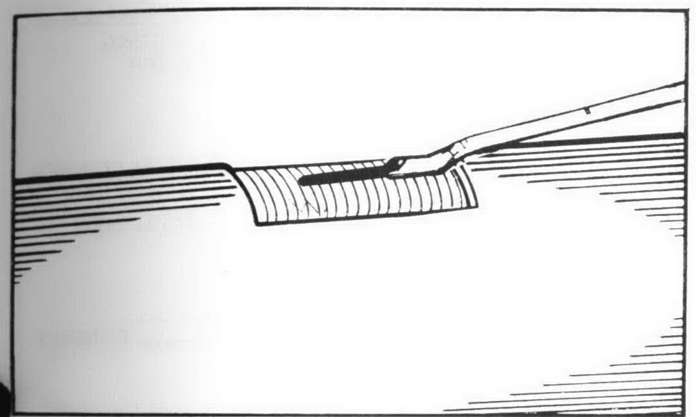
Apply a heavy layer of Perma-Kote over and around the Perma-Tape. Let dry for 30 min.

Cathodic Protection



Find the anode connection locations from the supplied drawings.

Remove a 2 in. section of coating and rasp the metal surface.



Strip the insulation off the end of the wire and lay it on the metal surface.

Cathodic Protection

To prepare the welder:

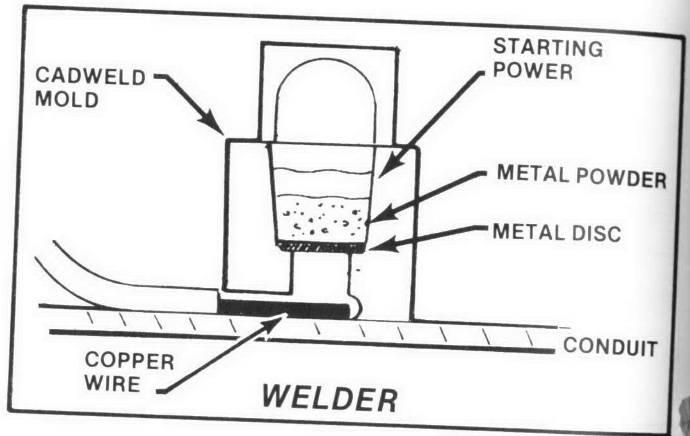
√ Place the metal disc in the bottom of the pocket of the welder.

√ Open a cartridge and dump the metal powder into the pocket.

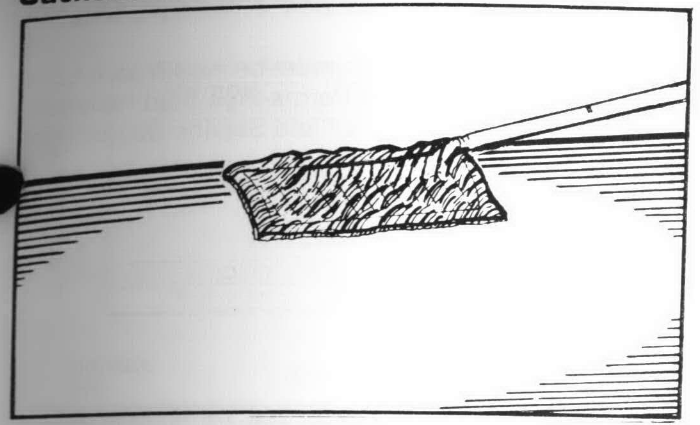
√ Squeeze the base of the cartridge and dump the starting powder into the pocket.

√ Close the cover.

√ Place the welder over the wire and hold it firmly in place. The gun should be pointed away from the operator when ignited.



Cathodic Protection



√ File off excess welding slag. Repair this area following the guidelines in ***Bruised Coating.***

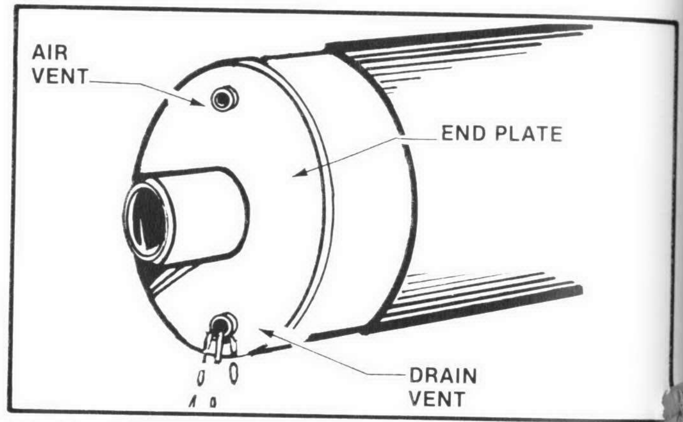
Field Alterations

If the size or shape of a run must be modified to complete the job, consult the Perma-Pipe field representative or call Perma-Pipe's Field Service Department at 312/966-2150.

Wet Insulation

If the EsCon-A insulation gets wet, it must be drained before start-up.

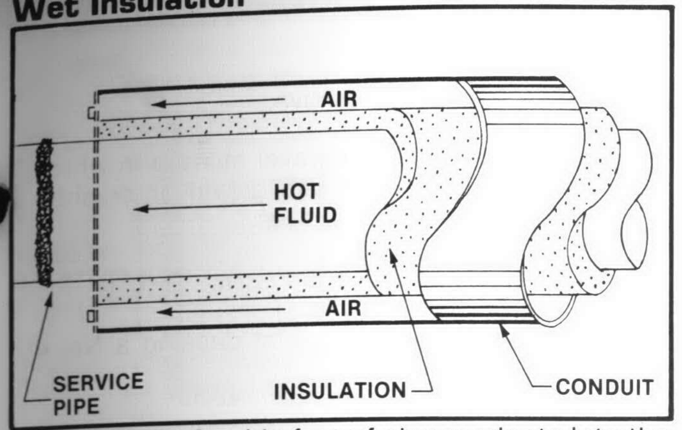
Contact the Perma-Pipe field representative.



Unplug the vent and the drain at the high end of the run.

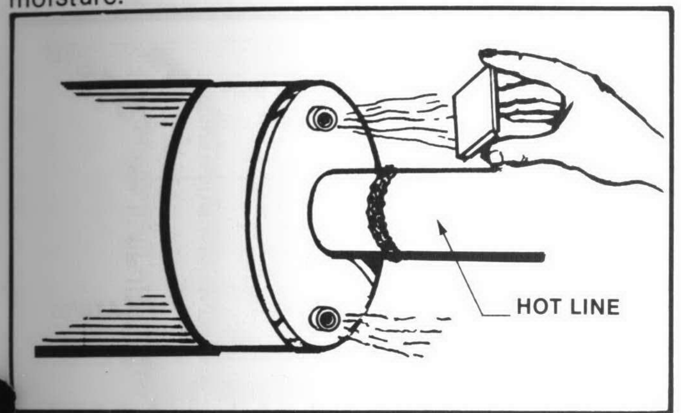
Drain the conduit at the low end of the run.

Connect the carrier pipe to a hot line. Slowly heat the system up to at least 220°F.



Force at least 2 cubic feet of air per minute into the low end of the run.

CAUTION: Do not stand in front of the exhaust vent during this procedure. The hot fluid should dry out the insulation and the forced air will carry out the moisture.

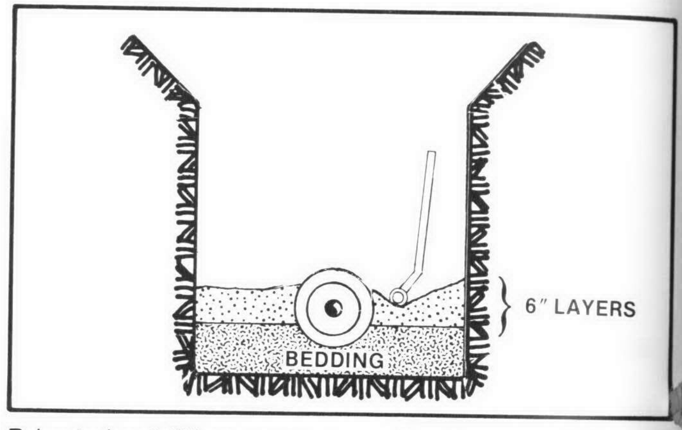


Place a cold mirror at the exhaust vent. If the mirror fogs, the insulation is still wet. Continue the drying process until moisture is no longer being vented.

It may be necessary to increase the air pressure and/or fluid temperature.

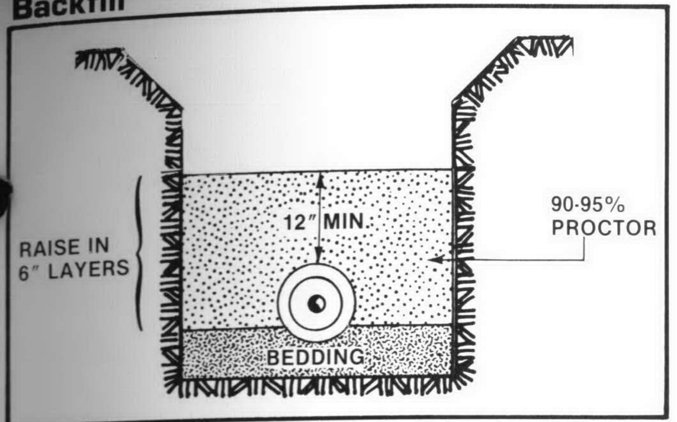
Backfill materials should have:

1. Sand or a sand-with-gravel mixture in which the gravel is either pea gravel or crushed stone without sharp edges.
2. Particles not larger than ½ in.
3. 90 percent of the material passing a No. 4 sieve.
4. 90 percent retained by a No. 200 sieve.
5. All unsuitable material removed from the backfill soil.

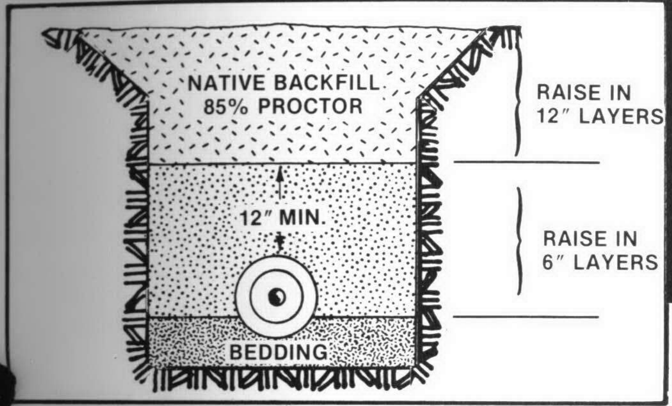


Prior to backfilling, remove any foreign materials such as shoring, braces, support blocks. Carefully compact the area directly around the pipe in 6 in. layers.

Backfill



The recommended backfill material should be used to at least 12 in. above the pipe. Compact in 6 in. layers to 90-95% proctor. If surface loading conditions exist, backfill to grade in this manner.



Under normal condition, backfill to grade in 1 ft. lifts and compact to 85% proctor. Native soil can be used provided it is non-organic and all particles are less than ½ in. in size.

TECHNICAL SUPPLEMENT

SECTION II

RECEIVING — Unloading

EsCon-A assemblies must be handled with care to avoid damaging the protective outer coating, the conduit, the insulation, or the carrier pipe.

Each section should be supported by two or more nylon slings. The protective outer coating is designed to protect the casing from corrosion after it is buried. The slings are needed to protect the coating during handling. Slings are provided free of charge by Perma-Pipe. Steel cables or chains are not acceptable. A choke sling and a spreader bar are shown in Section I as ways of lifting the assemblies.

Improper handling or impacts on the conduit result in damages that must be either repaired or replaced at the customer's expense. Proper handling will result in a successful installation at a minimal cost.

Upon unloading, each EsCon-A assembly must be visually inspected and tested.

All EsCon-A assemblies should be holiday tested in accordance with the procedure outlined in Section I.

Storage

If the EsCon-A is stored at a central location, it should be restacked in the same fashion that it was received. Foam or other soft padding should be used between the layers.

A considerable amount of damage to the EsCon-A may result from improper storage. EsCon-A is shipped with foam padding between the wooden braces and the conduit. These materials should be taken from the truck and used for protecting the coating at the project site.

For long-term storage of EsCon-A, when the pipe is to be unused for 2 months or longer, the following recommendations should be observed:

The assemblies must be stored on high ground to prevent water damage. The end caps and plastic bags must be retained on the ends of the assemblies to prevent water from getting into the annulus between the casing and the insulation. If the end closure is damaged or removed, the customer should make provisions to protect the assembly interior from water or debris. A small amount of time spent in preventing water intrusion is much less expensive than a "drying out" operation later in the project.

In extremely hot or cold environments extra care may be required to prevent damage to the coating.

In very cold weather:

√ Assemblies should not be moved or handled below 25°F.

√ Assemblies should not be stacked more than two layers high.

√ All stacks of EsCon-A should be covered with a tarp to shade them from the sun and to prevent ice formation on the conduit.

√ Light colored, opaque tarps are preferred.

Shipping bars are **always** to remain on the assembly ends until the carrier pipes are to be welded.

EXCAVATION

All types of pipe derive some of their strength from the passive soil resistance on the sides of the pipe. Therefore, the proper excavation of the trench is very important to ensure a structurally sound system.

Usually the centerline dimensions for the placement of the pipe in the trench can be found in the submittal drawings. If the trench dimensions are not specified, Perma-Pipe offers its standard recommendations.

The trench width should allow at least 6 inches between the conduit and the trench walls as shown in Section I, EXCAVATION. Tables D & E give the trench width for single or double combinations of conduit along with the centerline dimensions. If more than two pipes are used in the same trench, add 6 inches plus the outer diameter of the additional pipe to the double conduit trench width for each additional pipe.

It is important to note that this minimum trench width is for the general width of the run. The trench should be considerably wider at field joint locations to allow room for welding and field joint closure. Additional room should be provided by digging bell holes. Bell holes are simply small ditches dug in the base of the trench at field joint locations. Experience shows that bell holes about 3 ft. in diameter permit the most freedom at a minimum additional excavation cost. After completing the field joints, the bell holes should be compacted to a 90-95% modified proctor density.

The trench width should be kept to a minimum and the walls should be as vertical as possible.

TABLE D
Minimum Trench Dimensions
Single Pipe

Conduit Size (Inches)	Trench Width (Inches)
6⅝	19
8⅝	21
10¾	23
12¾	26
14	26
16	28
18	30
20	32
22	34
24	36

TABLE E
Minimum Trench Dimensions
Multi-pipe

Conduit Combination (Inches)	Trench Dimensions X (Inches)	Width (Inches)
6⅝ + 6⅝	13	31
8⅝ + 6⅝	14	33
+ 8⅝	15	35
10¾ + 6⅝	15	35
+ 8⅝	16	37
+ 10¾	17	39
12¾ + 6⅝	16	37
+ 8⅝	17	39
+ 10¾	18	41
+ 12¾	19	43
14 + 6⅝	17	39
+ 8⅝	18	41
+ 10¾	19	43
+ 12¾	20	45
+ 14	21	46
16 + 6⅝	18	41
+ 8⅝	19	43
+ 10¾	20	45
+ 12¾	21	47
+ 14	22	48
+ 16	23	50
18 + 6⅝	19	43
+ 8⅝	20	45
+ 10¾	21	47
+ 12¾	22	49
+ 14	23	50
+ 16	24	52
+ 18	25	54

TABLE E
Minimum Trench Dimensions
Multi-pipe (continued)

Conduit Combination (Inches)		Trench Dimensions X (Inches)	Trench Dimensions Width (Inches)
20	+ 6⅝	20	45
	+ 8⅝	21	47
	+ 10¾	22	49
	+ 12¾	23	51
	+ 14	24	52
	+ 16	25	54
	+ 18	26	56
	+ 20	27	58
22	+ 6⅝	21	47
	+ 8⅝	22	49
	+ 10¾	23	51
	+ 12¾	24	53
	+ 14	25	54
	+ 16	26	56
	+ 18	27	58
	+ 20	28	60
	+ 22	29	62
24	+ 6⅝	22	49
	+ 8⅝	23	51
	+ 10¾	24	53
	+ 12¾	25	55
	+ 14	26	56
	+ 16	27	58
	+ 18	28	60
	+ 20	29	62
	+ 22	30	64
	+ 24	31	66

An unstable soil condition is sometimes encountered during excavation. Usually this exists with deep casing burials. This condition must be stabilized before laying any conduit systems; and the installing contractor should use staybracing, trench jacks or sheeting to prevent any cave-ins during installation.

State and federal regulations for sheeting or bracing should be followed where applicable. Where shoring or sheeting is removed, backfill should be placed and compacted as the sheeting is removed to minimize voids beneath the sheeting. Should organic soils or plastic clays and silts with high liquid limits that are incapable of supporting the casing be encountered when the excavation is opened, the poor soil should be removed and replaced with a suitable bedding material to a depth that will provide a firm, stable foundation.

The depth of burial should be between 2 and 12 ft. deep. See Section I, TRENCH DEPTH.

The trench floor must be completely clear of stones and rocks, and a bedding material must be laid on the trench floor. The bedding material should be within the limits of the material specified in Section I, BACKFILL.

ASSEMBLY

Layout

After excavation is complete and the customer is ready to install the system, the EsCon-A should be distributed along the trench. Installation can be simplified by laying the assemblies in order along the trench according to the P.D.L.

Certain assemblies are marked with a stripe to indicate the specific orientation of the pipe. Assemblies with a blue stripe on one end must be placed with that end toward the adjacent elbow. Elbows are sometimes modified to allow for the thermal expansion of the carrier pipe. Part of the expansion movement will be transferred to the straight assembly it is connected to. Perma-Pipe utilizes oval supports at one end of the straight assembly to allow for this movement. The blue stripe indicates the location of those oval supports.

The oval supports must also be oriented correctly with respect to the adjacent pipe. The proper positioning of the pipe can be found because Perma-Pipe has marked the word "TOP" on each assembly. The "TOP" label should be facing exactly straight up in the 12 o'clock position.

Adjacent assemblies with white stripes should be positioned with the striped ends together. When cold springing is used in the EsCon-A system, the field joints to be sprung are pre-cut to specific lengths. The correct pipe ends must be welded together for them to be sprung correctly. Thus, a white stripe is painted on the pipe ends which are to be positioned together for cold springing.

Pipe Connections

Check to make sure that the closure sleeve is around the conduit before welding the carrier pipes together. It may be impossible to slip the closure sleeve over the conduit after the weld is made. If this happens, the closure sleeve must be cut in half, positioned around the conduit and rewelded in place.

Before continuing, check to see if the legs of the expansion loops are perpendicular to the rest of the run and parallel to each other. If the legs of the loop are not positioned correctly, it may affect the cold springing and/or the length of the run.

Welding Procedures

Do not remove the protective end bags and pipe caps until the carrier pipes are to be welded. If field joint closures are not completed immediately after the carrier pipe connections, it is recommended to use a temporary covering such as plastic sheeting and seal it with tape to keep out moisture, rain and dirt. This will prevent the need for an expensive "drying out" procedure at the end of the project.

Cold Springing

Cold springing is designed into the EsCon-A system by Perma-Pipe to reduce the amount of oversized casing needed at ells to allow for pipe expansion. This significantly reduces installed cost.

If cold springing is done incorrectly, the expansion of the service pipe will cause a loop to swell as shown in Figure 1, and destroy the insulation on that section of pipe.

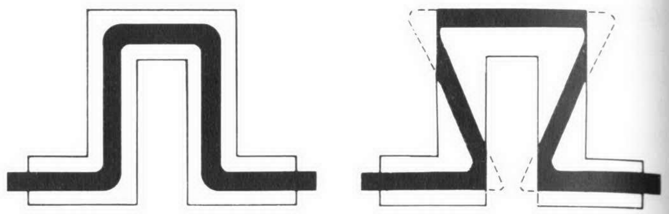


Figure 1. Pipe Expansion without Proper Cold Springing

When cold springing is utilized, the legs of the expansion loop are initially pulled out as shown in Figure 2. These pipe ends are then connected to the rest of the run of pipe. Although the pipe will now expand just as much when put into service, it will only swell out a fraction of what it would without cold springing and thus, allow the insulation to remain intact.

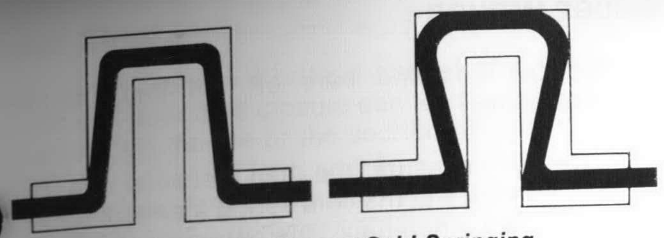


Figure 2. With Correct Cold Springing

It must be noted that the key to the above description is that the legs of the expansion loop cannot be allowed to pull back to their original positions before the line is put into service. This is why Perma-Pipe recommends that concrete blocks be poured around each anchor before cold springing.

Perma-Pipe realizes that there are other ways to cold spring, however, care must be taken to prevent any movement of the pipe back to its original position. The amount that is effectively cold sprung in the field must be exactly the amount calculated and specified by the Perma-Pipe engineers.

If time is taken to plan the installation, work can proceed at another location while waiting for anchors to be poured and cured.

Occasionally, pouring anchors first is not possible or desirable. In this case, the Perma-Pipe field representative must be consulted. The field representative might provide an alternate recommendation similar to the following Bridge Method.

BRIDGE METHOD

- √ Cut the shipping bars off the ends of the assemblies.
- √ Carefully measure the gap between the two outer casings at the cold spring location. It must remain a 12-inch gap. This gap must remain **exactly** 12 inches throughout the entire procedure.
- √ Position a shipping bar or similar piece of metal, the *BRIDGE*, between the two casings and weld it to the inside edges of the conduit as shown in Figure 3.
- √ Repeat this at every field joint location on the run.

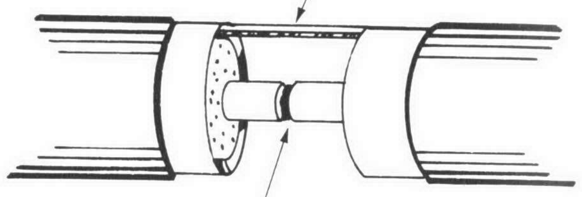


Figure 3. Bridge Method

- √ Follow the regular cold spring steps.
- √ **Do not** remove the *BRIDGE* from between the casings. Complete the field closures with the bridges in place.

Shrink Sleeve

Field joint closure is a critical part of any pipe installation. A poor field closure can lead to corrosion and, ultimately, failure of the section of pipe.

The EsCon-A system offers maximum protection at field closures with a minimum amount of labor. Consisting of a metal closure sleeve welded across the field joint opening and a heat shrinkable sleeve covering the exposed metal, EsCon-A field closures are virtually corrosion proof.

The shrink sleeve forms its seal in two ways simultaneously. The recovery (shrinking) of the sleeve is due to the heat that it absorbs. As the sleeve recovers, an adhesive sealant softens and forms a bond with the pipe surface. The effectiveness of the seal is dependent upon how well these processes are completed.

In order to heat the sleeve correctly, the proper propane equipment should be used. Perma-Pipe, through the field representative, will loan the customer the necessary standard propane torch, free of charge. The LP tank, hose, fittings, unions, valves and regulators are provided by the customer.

If the customer wishes to supply the propane torch, it should meet the following specifications or be approved by Perma-Pipe field service.

- ☑ Heavy duty hose type LP torch
- ☑ High capacity flame, min. 12-18 in.
- ☑ Gas consumption, min. 140,000 BTU/hr.

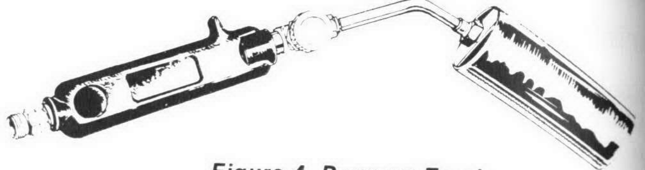


Figure 4. Propane Torch

When using the torch, the flame should be kept at least 6 inches away from the shrink sleeve and at an angle to the surface. Holding the torch at an angle allows the flame to bounce off of the sleeve and decrease the local intensity of the heat. Distributed heat results in a more even recovery. If the flame is held too close to the surface, the material will burn and the sleeve may tear around the burned areas.

The entire metal closure sleeve should be preheated with the torch until it is warm to the touch (approximately 130°F). Taking the time to properly preheat the closure sleeve results in a better bond with the shrink sleeve. If the closure sleeve has been sufficiently preheated, the shrink sleeve will adhere to the metal immediately.

WRAPPING

After the top of the shrink sleeve is bonded to the closure sleeve, as described in Section I, the rest of the sleeve will be wrapped around the conduit. Staying within the chalk guidelines when wrapping will help the sleeve to shrink uniformly.

When wrapping the shrink sleeve, leave a gap of approximately 1 inch between the sleeve and the bottom of the conduit. This gives the sleeve room to shrink properly. If the sleeve is wrapped snugly without a gap, it may pull apart or tear during heating.

HEATING THE SHRINK SLEEVE

After wrapping the shrink sleeve, the closure tape should be preheated for about 5 seconds. Do not overheat the tape as it will soften too much. Apply it directly over the seam of the overlap and press down firmly. Do not try to smooth the patch out.

If care is not taken in applying the tape, the sleeve could separate at this point during the recovery.

The shrink sleeve must be heated first in the center and then out toward the edges. This prevents air pockets from forming underneath the sleeve and causing the sleeve to tear. Starting at a bottom center point, wave the torch across the surface of the sleeve, keeping it in constant motion to prevent burning.

As this section begins to shrink, move circumferentially around the center of the sleeve. The sleeve only tolerates a certain amount of heat as it shrinks, thus the torch should be moved as soon as a section starts to shrink and then brought back later if needed. Continue until the entire center section is shiny and even.

Begin moving the torch to the left and repeat the above procedure until the entire left side is done. Then move the torch to the right side and heat it in the same way.

The torch **must follow a continuous path** as it is moved around the sleeve. Skipping to different sections will result in air pockets underneath the sleeve. See Section I, SHRINK SLEEVE.

The edges of the sleeve should be heated last and then pressed down firmly by hand. Black adhesive oozing along the entire edge indicates a good seal. Check the adhesion of the closure tape and press it down firmly if necessary.

If the wind is a problem, use your body as a shield to protect the flame. Continue to keep the torch at an angle to the sleeve and pointed in the direction the wind is blowing. This should result in a fairly even flame. Do not increase the size of the flame, as this could overheat the shrink sleeve.

The Perma-Pipe field representative will be on hand to demonstrate and check the application of the shrink sleeves.

COATING REPAIR

Occasionally, a section of pipe will be damaged or bruised during shipment or installation. If the bare metal of the conduit is exposed, the coating is considered DAMAGED. The coating is BRUISED if the felt is torn and the coal tar is showing, but no bare metal is exposed. A DAMAGED or BRUISED coating must be repaired with Perma-Kote and Perma-Tape, as specified in Section I, COATING REPAIR.

When applying the Perma-Kote and Perma-Tape, the following environmental limitations should be observed:

- ✓ The Perma-Tape should be applied in temperatures above 25°F. Should it be necessary to apply the material in outside temperatures below 50°F, the Perma-Tape should be stored in a heated area (70°F) prior to use. Repairing DAMAGED coating in extreme cold (less than 25°F) should be avoided. Once initial adhesion of the Perma-Tape is attained, complete fusion bonding will occur. While mechanical adhesion is attained immediately, the complete cure will take several hours; however, the repaired pipe can be backfilled within 2 hours.

- ✓ The Perma-Kote should be applied at temperatures above 25°F. Since it will become viscous at temperatures below this point, it should be stored in a heated area (70°F) to facilitate application. Normal drying time will increase approximately 10 min. per 10°F drop in temperature.

- ✓ The Perma-Kote must not be applied over wet surfaces. Any condensation must be removed before application of the Perma-Kote. In extremely high humidity, a longer drying time is required. No loss of protection will occur, regardless of the humidity, once the Perma-Tape has sufficiently cured.

- ✓ In areas where the damaged area is greater than 200 sq. in., or at a field alteration, a shrink sleeve should be used for the coating repair. See Section I, SHRINK SLEEVE and consult your field representative.

CATHODIC PROTECTION

Cathodic Protection may be required in EsCon-A systems where the soil is determined to be highly corrosive.

Corrosion of the conduit is the result of an electrochemical reaction between the metal pipe and the soil. A galvanic potential exists between the anodic and cathodic areas of the pipe, and this potential drives current through the soil between the two areas. At anodic areas (anodes) there is corrosion; at cathodic areas (cathodes) there is not.

Cathodic protection is a process which makes the entire pipe a cathode by means of an impressed current or a sacrificial anode.

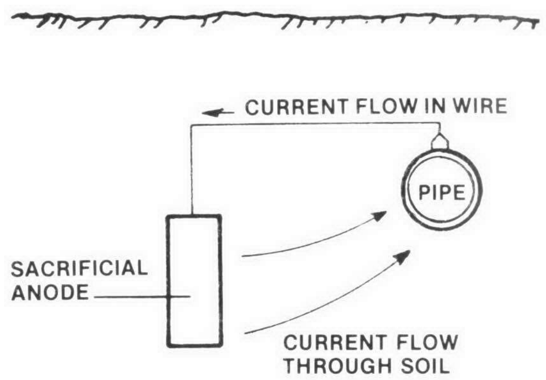


Figure 5. Sacrificial Anode System

The sacrifical anode method (Figure 5) is used primarily for small to medium-length installations. An anode, usually made of magnesium, is buried

near the pipe and connected to a wire which is welded to the pipe. The potential difference existing between the pipe and the anode makes the entire pipe a cathode. The current is driven from the cathode through the wire to the anode and back to the cathode through the soil.

It is important that:

1. The potential between the anode and the pipe is sufficient to overcome the anode-cathode areas of the pipe

2. The sacrificial anode has enough material to last for a reasonably long time.

3. The anodes have a high efficiency. Most of the energy generated from the anode should be directed to the cathodic protection system.

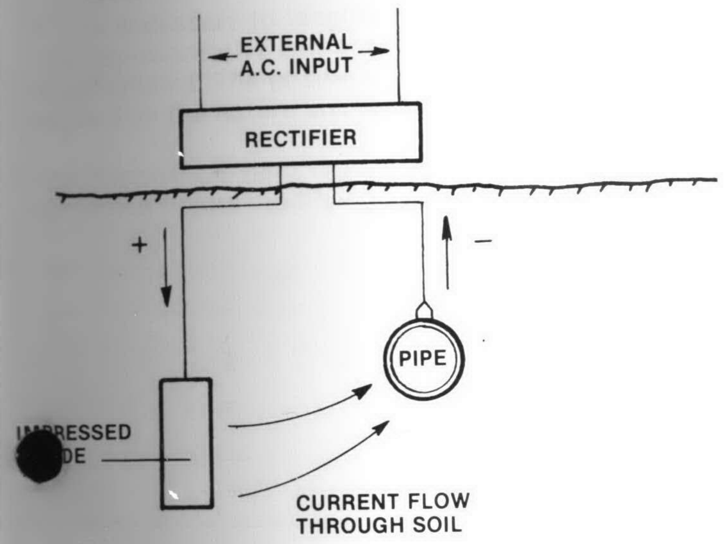


Figure 6. Impressed Current System

The impressed current method (Figure 6) is used for pipe systems that are very long. A rectifier delivers an electrical current from an external source into the ground anodes. This impressed (or forced) current is, in turn, discharged through the soil and into the pipe which then becomes the cathode. The circuit is completed by a wire running from the pipe back to the rectifier.

Because the anodes are not using a self-generating current, they will not deteriorate; however, if the positive connection from the rectifier is attached to the pipe, the pipe will corrode very quickly. This is the opposite of the desired effect.

FIELD ALTERATIONS

All field modifications to the EsCon-A system must be cleared with Perma-Pipe. Changing the length or direction of the system may result in a faulty installation requiring costly repairs in the future.

Every installation should have field verification of the submittal drawings. This will eliminate most dimension problems and will also allow Perma-Pipe time to re-engineer the system if needed.

Even with field verification, there will occasionally be an installation that does not run true to plan. If additional materials are required, the Perma-Pipe field representative should be contacted immediately.

If it is necessary to lengthen or shorten a run, the field representative will specify where to make the modifications. The position of the modification will depend on the nature and location of the problem.

The Perma-Pipe field representative must also be contacted before modifying the direction of a run.

BACKFILL

The most crucial part of the backfilling process is the compaction of soil underneath and alongside of the conduit. A hand tamping device can be constructed easily and economically by joining small diameter pipe. This tool will compact the soil firmly and evenly around the pipe. It should be used in place of mechanical tampers when compacting around the pipe to prevent damage to the Elephant Hide™ coating.

Figure 7. Compaction Tool

Backfill materials and procedure should be as described in Section I, BACKFILL.

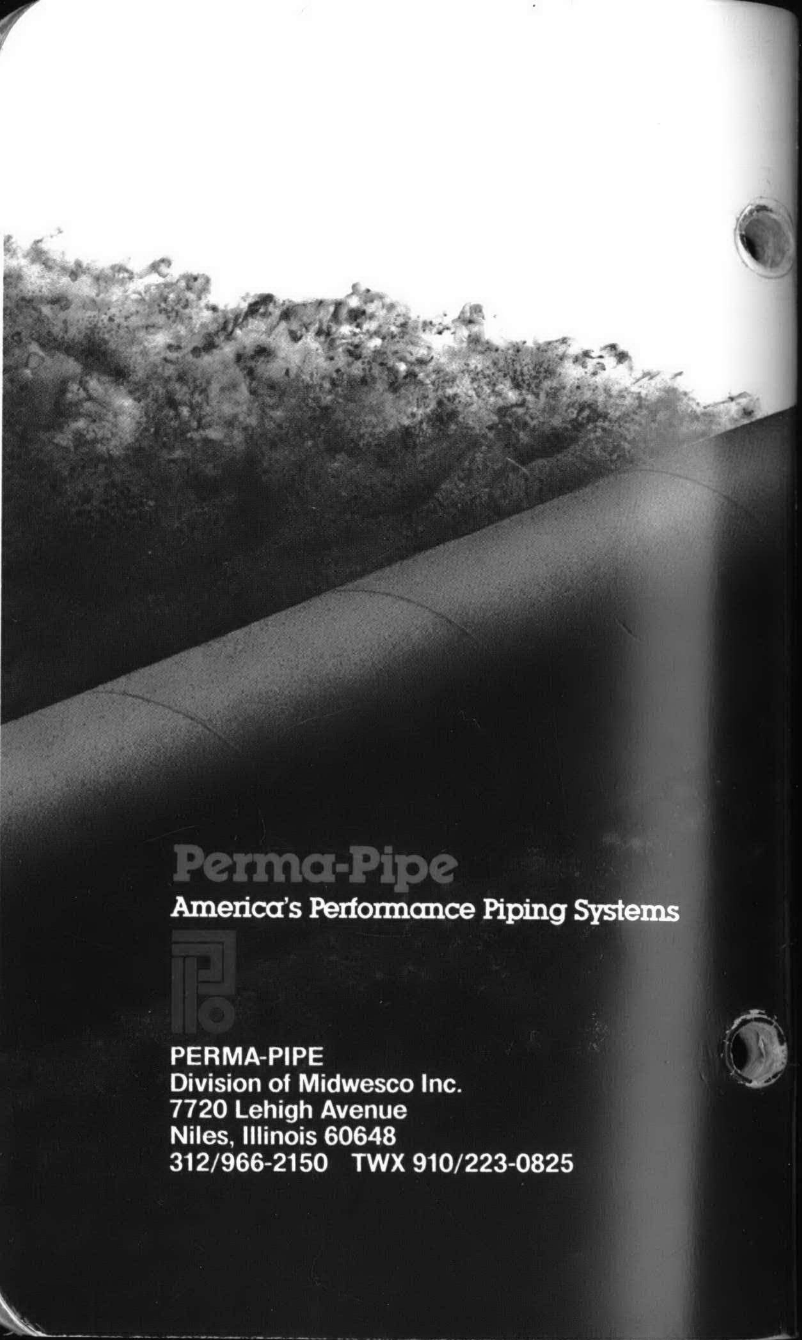
Perma-Pipe's outer conduit is a flexible pipe capable of withstanding deflections of its geometric shape without structural damage. As the conduit deforms due to surface (live) loads and soil loads, the sides move outward against the soil developing passive resistance pressure from the soil. This passive soil pressure can be great enough to increase the load-carrying capacity of a flexible pipe significantly. The extent of this increase is dependent on many conditions, in particular, the type of soil and the degree of compaction. If Perma-Pipe's recommended procedures are followed, a minimum burial depth of 2 feet can be established. It should be noted that shallower burial depths increase heat losses slightly.

Special analyzation of minimum burial depths is required at taxiways, runways, railroads, and other areas of high surface loading conditions. It is recommended that the customer contact both Perma-Pipe and the local authority for more specific instructions.

GLOSSARY

Air Test	Pressure testing the casing welds with air.
Anchor	A metal plate factory welded to both the conduit and carrier pipe, used in arresting movement of the pipe.
Anchor Blocks	Concrete thrust blocks poured around the anchors.
Annular Air Space	The gap between the insulated carrier pipe and the inside conduit wall.
Assembly	A prefabricated section of pipe.
Bell Hole	A hole dug out at a field joint location to enlarge the work area.
Butt Weld	A weld made between two adjoining pipe ends.
Carrier Pipe	The pipe through which the steam or liquid is transported.
Casing	The metal conduit protecting the insulated pipe line.
Cathodic Protection	An electro-chemical method of preventing pipe corrosion.
Closure Sleeve	A prefabricated metal sleeve which acts as the casing at field joints.
Cold Springing	Shifting the position of the carrier pipe during assembly to counteract the pipe expansion.
Coupling Gap	The extra space needed between two carrier pipes when welding with a backing ring.
Crucial Period	An installation period requiring supervision by the local Perma-Pipe field representative.
Elephant Hide™	The factory applied, protective coal tar coating on the conduit.
Ell (conduit elbow)	A mitered fitting which produces a change in direction.
End Seal	A metal plate sealing off the pipe at the end of the run, usually at a manhole.
Expansion Loop	A U-shaped assembly which allows for thermal expansion of the pipe.
Field Joint	A field coupling of two carrier pipes.
Gland Seal	An end seal which allows lateral movement of the pipe within a wall.
Holiday	A void or hole in the Elephant Hide™ coating, commonly called a "jeep."
Holiday Detector	An electronic detector used to locate voids.
Hydrostatic Test	A water pressure test of the carrier pipe welds.
Leak Plate	A plate welded to the pipe at end seal locations to prevent water from entering the manhole.
Modified Proctor	A density scale of soil compaction.
Natural Angle of Repose	The slope at which soil rests without artificial support.
PDL	The Part Drawing Layout is a diagram indicating the relative positions of the assemblies.
Perma-Kote	The black mastic used to repair bruises and/or damages in the coal tar coating.
Perma-Tape	The patch material used in repairing bruises and/or damages in the coal tar coating.
Prefabricated	All possible work is done in the Perma Pipe factory, leaving only field connections of assemblies.
Shipping Bars	Metal bars welded on the ends of the assemblies to prevent damaging movement during shipping.
Should	"Should" or "it is recommended" is used to indicate that a provision is not mandatory, but recommended as good practice.
Shrink Sleeve	A heat-shrinkable mat which tightly seals the closure sleeve.
Socketweld Coupling	A coupling used in welding small diameter pipe (2 in. or less).
Spreader Bar	A bar used with two nylon slings that controls the swinging of the assembly during handling.
Tack Weld	A weld made to hold parts of a weldment in proper alignment until the final welds are made.

NOTES



Perma-Pipe

America's Performance Piping Systems

PERMA-PIPE
Division of Midwesco Inc.
7720 Lehigh Avenue
Niles, Illinois 60648
312/966-2150 TWX 910/223-0825

FRP POLY-THERM™ GENERAL NOTES

1.0 All preinsulated pipe shall be POLY-THERM™ as manufactured by PERMA-PIPE™, which is comprised of service pipe, rigid polyurethane foam insulation, and fiberglass reinforced polyester outer jacket.

1.1 Service pipes shall be: BONDSTRAND SERIES 2000 FRP PER MIL-P-28584A

1.2 Service pipe fittings shall be: BONDSTRAND FRP PER MIL-P-28584A SHIPPED LOOSE AND UNINSULATED.

1.3 Insulation shall be rigid polyurethane foam, applied directly onto straight sections of pipe. The polyurethane foam insulation shall have the following density and initial K factor at 75°F (24°C).

[X] 2 lbs/ft³ with a K factor not greater than .13 BTU-IN/HR-FT²·°F [.019 W/M-K]
[ ] 3 lbs/ft³ with a K factor not greater than .14 BTU-IN/HR-FT²·°F [.020 W/M-K]
[ ] other

1.4 The outer jacket for standard straight sections of pipe shall be continuous rovings of fiberglass saturated with isophthalic polyester resin wound in a helical pattern to the minimum thickness indicated below:

Service Pipe Size	Outer Jacket Thickness
3"	60 MILS

2.0 Dimensions shown are to the inside face of building walls and manholes. Taking of field measurements and their verification are entirely the responsibility of the purchaser. Any changes must be indicated on this drawing. In addition, before manufacturing can begin, the purchaser must furnish and/or verify the following information:

2.1 Wall thicknesses at all points of entry

2.2 Service line design temperatures: CONDENSATE Line @ 180°F
Line @ °F
Line @ °F

3.0 Each POLY-THERM™ unit shall prevent moisture ingression into the insulation with end seals in the factory by winding the FRP jacket over the tapered insulation and bonding it onto the service pipe.

4.0 Thrust and anchor blocks shall be field poured and keyed into undisturbed earth by others at changes in direction and, if specified, at building entries. All thrust blocks shall be allowed to completely cure before operating the system at design temperatures. The Owner's engineer is responsible for thrust block design.

5.0 Wall and floor sleeves, including packing, shall not be furnished by PERMA-PIPE™.

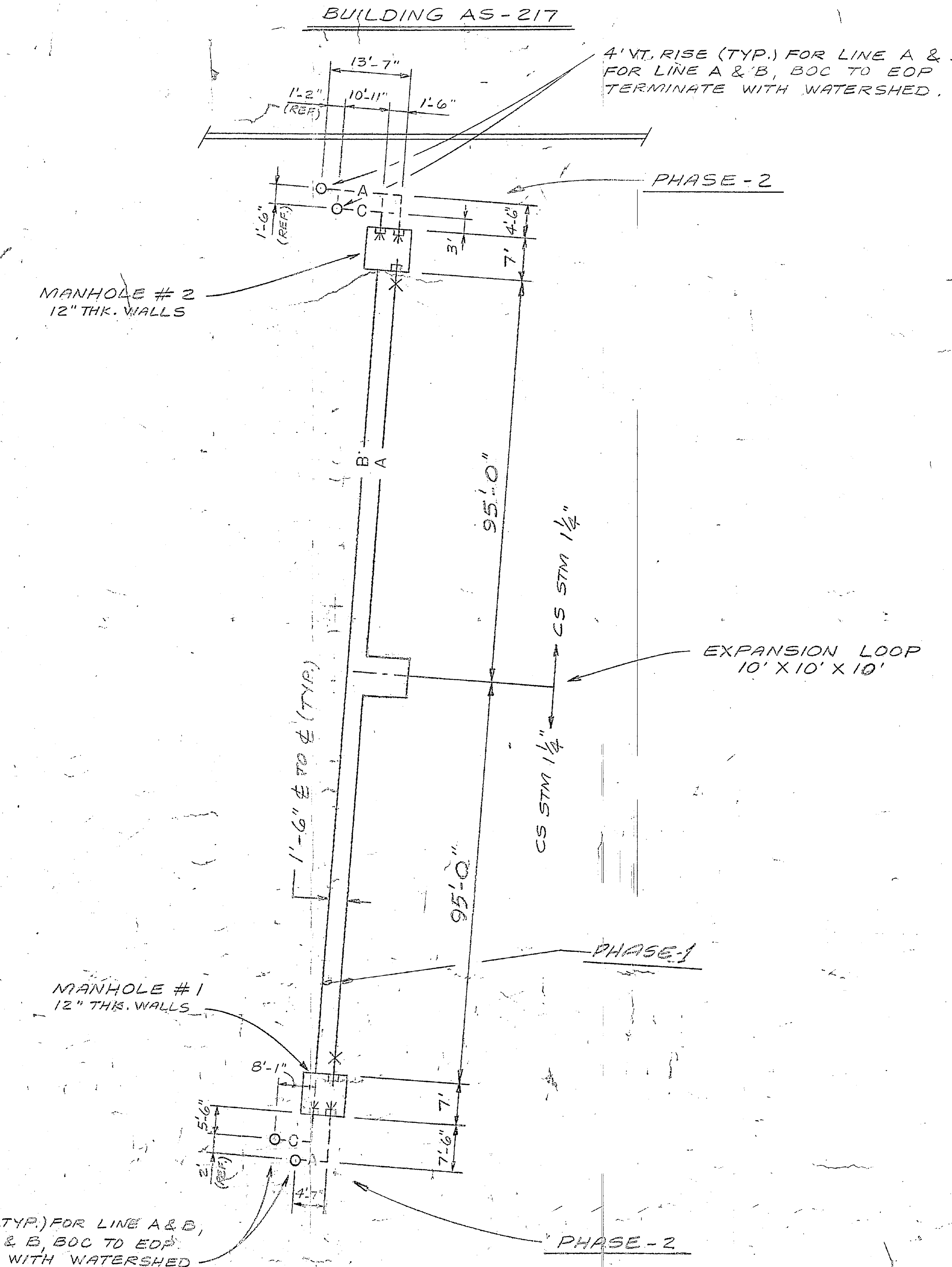
6.0 FRP pipe to be shipped in 30 FT. random lengths.

7.0 PERMA-PIPE™ shall supply FRP flanges (shipped loose and uninsulated) for all building and manhole entries. The contractor shall furnish all steel components within structure to connect up to FRP flanges.

8.0 All connections between FRP pipe and metal pipe shall be made within manholes or buildings. Metal pipe must be anchored within 5' of flanged connection.

9.0 Each pipe section shall be marked with the following: PERMA-PIPE™ POLY-THERM™ BONDSTRAND SERIES 2000/SPEC. MIL-P-28584.

10.0 FLANGES, HEAT BLANKET, LOCATOR TAPE, ADHESIVE KITS, AND HEAT SHRINKABLE END SEAL ARE TO BE FURNISHED BY PERMA-PIPE.



CONDUIT—GENERAL NOTES

1. Conduit Casings shall be spirally welded steel, manufactured to the specification ASTM A-211, having wall thicknesses per conduit diameter as follows:
21 7/8" and below — 10 gauge 22"-26" — gauge 27"-36" — gauge

2. Conduit Casing Coating shall conform to military specifications.
[X] Exterior - PERMA-PIPE "elephant hide" and consists of coal tar enamel, interposed layer of glass fabric and an outer protective jacket of 15 pound coal tar saturated asbestos pipe line felt to a minimum coating thickness of 1/8", exclusive of felt over wrap. Coating shall be holiday spark tested at 10,000 volts.
Interior - Heat and corrosion resistant primer.
[ ] Other -

3. Service piping shall be:
6" PIPE SCH. 40 ... E.R.W.

4. Service pipe insulation shall be: MINERAL FIBER

5. Service pipe fittings shall be: FORGED STEEL BUTT-WELD.

6. All service piping shall be hydrostatically tested at the mill. Test certificates are available if requested with approval of this submittal.

7. Testing of factory service pipe welds: Random [X] X-Ray [ ]
Not Specified [ ] % [ ] Hydrostatic [X] at 250 psig.
100% [ ] Other [ ]

8. All casing shall be air pressure tested at the mill at 15 psig.

9. All factory casing welds shall be air pressure tested to a minimum of 15 psig.

10. A stress analysis of this system has been made in accordance with the rules and procedures as set forth in the American National Standard Code For Pressure Piping (ANSI B-31), Power Piping Section B31.1 - latest edition. This stress analysis was made assuming that the dimensions and service line temperatures shown on this drawing are correct. This system is within the limits set forth for allowable stress in that code based upon the assumptions herein.

11. The purchaser must furnish and/or verify the following information before manufacturing of the system can begin:

A. Field measurements including wall thicknesses at all points of entry. The accuracy of field measurements are entirely the responsibility of the purchaser. This information must be shown on these drawings.

B. Service line temperatures: STEAM Line 366°F @ 150 PSIG
Line °F Line °F

12. Dashed lines indicate oval pipe supports. All exp. loops require oval supports.

13. Where required, service piping shall be cold sprung in the field 50% of the total amount of expansion. The amount of cold springing is indicated on the layout drawing(s) by the symbol C.S.

14. Units shall be shipped with a shipping bar welded to both the conduit and service pipe(s). Removal of said bars and repair of service pipe(s) and/or conduit, if needed, shall be the responsibility of the installing contractor:

15. Building and manhole pipe entries require the following:
[X] For end seals, leak plates to be shipped loose by P-P to be welded in field.
[ ] Wall sleeves and link seals to be provided
By P-P [ ] By Others [ ] For Gland Seals Only [ ]

~~16. [ ] For pipe sizes 2" and smaller socketweld couplings are required at field joints. Allowances for the stop in the coupling will be made at the factory and these pipe ends will remain unbeveled. It is the purchaser's responsibility to provide the socketweld coupling.~~

17. A blue stripe on the exterior of the casing indicates oval type pipe supports and must be connected to an adjacent compensating elbow. Similarly, a white stripe on the casing indicates cold springing is required at this joint. Provisions for cold springing were made at the factory. This location will be shown on the Part Drawing Layout.

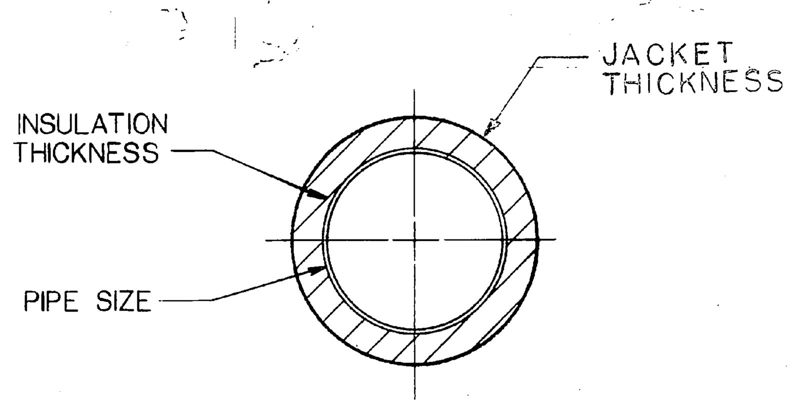
18. For pipe support details, see drawing no. 250 (oval), 220 (straight).

19. Field joints shall be patch coated with a standard Perma-Pipe heat shrinkable sleeve.

20. DIMENSIONS SHOWN ARE TO INSIDE FACE OF WALLS.

LEGEND

SYMBOL	DESCRIPTION	DRAWING
	END SEAL	
	GLAND SEAL	
	ELBOW	
	EXPANSION LOOP	
	ANCHOR	
	ANCHOR ELBOW	
	CAP (FUTURE CONN.)	
	WATERSHED	



POLY-THERM CROSS SECTION			
SECTION	PIPE SIZE	INSULATION	SERVICE
B	3"	1½"	CONDENSATE

CATHODIC PROTECTION NOTES

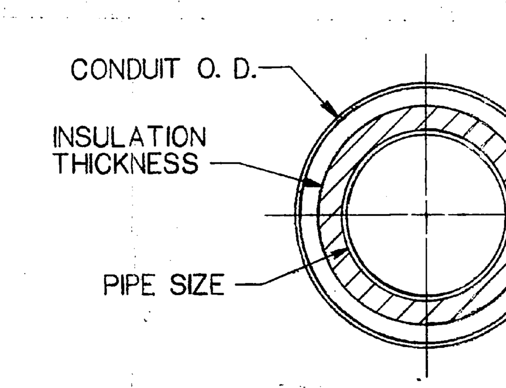
1. Cathodic protection submittal will be forthcoming under separate cover. One (1) copy of this submittal must be returned marked approved prior to cathodic materials being released for shipment.

2. Certain aspects of the cathodic installation should coincide with the installation of the pipe. Prior to installation of the pipe and the cathodic materials, the installing contractor should consult his local PERMA-PIPE representative to coordinate a site visit by a cathodic protection representative to instruct installation.

3. It is the responsibility of the installing contractor to maintain a completely isolated system free from all metal to metal contact with foreign metallic structures.

4. If a tie-in to an existing system is required without benefit of a pit or manhole in which to isolate the system, it shall be the responsibility of the owner to insure that the existing system is cathodically protected at an acceptable level, or we cannot assume responsibility for adequate protection of that particular run.

5. Flange isolation kits to match 150 PSI flanges.



CONDUIT CROSS SECTION				
SECTION	PIPE SIZE	INSULATION	CONDUIT	SERVICE
A	6"	2½"	16"	H.P. STEAM
C	3"	1½"	10¾"	COND.

DRAWN BY AM				
APPROVED BY				
DATE 7-23-87				

REV. NO	DATE	REVISION	BY	APPR
A	12-7-87	REV. PER CUST. REQUEST		
B	01/22/88	REV. PER CUSTOMER'S REQUEST.	AM	

ROBERT A. MAFFEI 36083 REGISTERED PROFESSIONAL ENGINEER ILLINOIS

PERMA-PIPE
A DIVISION OF MIDWESCO, INC.
7720 LEHIGH AVE. NILES, ILL. 60648
MANUFACTURING FACILITY
1310 QUARLES DR. LEBANON, TENN. 37087

ENERGY DISTRIBUTION SYSTEM

FOR

NEW RIVER, CAMP LEJEUNE

JOB NUMBER PCF-1256 PTF-1257
DRAWING NO. 87-173-DB
SCALE 1" = 20'-0"
SHEET 1 OF 1
CUSTOMER SNEEDEN, INC.

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DESCRIPTION:

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9

TOS

MARK-TIME

A COMPLETE LINE OF PORTABLE AND BUILT-IN TIME SWITCHES AND BELL TIMERS FOR HOME, INDUSTRY, AND OEM'S.

WALL BOX TIME SWITCHES

90000 Series-S.P.S.T.

popular M.^RK-TIME 90000 Series automatically turns F" ventilatin fans, heaters, heat lamps, lights, and can ate as a thermostat bypass. Saves ENERGY, MONEY, and and tear of equipment. Adds convenience to installations otels, motels, hospitals, homes, schools, offices and in- rial plants. As easy to install as a toggle switch. In- dually packed with wood grain finish, metal calibrated ch plate, knob and mounting hardware.

l Feature: Holds current "ON" without operation of timing hanism; timing begins when knob is turned to a time od.

F" type switch breaks circuit at end of time cycle.

" type switch makes circuit at end of time cycle and is able on special order.

Cat. No.	Time Cycle	Gang Mounting Plates A	B	C	D	Notes
WITHOUT HOLD						
90004	0-5 min.	D14L	D14LB	D14LA	D517	Brushed Aluminum finished plates are also available to accommodate the time switch and (A) up to three Despard devices. (B) a toggle switch or (C) a duplex outlet. Adhesive backed MYLAR DIALS (D) are available to modify a standard gang switch plate.
90005	0-15 min.	D14J	D14JB	D14JA	D511	
90006	0-30 min.	D14G	D14GB	D14GA	D510	
90008	0-60 min.	D14N	D14NB	D14NA	D674	
90281	0-2 hrs.	—	D14QJ	D14QF	D2080	
90102	0-3 hrs.	—	D14QH	D14QE	D2081	
90240	0-4 hrs.	—	—	—	—	
90007	0-6 hrs.	—	D14QG	D14QD	D2060	
90001	0-12 hrs.	D14Q	D14QB	D14QA	D2044	
WITH HOLD						
90021	0-3 min.	—	D14EB	D14EA	D515	
90030	0-5 min.	—	—	—	—	
90032	0-30 min.	—	—	—	—	
90024	0-60 min.	D14C	D14CB	D14CA	D516	
90017	0-6 hrs.	—	—	—	—	
90015	0-12 hrs.	D14A	D14AB	D14AA	D499	

RATING: 20 Amps, 125V. AC., 1hp., 10 Amps, 250 V. AC., 1hp., 10 Amps, 277 V. AC., 7 Amps, 125V AC. tungsten rating S.P.S.T., UL & CSA listed. For outside installation — NEMA type 3R enclosure recommended.

WALL BOX TIME SWITCH WITH MOVABLE STOP

90500 Series

Box time switches with movable stop have the same char- ristics and use as the above 90000 series Wall Box time ches. The movable stop allows maximum timings to be ged in the field. It is available in 6 hour and 12 hour timings. 6 hour time switch can be set at 30 minute increments from 5½ hours. The 12 hour time switch can be set at 1 hour ements from 2 hours to 11 hours.

No. 90504 - 6 hr. No. 90503 - 12 hr.	
vable stop kits to convert already installed n stock 90000 series 6 hour and 12 hour ...itches.	Movable Stop Kit DBX629(6 hr.) DBX...

HEAVY DUTY WALL BOX TIME SWITCH

72000 AB D.P.S.T.

74000 AB S.P.D.T.

These series time switches are designed to be installed in double gang wall boxes 2½" deep. They make possible inexpensive, simple, manual time control of 240V. circuits controlling equipment such as air conditioners, heaters, and ventilating equipment.

Time switches are individually packed with brushed aluminum satin finish dials with black characters, knob, mounting hardware, and complete installation instructions.

Catalog Number WITHOUT HOLD	WITH HOLD	Time Cycle
72000 AB — D.P.S.T.		
72130 AB	72131 AB	0-1 hr.
72132 AB	—	0-2 hrs.
72133 AB	—	0-4 hrs.
72134 AB	72135 AB	0-5 hrs.
72136 AB	72137 AB	0-12 hrs.
74000 AB — S.P.D.T.		
74112 AB	74113 AB	0-1 hr.
74114 AB	—	0-2 hrs.
74115 AB	—	0 4 hrs
74116 AB	74117 AB	0-5 hrs.
74118 AB	74119 AB	0-12 hrs.

RAT... AC. 1 hp. 120V AC. ... ries — D.P.S.T. ...ies — S.P.D.T.

TS-1, TS-2,

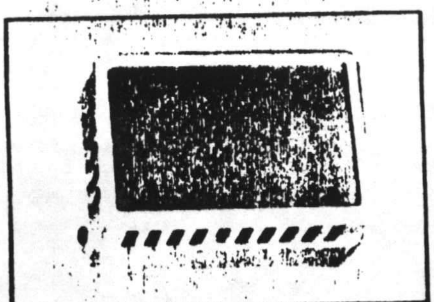
KELE & ASSOCIATES

MASTER PRICE SHEET
JANUARY 1,1987

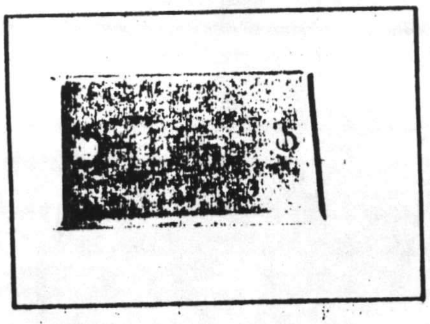
• **BARBER COLMAN**

TYPE 5, 1000 ohm BALCO RTD SENSORS

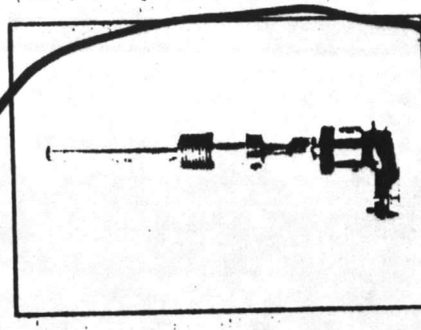
TYPE	MODEL
SPACE	ST-S5P
SPACE	ST-S5
WATER	ST-W5
DUCT	ST-D5
OSA	ST-O5
UNIVERSAL	ST-A5
RAW SENSOR	ST-R5



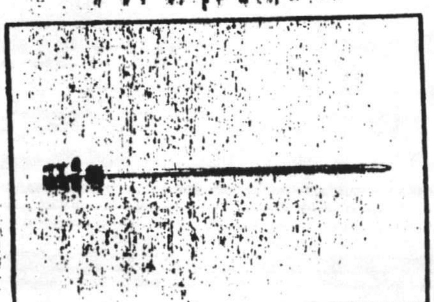
ST-(S)urface TYPE (P)lastic



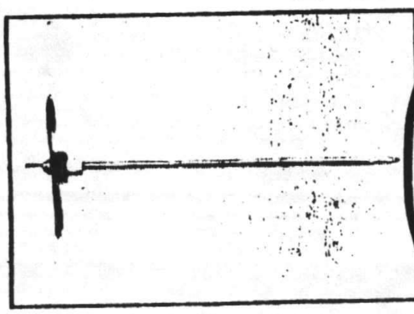
ST-(S)urface



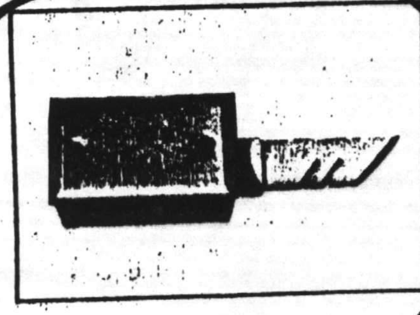
ST-(W)ater



ST-(A)ll Purpose



ST-(D)uct



ST-(O)utdoor

P. O. Box 34817 / Memphis, TN 38184 / 901-382-4300

R-3, R-4, R-5, R-6, R-7, R-8, R-9, R-10, R-11, R-12

IDEC RH SERIES MIDGET POWER/GENERAL PURPOSE

SPECIFICATIONS

Contact Material	Silver cadmium oxide (Ag-CdO)
Contact Resistance	50 mΩ max. (initial value)
Operate Time	SPDT(RH1), DPDT(RH2) ... 20 msec max., 3PDT(RH3), 4PDT(RH4) ... 25 msec max.
Release Time	SPDT(RH1), DPDT(RH2) ... 20 msec max., 3PDT(RH3), 4PDT(RH4) ... 25 msec max.
Power Consumption (Approx.)	SPDT(RH1) ... AC: 1.1 VA (50 Hz), 1 VA (60 Hz), DC: 0.8W DPDT(RH2) ... AC: 1.4 VA (50 Hz), 1.2 VA (60 Hz), DC: 0.9W 3PDT(RH3) ... AC: 2 VA (50 Hz), 1.7 VA (60 Hz), DC: 1.5W 4PDT(RH4) ... AC: 2.5 VA (50 Hz), 2 VA (60 Hz), DC: 1.5W
Insulation Resistance	100 MΩ min. (measured at 500V DC megger)
Dielectric Strength	SPDT(RH1) Between live and non-live parts: 2000V AC, 1 minute Between contact circuit and operating coil: 2000V AC, 1 minute Between contacts of the same pole: 1000V AC, 1 minute DPDT(RH2), 3PDT(RH3), 4PDT(RH4) Between live and non-live parts: 2000V AC, 1 minute Between contact circuit and operating coil: 2000V AC, 1 minute Between contact circuits: 1500V AC, 1 minute Between contacts of the same pole: 1000V AC, 1 minute
Frequency Response	1800 operations/hour
Temperature Rise	Coil: 85 deg. max., Contact: 65 deg. max.
Vibration Resistance	0 to 6g (55 Hz max.)
Shock Resistance	SPDT(RH1), DPDT(RH2) ... 20g, 3PDT(RH3), 4PDT(RH4) ... 10g
Operating Temperature	-22° to +158°F (-30°C to +70°C)
Weight (Approx.)	RH1: 24g, RH2: 37g, RH3: 50g, RH4: 74g
Life Expectancy	Electrical: 500,000 operations or more (120V AC, 10A)* Mechanical: 50,000,000 operations or more

Note:* 200,000 operations or more (120V AC, 10A) in SPDT(RH1), 3PDT(RH3), 4PDT(RH4) types

COIL RATINGS

Rated Voltage (V)		Rated Current (mA) ± 15% at 20°C								Coil Resistance (Ω) ±10% at 20°C				Continuous Applied Voltage (Max.) 20°C	Pick up Voltage (min.) at 20°C
		60 Hz				50 Hz									
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	*4PDT	SPDT	DPDT	3PDT	4PDT		
AC	6V	150	200	280	330	170	238	330	387	18.8	9.6	6.0	5.4	110% of rated voltage without overheating	80% of rated voltage
	12V	75	100	140	165	86	118	165	196	76.8	40.5	25.3	21.2		
	24V	37	50	70	83	42	59.7	81	98	300	156.7	103	84.5		
	120V	7.5	11	14.2	16.5	8.6	12.9	16.4	19.5	7680	4280	2770	2220		
	*240V	—	5.5	7.1	8.3	—	6.5	8.2	9.8	—	15720	12110	9120		
DC		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT		
	6V	128		150		240		250		47	40	25	24	110% of rated voltage without overheating	80% of rated voltage
	12V	64		75		120		125		188	160	100	96		
	24V	32		36.9		60		62		750	650	400	388		
	48V	18		18.5		30		31		2660	2660	1600	1550		
	110V	8.0		9.1		12.8		15		13800	12100	8600	7340		

Note: Rated voltages marked with * are not available for SPDT models.

CONTACT RATING UL RATINGS (RH1, RH2, RH3, RH4)

VOLTAGE (V)	RESISTIVE (A)				INDUCTIVE (A)				HORSE POWER	
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT DPDT	3PDT
120 AC	10	10	10	10	7	7	—	7.5	1/3	1/6
240 AC	10	10	—	7.5	7	7	6.5A/Pole 20A Total	5	1	1/3
30 DC	10	10	10	10	7	7	10	10	—	—

DPS

P74 SERIES DIFFERENTIAL PRESSURE CONTROLS

Series P74 measures the pressure difference between two sources (supply and return lines). A change in pressure at either control element will reposition the switching mechanism to cause corrective action of supplementary control equipment.

Typical Applications Include:
— Pressure sensing on chillers, water cooled condensors, or heating systems for proof of flow.
— Lube oil protection for refrigeration compressors (same as the P28, but does not incorporate time delay).
— Positions M100 series motor actuated valves (P74JA-2).

Features Include:
— Field proven Pennswitch with completely enclosed contact mechanism.
— Pressure differential setting easily changed without removing cover.
— Universal mounting bracket supplied.

TO ORDER: Specify Catalog Number only.

P74

FOR ALL REFRIGERANTS EXCEPT AMMONIA

Catalog Number	Switch Action	Press. Diff. Range psig (kPa)	Pressure Connections	Electrical Ratings	Max. Bellows Pressure (Momentary) psig (kPa)	Bellows Material	Shipping Weight
P74AA-1	SPST Closes On Decreases In Press. Diff.	8 to 70 Adjustable (55 to 483)	36" Cap. with ¼" Flare Nut	20 amp. 120 V AC 50/60 Hz	325 (2241)	Stainless Steel	2.4 lb. (1.1 kg.)
P74BA-1	SPST Opens On Decrease In Press. Diff.						
P74FA-1	SPDT (Snap-Acting)	8 to 60 (55 to 414)	¼" Male Flare	6 amp. 120 V AC 50/60 Hz	180 (1241)	Brass	
P74FA-5			¼" FNPT				
P74JA-2	SPDT (Floating)		¼" Male Flare	1 amp. 24 V AC 50/60 Hz			

Q15 ELECTRONIC IGNITION SYSTEMS

FOR NATURAL GAS FURNACES AND BOILERS

This solid state ignition control lights a pilot burner by spark. Pilot gas is ignited and burns during each running cycle (intermittent pilot). This system permits the main gas valve to open only when the pilot burner is proven to be lit. Applicable to all gas burning equipment using a proven pilot.

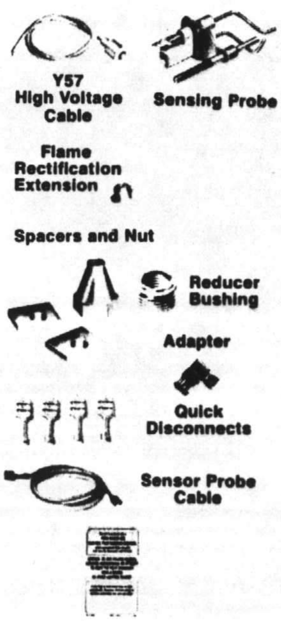
With its fast response to loss of flame, the Q15 is ideal for power vent or gravity vent equipment.

OFFERED ONLY THROUGH JOHNSON CONTROLS AUTHORIZED QUALIFIED ENERGY CONSERVATION WHOLESALERS.

Features Include
— Saves gas energy. Pilot gas is on only during running cycle. No need to shut off pilot during summer air conditioning season.
— Flame detection system provides long life due to solid state components.
— Fast response-control recycles within 0.8 second from loss of flame.
— Eliminates most purge requirements.
— Fully automatic operation on demand for heat.
— Redundant gas valve.
— AGA & CGA design certified.

TO ORDER: Specify Catalog Number only.

G60
Ignition Control



Y57
High Voltage Cable

Sensing Probe

Flame Rectification Extension

Spacers and Nut

Reducer Bushing

Adapter

Quick Disconnects

Sensor Probe Cable

Lighting Instruction Sticker

The Q15 MIZER system comes complete as shown

SPECIFICATIONS

Electrical Connections	Voltage	Regulator Pressure	Max. Operating Pressure	Valve Size	Ambient Temperature Limits
¼" Male Quick Connects	25 V. 60 Hz	3" to 6" W.C. (0.7 to 1.5 kPa)	0.5 psig (3.4 kPa)	½" x ¾" Includes a ¾" to ½" Reducer	−40 to 150° F (−40 to 66°C)

Catalog Number	Ignition Type	Regulator Setting	Comments
Q15EAA-1	Automatic Reset	3.5 ± 0.2" @ 125,000 Btuh	—
Q15FAA-1	Automatic Reset	3.5 ± 0.2" @ 125,000 Btuh	Slow Opening Valve
*Q15GAA-1	Manual Reset	3.5 ± 0.2" @ 125,000 Btuh	100% Lockout

* 30 second trial for pilot gas ignition.

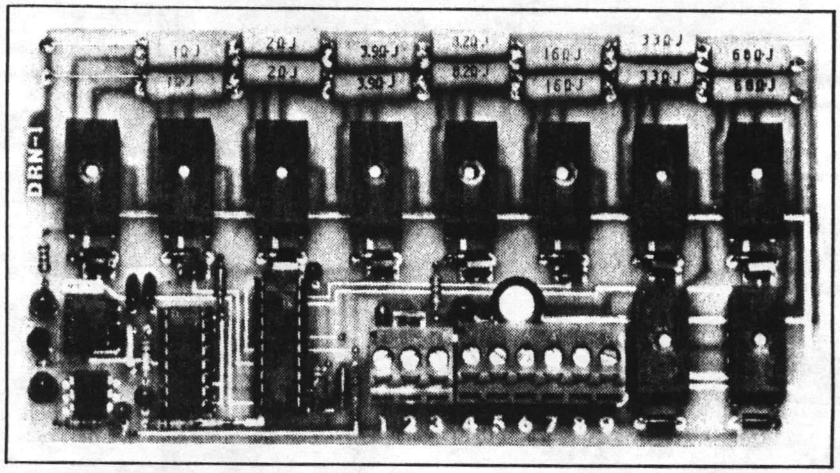
RC-1

Products Division
Technical Data Sheet

ETC

ENERGROUP TECHNOLOGIES CORPORATION
2730 SOUTH TIBBS • INDIANAPOLIS, INDIANA 46241
317-243-1636

DIGITAL RESISTIVE NETWORK CONTROLLER — DRN



FEATURES

★ **Electronic Control of Resistance Networks**

★ **On Board Failback Capabilities**

★ **Isolated Resistance Network**

★ **Virtual Linear Output**

PRODUCT OVERVIEW

The DRN is an electronic interface product that allows microprocessor control of a variable resistive controlled circuit. The DRN directly replaces a variable resistive controller and accepts a single pulse width modulated input, a 4-20 ma analog input or 0-5 vdc analog input signal.

All versions of the DRN have on board failback relays that lock out the original resistive controller during DRN operation. However, if the DRN supply voltage is lost, control of the circuit will revert back to the original controller. This feature allows remote hand & system overrides.

The standard resistance ranges available are 135 ohm and 1000 ohm. The 135 ohm model has 127 steps of accuracy and the 1000 ohm model has 255 steps of accuracy. Custom ranges are available.

There are LED indicators for power and signal voltage.

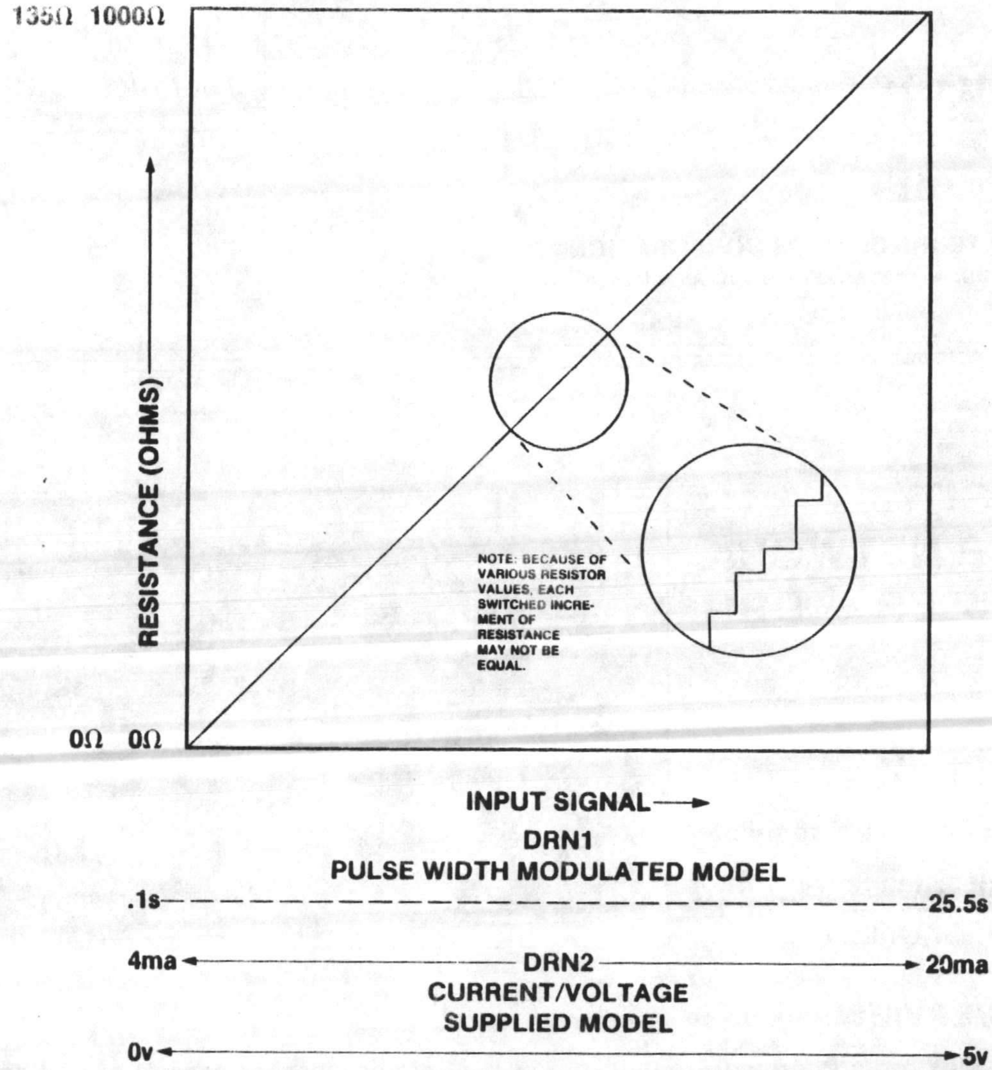
The DRN signal input terminals are wired to the normally open contacts of one output on the controlling microprocessor. The DRN 1 accepts a single pulse width modulated input signal (time duration of contact closure) that ranges from .1 to 25.4 seconds in duration. The DRN 2 accepts either a continuous analog 4-20ma or 0-5 vdc input signal.

The DRN will then select a binary sequence of resistors that is proportional to the input signal.

All three connections of the simulated potentiometer are available: the wiper and both the clockwise and counter clockwise end connections.

APPLICATION

Typical applications include the replacement of a rotary or slide wire potentiometer as a controlling device. An example of these type of controls is a proportional thermostat or a manual proportional control that is used in HVAC applications. The DRN can thus be used to control actuators for valve, vane or damper positioning. Other applications include any requirement for analog resistance.



SPECIFICATIONS

SUPPLY VOLTAGE	- 24 vdc +/- 20%
SUPPLY CURRENT	- 350 ma
INPUT PULSE (DRN1)	- .1 to 25.4 seconds of dry contact or solid state closure sink to (-) 24 vdc @ 11 ma
INPUT SIGNAL CURRENT (DRN2C)	- 4-20 ma source (sink version optional)
INPUT SIGNAL VOLTAGE (DRN2V)	- 0-5 vdc
TEMPERATURE RANGE	- - 20 degrees to + 150 degrees F.
RELAY CONTACTS	- gold overlay silver palladium cross bar 20 million closure life expectancy.
RESISTANCE OUTPUT	- 135 ohm, +/- 5%, 3 watts, 127 steps resolution. 1000 ohm +/- 5%, .25 watts, 225 steps resolution.

ORDERING INFORMATION

TO ORDER SPECIFY: DRN __ — ______

1 - pulse width modulated input.
2V - 0-5 vdc input.
2C - 4-20 ma

135 - 135 ohm resistance range.
1000 - 1000 ohm resistance range.
*custom ranges available.

FS-1

JOHNSON CONTROLS

Johnson Controls, Inc.
Penn Division

2221 Camden Court
Oak Brook IL 60521

Type F61MB Vaportight Flow Switch With NEMA 4 Enclosure

APPLICATION

This Vaportight Flow Switch meets NEMA Type 4 requirements and is U. L. listed as raintight. Type F61MB is recommended for use on indoor or outdoor applications in high humidity atmospheres, on liquid lines handling fluids below dewpoint temperature or below 32 F (0 C). Typical applications of Type F61MB are for automatic control, interlock or alarm sounding where some minimum liquid flow is required.

Type F61MB is used on liquid lines carrying well water, swimming pool water, seawater, brine or ethylene glycol. Not for use with hazardous fluids or in hazardous atmospheres.

The SPDT switch can be wired to close one circuit and open a second circuit when liquid flow either exceeds or drops below the adjusted flow rate.

This flow switch may be mounted in a horizontal pipe line or a vertical pipe line with upward liquid flow. It is not recommended for installations where liquid flow is downward. When mounted in a vertical pipe line with upward flow, the switch will trip at a higher flow than shown.

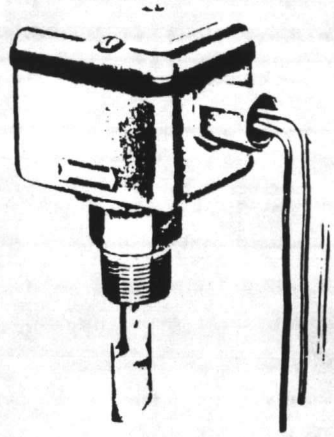


Fig. 1 — Type F61MB flow switch.

FEATURES

— Conduit hole is vapor-sealed at the factory.

— Sturdy, gasketed drawn steel NEMA 4 enclosure.

— Dependable enclosed snap-acting switch.

— Packless construction—switch assembly is sealed from line by phosphor bronze bellows.

— Easy to wire—pre-wired, color coded, solid conductor leads.

— Maximum liquid pressure of 150 psig. (1034 kPa).

GENERAL DESCRIPTION

This flow switch has a NEMA 4 enclosure with brass pipe connector. All parts in contact with the liquid are brass or bronze. The switch compartment is completely sealed from the liquid in the line by a phosphor bronze bellows seal. The paddle has three segments designed for pipes 1" and larger. Segments of the paddle can be removed or trimmed as needed for pipes under 3". A 6" paddle is also included for installing in pipes larger than 3".

The SPDT Pennswitch has three #14 AWG solid conductor colored wire leads for easy wiring. The switch is factory set at approximately the minimum flow rate (see table). It must not be set lower than the factory setting as this may result in the switch failing to return at a "no flow" condition. A higher flow rate setting may be obtained in the field by turning the range adjusting screw clockwise.

SPECIFICATIONS

TYPICAL FLOW RATES — G.P.M. (m^3/hr) REQUIRED TO ACTUATE SWITCH

Line Pipe Size		1"	1¼"	1½"	2"	2½"	3"	4" *	5" *	6" *	8" *
Min. Adj.	Flow Increase R to Y Closes	4.2 (1.0)	5.8 (1.3)	7.5 (1.7)	13.7 (3.1)	18.0 (4.1)	27.5 (6.2)	65.0 (14.8) 37.0† (8.4)	125.0 (28.4) 57.0† (12.9)	190.0 (43.1) 74.0† (16.8)	375.0 (85.2) 205.0† (46.6)
	Flow Decrease R to B Closes	2.5 (0.6)	3.7 (0.8)	5.0 (1.1)	9.5 (2.2)	12.5 (2.8)	19.0 (4.3)	50.0 (11.4) 27.0† (6.1)	101.0 (22.9) 41.0† (9.3)	158.0 (35.9) 54.0† (12.3)	320.0 (72.7) 170.0† (38.6)
Max. Adj.	Flow Increase R to Y Closes	8.8 (2.0)	13.3 (3.0)	19.2 (4.4)	29.0 (6.6)	34.5 (7.8)	53.0 (12.0)	128.0 (29.1) 81.0† (13.4)	245.0 (55.6) 118.0† (26.8)	375.0 (85.2) 144.0† (32.7)	760.0 (172.6) 415.0† (94.2)
	Flow Decrease R to B Closes	8.5 (1.9)	12.5 (2.8)	18.0 (4.1)	27.0 (6.1)	32.0 (7.3)	50.0 (11.4)	122.0 (27.7) 76.0† (17.3)	235.0 (53.4) 111.0† (25.2)	360.0 (81.8) 135.0† (30.7)	730.0 (165.8) 400.0† (90.8)

* Flow rates for these sizes are calculated.

† These gpm figures are for switch with 6" paddle. For 4" and 5" line pipe the paddle is trimmed.

Penn-Baso Products

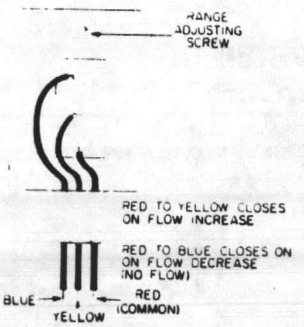


Fig. 2 — View of switch showing the wire lead identification and range adjusting screw location.

Maximum Liquid Pressure: 150 psig. (1034 kPa).

Maximum Liquid Temperature: 250 F (121 C).

Minimum Liquid Temperature: −20 F (−29 C).

Switch Action: SPDT snap-acting contacts.

Pipe Connector: 1" NPT threads.

Conduit Connector: ½" female connector.

Paddle: Three paddles attached. Removable paddle for 1" and 2" pipe. Use all three for pipes 3" and larger. A 6" paddle is included and can be trimmed to fit 4" and 5" pipes.

Case and Cover: .062" (1.57mm) drawn steel with gray enamel finish.

Shipping Weight: Individual pack 2.8 lbs. (1.3 kg).

ELECTRICAL RATINGS

Motor Ratings	120 V.	208 V.	240 V.	277 V.
Horsepower	1	1	1	—
A.C. Full Load Amps.	16.0	8.8	8.0	—
A.C. Locked Rotor Amps.	96.0	52.8	48.0	—
Non-Inductive or Resistance Load Amps.	16.0	16.0	16.0	16.0
Pilot Duty — 125 VA 24 to 277 V. A.C.				

REPAIRS AND REPLACEMENT

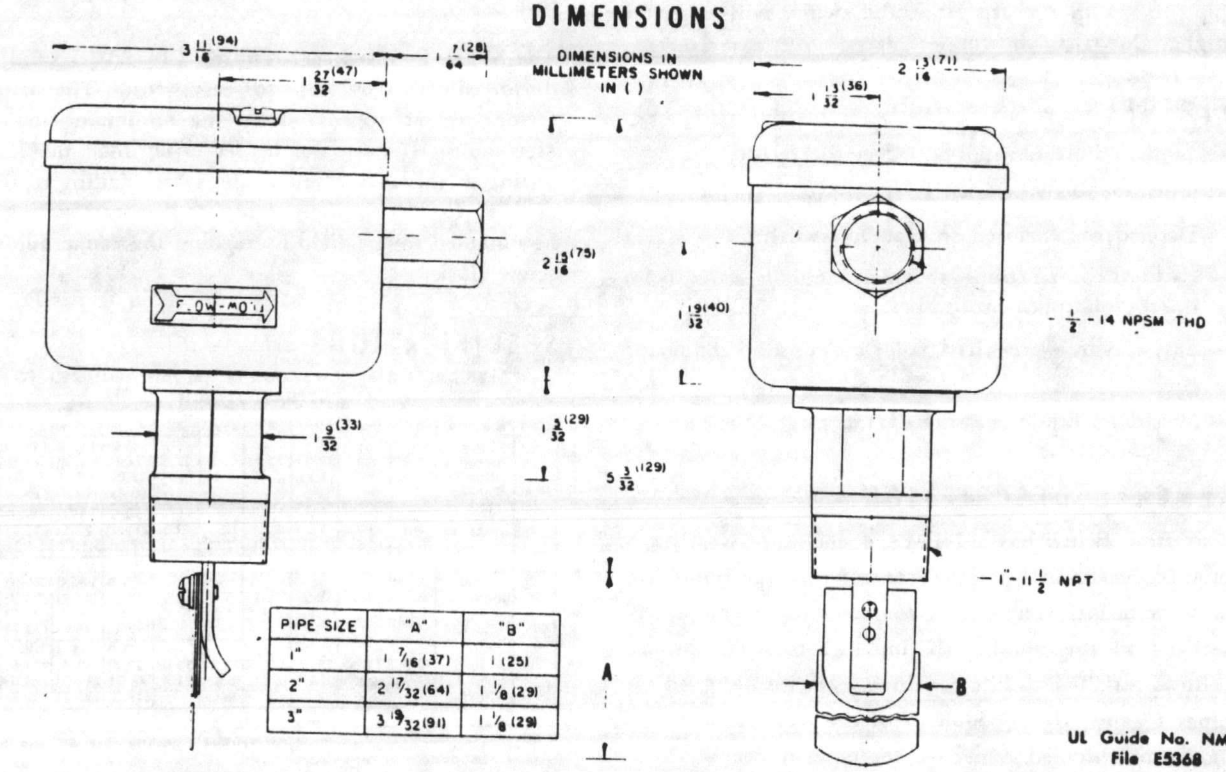
Paddles and cover may be replaced in the field. Other field repairs must not be made. Replacement flow switches may be obtained from the nearest Penn-Baso Wholesaler. When ordering a replacement switch, specify Product Number as shown on the flow switch.

Replacement Kit Number	Description
KIT21A-600	3 - 1 paddle
KIT21A-601	6" paddle

ORDERING INFORMATION

To order, specify Product Number F61MB-1.

DIMENSIONS



PIPE SIZE	"A"	"B"
1"	1 7/16 (37)	1 (25)
2"	2 17/32 (64)	1 1/8 (29)
3"	3 19/32 (91)	1 1/8 (29)

UL Guide No. NMFT
File E5368

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

TX-1

20/20 INTERFACE PRODUCTS

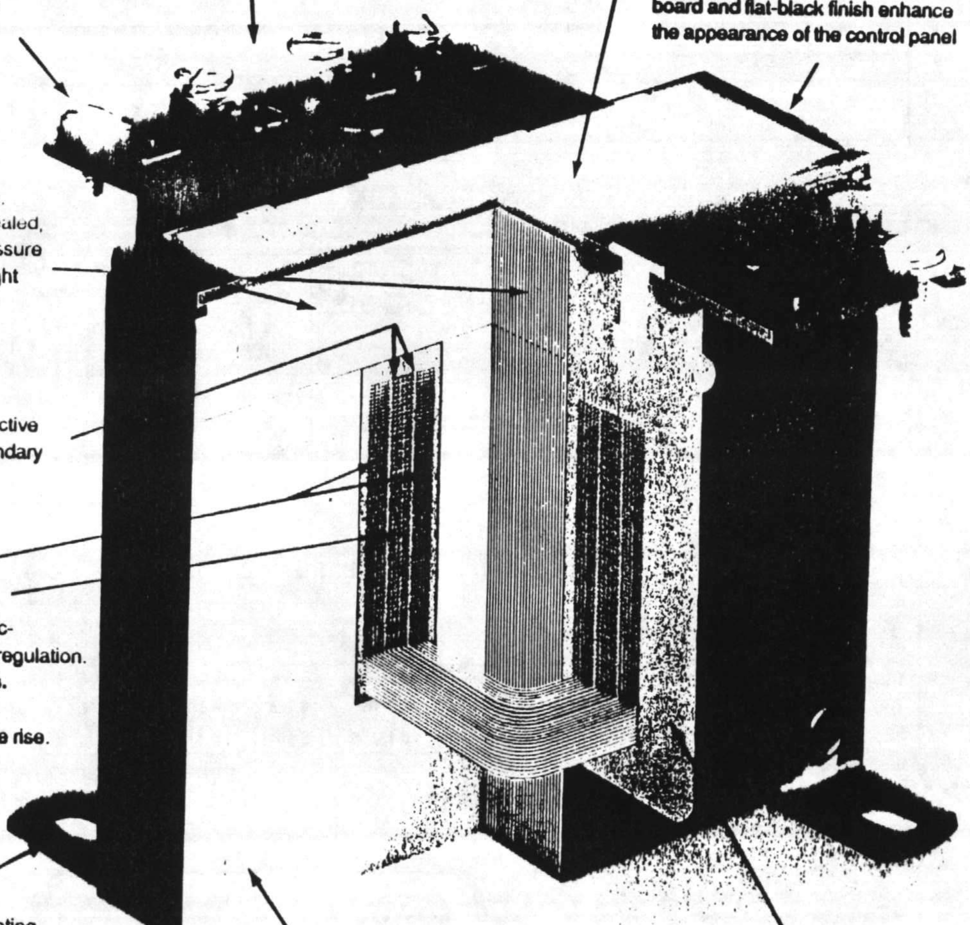
HEVI-DUTY ELECTRIC SERIES E CONTROL TRANSFORMERS UL & CSA LISTED

High-torque plated terminals. Promotes simplified wiring. Terminals are readily accessible and easy to hook up. Furnished with plated brass binder head terminal screws, installed, ready to use.

Swing-Klip™ connecting links. Simplifies series-parallel terminal jumping, eliminates need for user-supplied jumper wires.

Reverse etched metal name-plate. Won't peel or crack with age. Rating and connection data stay easy to read.

Smooth flat-black exterior. Molded coils, glass fiber terminal board and flat-black finish enhance the appearance of the control panel



Superior lamination. Fine grade, grain-oriented silicon steel is annealed, edge-coated and core-plated to assure a flat surface without burrs for a tight core stack.

Precise spacing between windings. Helps reduce reactive component to improve secondary regulation.

Interleaved windings. Primary windings (A) and secondary windings (B) are interleaved to reduce reactance and maximize voltage regulation.

Oversized copper windings. Reduces resistance loss and contributes to low temperature rise.

Slotted mounting feet. Allows for quick, easy, unobstructed mounting.

Mechanical fastening. Core is bound with insulated rivets rather than welding to maintain insulation between laminations for reduced losses and neat appearance.

Solid epoxy encapsulation. Dissipates heats quickly,efficiently. Completely seals coil against moisture, dirt and other airborne contaminants.

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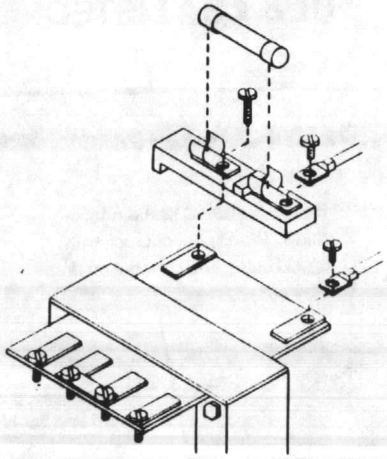
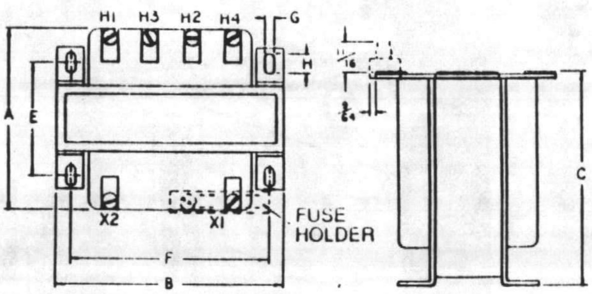
1-XT

FB-1 fuse block



Optional fuse block is easy to mount. It will accommodate 1/4" x 1 1/4" type MDL or MDX dual element fuses which are designed for circuits for high inrush currents. Maximum voltage rating is 250 volts and maximum current rating is 15 amperes. Due to this voltage rating, the FB-1 is always used on the output terminals of the transformers. The secondary must be a single winding, under 250 volts, and the fuse holder must be attached to the X-1 terminal. The FB-1, with screws and instructions, is packaged separately, ready to use.



CATALOG NUMBERS & DIMENSIONS

VA Rating 55°C	VA Rating <50°C	Catalog Number	VOLTAGE	A	B	C	E	F	G	H	SHIP WT LBS.
105	100	E105	120/240:24	3 9/16	3 3/8	3 1/4	2 3/8	2 13/16	13/64	21/64	4.1
180	150	E180	120/240:24	4 7/16	4 1/2	4 1/8	2 1/4	3 3/4	13/64	21/64	6.8
320	300	E320	120/240:24/48	4 13/16	5 1/4	4 5/16	3 1/4	4 3/8	5/16	11/16	12.0

Fuse block cannot be used on number E320

Every Type E Transformer

is backed by

HEVI-DUTY ELECTRIC'S

10 - YEAR WARRANTY

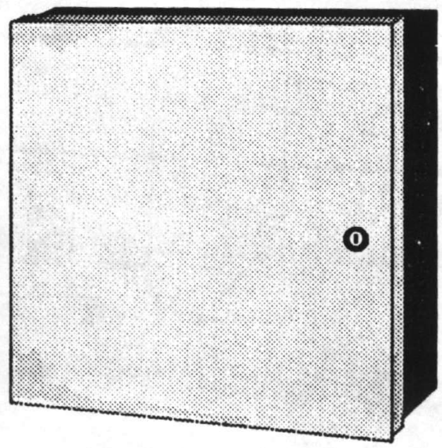
CONTROL PANEL, DTC PANEL

20/20 INTERFACE PRODUCTS

RET SERIES LARGE ENCLOSURES WITH PERFORATED METAL SUB PANELS

FEATURES

- Can be mounted with door hinged on left or right side.
- Door is removable.
- Perf - Panel is attached to outside of the enclosure shipping carton. Panel can be removed and shop fabricated without removing enclosure from the carton.
- Perf - Panel simplifies mounting of control components. No drilling or lay out. Just set the control components on the panel and attach with #6 or #8 self tapping screws in the pre-punched holes.
- Attractive two tone brown and tan bubble finish.
- Furnished with key lock.



INSTALLATION

1. It is recommended that the enclousure be installed before construction is completed. Base the timing on ease of installation and conduit runs in the walls. All wiring must conform to applicable local codes, ordinances, and regulations.
2. Use dimensions in Figure 1 to mark mounting locations, and drill four mounting holes.
3. Remove all necessary conduit knockouts.
4. Using proper mounting hardware for the type of wall construction involved, secure the enclosure to the surface.
5. Pull the conduit and wiring runs through the knockouts into the enclosure and tag (identify) per job drawings.
6. After completion of construction, clean out any debris or dust from the cabinet before installing the subpanel.

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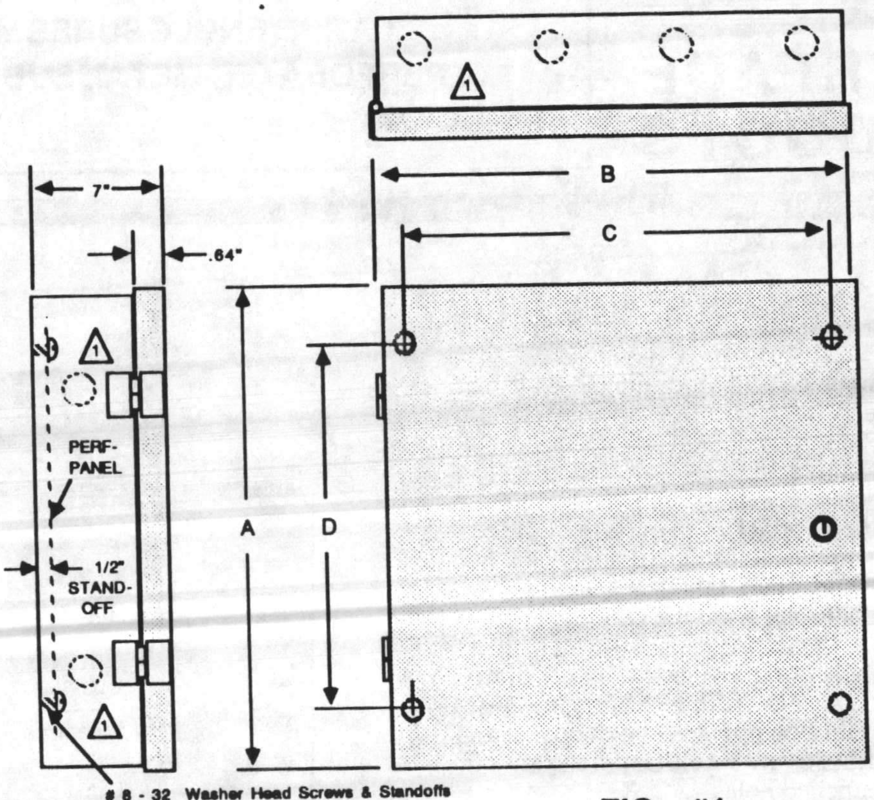


FIG #1

1 KNOCKOUTS ARE FOR 3/4" CONDUIT

ALL DIMENSIONS IN INCHES AND ARE NET INSIDE.

	MODEL	A	B	C	D	PERF-PANEL	STAND OFFS	NET WT.	KNOCKOUTS TOP & BOTTOM
	RET 2018	20	18	16 1/2	14	18" H x 16" W	4	34 lb.	3
DTC — CONTROL	RET 2620	26	20	18 1/2	20	24" H x 18" W	4	46 lb.	3
	RET 3826	38	26	24 1/2	32	36" H x 24" W	6	76 lb.	4

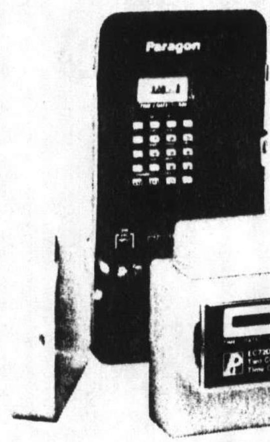
	MATERIAL	COLOR
ENCLOSURE	16 GA. GALVANEAL	BROWN
DOOR	16 GA. GALVANEAL	TAN
PERF-PANEL	16 GA. BLACK IRON	FLAT BLACK

PARAGON ELECTRIC COMPANY, INC.

SPEC DATA SHEET

TCK

EC72 and EC72D Electronic Time Controls



DESCRIPTION

The EC72 and EC72D are two-channel, microprocessor-based, solid-state time controls. These controls are used for switching two different electrical circuits according to a pre-set, time-of-day program. The momentary option converts both outputs to two second momentary contact closure.

APPLICATION

Applications include control of heating, ventilating, air conditioning, indoor and outdoor lighting, traffic intersection lights and school flashers. The 12 volt DC model is ideal for battery powered applications such as security systems, remote deer feeders and air sampling machines. Momentary contact is applicable to ringing bells and operating latching relays.

The EC72D is typically used in panels, indoor or outdoor. The EC72 is used for indoor stand-alone applications.

BENEFITS

- Precise control of 2 loads from 1 time base
- Application flexibility from choice of two models (DIN-rail and NEMA housing)
- 365 day programming provides "set and forget" operation
- 15 amp contact rating eliminates need for contactors
- Easy to understand programming

SPECIFICATIONS

Programming Capabilities

- True 7-day Programming - Each day of the week can be programmed uniquely plus a special holiday program.
- Holiday Programming - Twelve single day holidays and two holiday durations (multiple day) programmable by date.
- Daylight Savings Time and Leap Year Correction - Control can be programmed for automatic daylight savings time changeover in the spring and fall. Control automatically adjusts for leap year correction.
- 16 Events (Operations) Per Channel Available - An event is a programmed time for energizing or de-energizing the load relay.
- Repeat Program - Up to 112 events per week per channel available by using the repeat (daily) function.
- Manual Override - A temporary override starts immediately when initiated and will remain in effect until the next scheduled event.

Electrical

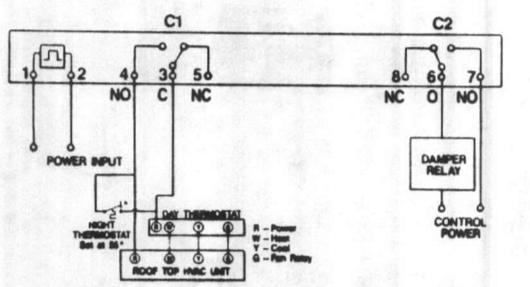
Power requirements:

EC72D-12	-	12Vdc
EC72(D)-24	-	24Vac (+10 -15%), 50/60Hz 4VA
EC72(D)-120	-	100-120Vac, 50/60Hz, 4VA
EC72(D)-240	-	200-240Vac, 50/60Hz, 4VA

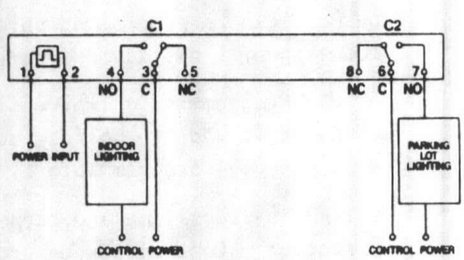
Output - Two SPDT relays with contacts rated as follows:

Voltage	Resistive	Inductive	H.P.	Pilot Duty
12Vdc	.1A - 15A	-	-	-
24Vac	15A	15A	1/10	60VA
120Vac	15A	15A	1/3	345VA
240Vac	10A	8A	1/2	450VA

Wiring - Terminals can accommodate 12 to 24 AWG wire.



Wiring Diagram for Nightime Setback & Damper Control



Wiring Diagram for Lighting

Momentary Option - By removing a jumper wire, the EC72(D) can be converted to a momentary output timer with all events ON. An ON event causes a two second contact closure.

Power Outage Carryover

Program and Time-of-day Backup - 100 hours of carryover with an alkaline 9 volt battery (not provided).

Following a power outage, the control assumes the programmed mode of operation.

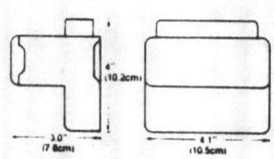
Accuracy

Time-of-day - Maintained time is as accurate as line frequency.

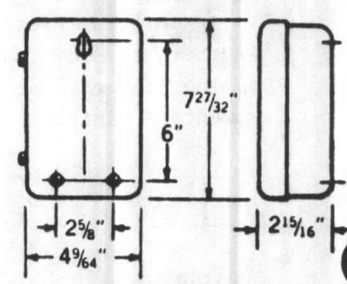
Resolution - One minute for time-of-day and programmed ON and OFF events.

Physical

	EC72D	EC72
Mounting:	Surface or DIN-rail (35mm, DIN-EN50022) with plug-in base	NEMA type 1 case
Weight:	Approximately 1 lb. 3 oz.	Approximately 2 lbs. 8 oz.



EC72D Dimensions



EC72 Dimensions

HOW TO SPECIFY

Installer shall furnish and install Paragon EC72 or EC72D Electronic Time Control. The microprocessor-based, solid-state time control shall have the capabilities of being programmed for each day of the week plus special holiday and being programmed for twelve single day holidays and two multiple day holiday durations. Control shall have 16 events per channel. The control shall have a momentary option providing for a two second momentary contact closure. The control shall have automatic daylight saving time changeover. During power outages, the control shall have 100 hours of carryover. The control shall have manual override capability.

PARAGON ELECTRIC COMPANY, INC.
606 Parkway Blvd., P.O. Box 28, Two Rivers, WI 54241
414-793-1161 Fax 414-793-3736 Telex 26-3450

IN CANADA: Paragon Electric Canada Ltd.
440 Phillip Street, Unit 15, Waterloo, Ontario N2L 5R9
519/746-2290 Fax (519) 746-2441 Telex 069-55168

IN EUROPE: Paragon Electric Limited
Unit 5, Bonville Trading Estate
Brislington, Bristol, England BS4 5QU
44(272)778-383 Fax 44(272)721704 Telex 44-9481

TC-1102-404
TC-4111
VC-9313-401-5-13
VS-9223-211-4-8
CP-8102
TS-8501
TS-8201
AT-215
TC-1161-479
VA-1403-301-4-4
TC-2974

Group Operations

NST

General Instructions

TC-1100 Series, TCR-1101 Two-Position Electric Room Thermostats

APPLICATION

For low or line voltage on-off control of fan coils, fans, motor starters, contactors, two-position electric actuators.

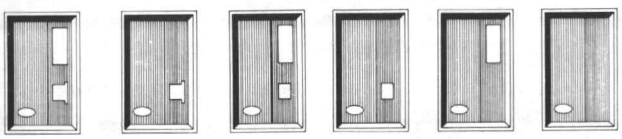
SPECIFICATIONS

Sensing Element: Bimetal.
Differential: 2°F (1°C).
Electrical Switch: Snap action SPDT.
Ratings, See Table 3.
Connections: Color coded 6" (152 mm) leads.
Cover: Beige plastic as standard.
Locations: NEMA Type 1 indoor only.
Mounting: Flush or surface 2 × 4 switch box or directly to wall (24 volt only).
Dimensions: 4-3/8" high × 2-7/8" wide × 1-5/8" deep (111 mm × 73 mm × 41 mm).
Anticipators Are Recommended:
Parallel for cooling. Series or parallel for heating.

OPTIONS

Add "dash-number" (-XXX) suffix to base part number for desired option. For metal covers, specify TC2-110X-XXX.

Anticipators: All thermostats mounted on concrete walls, or other wall surfaces that change temperature slowly, have reduced response time to changes in space temperature. Response time is further reduced for thermostats with guards that restrict air flow over the thermostat. Anticipators are recommended on thermostats that are subjected to restricted air flow conditions and in small spaces intended for human occupancy, i.e., hotel guest rooms and offices.



* Standard ** -116	-400 -410	-401†† -411††	-402†† -412††	-403†† -413††	-404†† -414††

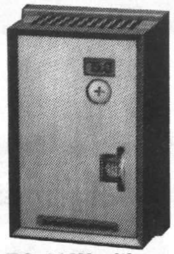
* °F (°C) ** °C

-500 parallel heat or cooling anticipation 24V standard cover
-501 parallel heat or cooling anticipation 120V standard cover
-502 parallel heat or cooling anticipation 240V standard cover
-601 10°F night depression 120V standard cover
-602 10°F night depression 24V standard cover
-603 10°F night depression 240V standard cover

††5/64" Allen screw used to secure cover.

ACCESSORIES

AE-170 Series	Electric time clock
AT-61 Series	Brushed bronze cover plates (except TCR-1101)
AT-82 Series	Digital thermometer cover kit (except TC2-110X)
AT-101	Lock cover kit
AT-104	Dial stop pins (NOTE: Pins included with each unit.)
AT-136	Title plates (day, night, heat, cool)
AT-504	Plaster hole cover kit (small)
AT-505	Surface mounting base
AT-546	Auxiliary mounting plate
AT-602	Selector switch sub-base DP4T
AT-603	Selector switch sub-base one DP4T, one DPDT
AT-1100 Series	Thermostat guards
TOOL-11	Calibration wrench
TOOL-13	Contact burnishing tool



TC-110X with Digital Thermometer Kit Installed

† †

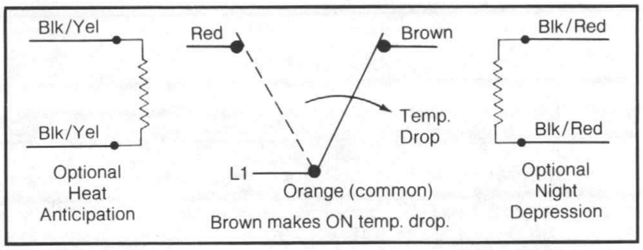


Figure 1. Switch Action and Lead Identification

TABLE 1. SPECIFICATIONS

Part Number	Setpoint Dial Range* Standard & -40X °F (°C)**	-116 & -41X °C	Cover Configurations
TC-1101	55 to 85 (13 to 29)	13 to 29	See Options
TC-1102	45 to 75 (7 to 23)	7 to 23	See Options
TC-1103	75 to 105 (24 to 40)	24 to 40	See Options
TCR-1101	55 to 85 only	—	One Blank Cover Insert & One Cover Insert with Control Dial Cutout***

*Dial stop pins included to limit setpoint range.
**Dual marked (except TCR-1101).
***One (1) 5/64" Allen head screw and 5/64" Allen wrench for securing cover to thermostat base included along with standard single slotted screw.

TABLE 2. AGENCY APPROVALS†

Configuration	UL	CSA
Metal Case (TC2-110X)	No	Yes
Plastic Cover (TC-110X)	Yes	No
Heat Anticipation or Night Depression (-500 or -600 Series)	No	No

TABLE 3. MAXIMUM ELECTRICAL RATINGS

Switch Action	Full Load Amps 24/120 Vac	Full Load Amps 240 Vac	Locked Rotor Amps 24/120 Vac	Locked Rotor Amps 240 Vac	Pilot Duty (VA)
Make for Heating	4.4 Orange to Brown Lead	2.2 Orange to Brown Lead	26.4 Orange to Brown Lead	13.2 Orange to Brown Lead	40 @ 24 Vac
Make for Cooling	3.0 Orange to Red Lead	1.5 Orange to Red Lead	18 Orange to Red Lead	9 Orange to Red Lead	210 @ 120/240 Vac

LITHO IN U.S.A. 7-87

PRE-INSTALLATION

Inspection

Visually inspect the carton for damage. If damaged, notify the appropriate carrier immediately. If undamaged, open the carton and visually inspect the device for obvious defects. Return damaged or defective products.

Required Installation Items

- Wiring diagrams
- Tools (not provided):
  Volt-ohm meter
  Appropriate screwdriver for mounting screws and terminal connections
- Appropriate accessories
- Mounting screws, two (2) provided for securing to a 2 × 4 conduit box

INSTALLATION

CAUTION

1. Installer must be a qualified, experienced technician.
2. Make all connections in accordance with the wiring diagram, and in accordance with national and local electrical codes. Class I wiring is required unless all circuits to contacts are powered from a Class II source. *Use copper conductors only.*
3. Do not exceed ratings of the device.

Mounting

Thermostats require upright mounting on a properly flat vertical surface. Locate the thermostat where it will be exposed to unrestricted circulation of air which represents the average temperature of the controlled space.

CAUTION

Do not locate the thermostat near sources of heat or cold, such as lamps, motors, sunlight or concealed ducts or pipes, or where there is a danger of electrocution (i.e., shower rooms).

The thermostat is designed for service in any normally encountered human environment. Avoid locations where excessive vibration, moisture, corrosive fumes or vapors are present. NEMA Type 1 covers are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment.

Thermostats with guards that restrict air flow must have heating or cooling anticipation.

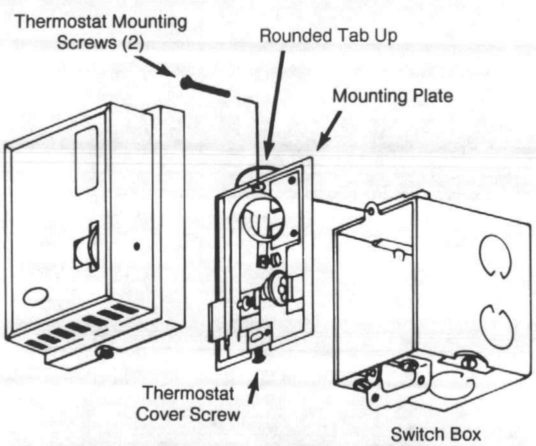


Figure 2. Thermostat Mounting

Procedure

1. Pull all wires.
2. Make electrical connections to thermostat. (Typical heat anticipation and night depression wiring diagrams are shown in Figures 6 through 8.)
3. Remove thermostat cover and fasten thermostat to box or wall.
4. Attach thermostat cover.

CHECKOUT

After installing a thermostat, make an initial check of the switching action. Verify the switch action by listening to and watching the switch contacts or by using a voltmeter between the proper sides of the switch.

1. Run the setpoint dial to a temperature above ambient. This should cause the thermostat to make a circuit between orange and brown leads.
2. Turn the setpoint dial setting down below ambient. This should cause the thermostat to make a circuit between orange and red leads.

CALIBRATION (See Figure 3)

All thermostats are precision calibrated at the factory and normally will not require any further attention. However, if recalibration is necessary, proceed as follows:

1. Turn off control power and power to night depression circuit, where applicable.
2. Set setpoint dial to correspond to actual stable room temperature, as read from an accurate thermometer.
3. Remove thermostat cover. Do not breathe on the thermostat or handle excessively as this will affect the accuracy of the final calibration.
4. If contact blade is made to the left (red) contact, with a small screwdriver, turn calibration screw counterclockwise (looking at head of screw) until blade makes to right (brown) contact.

NOTE

Each complete turn of screw changes calibration approximately 15°F (8°C).

Now turn screw very slowly clockwise until blade just makes the left (red) contact. Thermostat is now properly calibrated.

If contact blade is originally made to the right (brown) contact, turn calibration screw slowly clockwise until element just makes the left (red) contact. Thermostat is now properly calibrated.

5. Replace thermostat cover.
6. Turn on control power.
7. Recheck calibration about 30 minutes later to be sure heat from handling of or breathing on bimetal element did not result in an erroneous setting.

HEAT ANTICIPATION (See Figures 6 and 7)

Heat anticipation, series or parallel, is recommended for:

- Systems with excess heating capacity that can cause objectionable space temperature swings.
- Thermostats mounted on walls (i.e., concrete) that change temperature slowly and/or have insufficient air flow over the device.

COOLING ANTICIPATION (See Figure 8)

Parallel cooling anticipation is recommended for:

- Cooling anticipations where current draw exceeds 1 ampere. Cooling lockout (self heat of the thermostat causing over cooling of the space) can occur on these applications.
- Systems with excess cooling capacity that can cause objectionable space temperature swings.
- Thermostats mounted on walls (i.e., concrete) that change temperature slowly and/or have restricted air flow over the device.

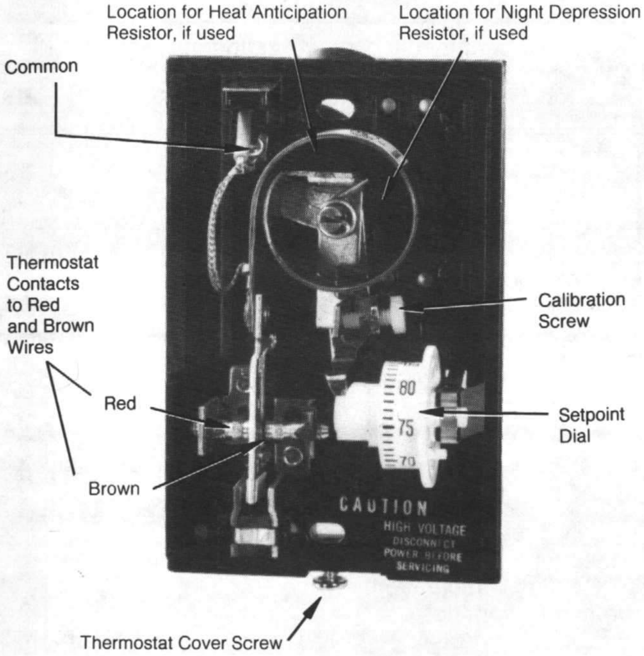


Figure 3.

CONCEALED CONTROL DIAL

Knurled Dial Removal (See Figure 4)

1. Remove thermostat cover.
2. Secure the control dial with hand so that the dial will not rotate.
3. Place needle nose pliers at knurled ring of the control dial at the points where the knurled ring is attached to the control dial.
4. Twist the pliers at each knurled ring attachment point until the entire knurled ring of the control dial is removed.

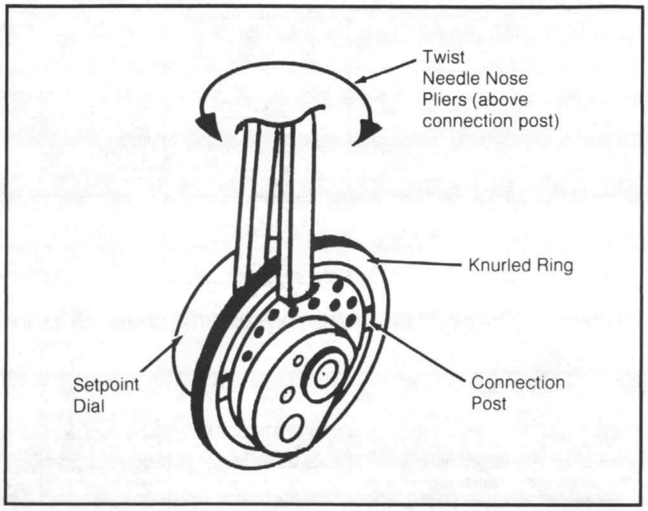


Figure 4. Knurled Dial Removal

LIMIT CONTROL DIAL RANGE

Dial Stop Pin Insertion — Included with Mounting Plate (See Figure 5)

1. Remove thermostat cover.
2. Secure the control dial with hand so that the dial will not rotate.
3. Place a dial stop pin in the jaws of a needle nose pliers.
4. Insert the dial stop pin in the appropriate hole on either (or both) side(s) of the control dial to restrict dial rotation.

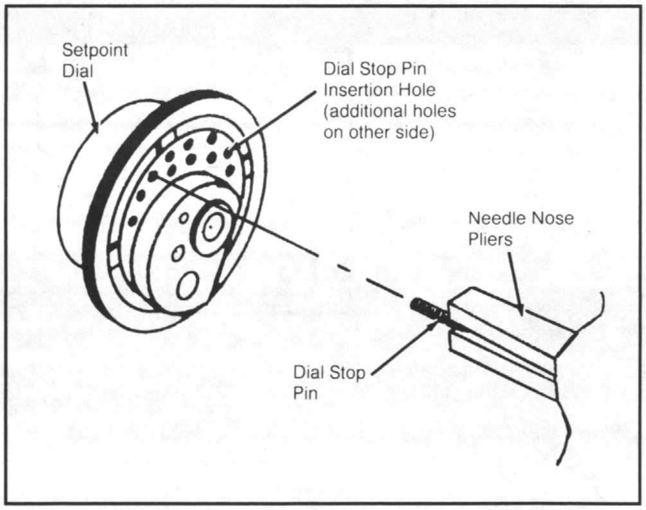


Figure 5. Dial Stop Pin Insertion

MAINTENANCE

Regular maintenance of the total system is recommended to assure sustained optimum performance.

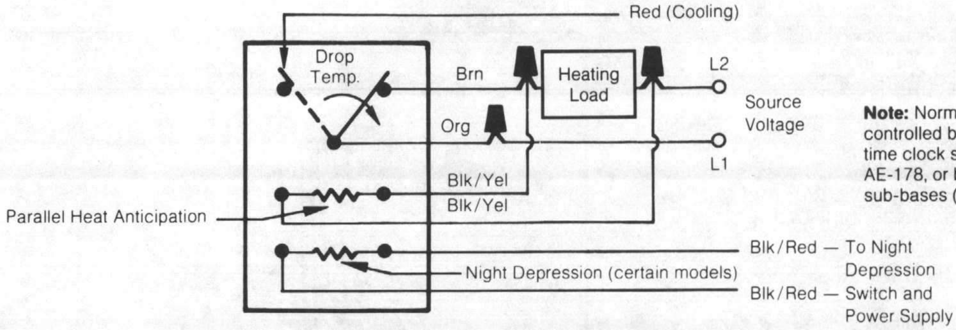
Open areas at bottom and around base of thermostat should be kept clean and free from obstructions to allow proper flow of air. If switch contacts need cleaning, this may be done with TOOL-13 (burnishing tool).

NOTE

Thermostat may require calibration after cleaning the contacts.

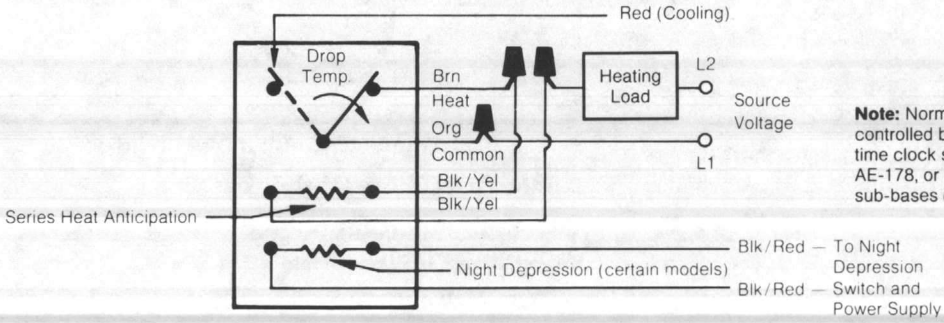
REPAIR

These thermostats are not field repairable. Replace a defective thermostat with a functional unit.



Note: Normally, night depression is controlled by a centrally located time clock such as AE-174 or AE-178, or by selector switch sub-bases (AT-602 or AT-603).

Figure 6. Typical of Parallel Heat Anticipation (heater size determined by voltage) with or without Night Depression



Note: Normally, night depression is controlled by a centrally located time clock such as AE-174 or AE-178, or by selector switch sub-bases (AT-602 or AT-603).

Figure 7. Typical of Series Heat Anticipation (heater size determined by ampere rating of load) with or without Night Depression

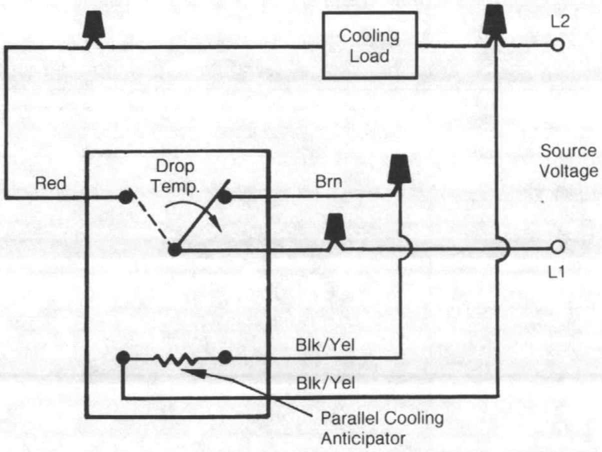
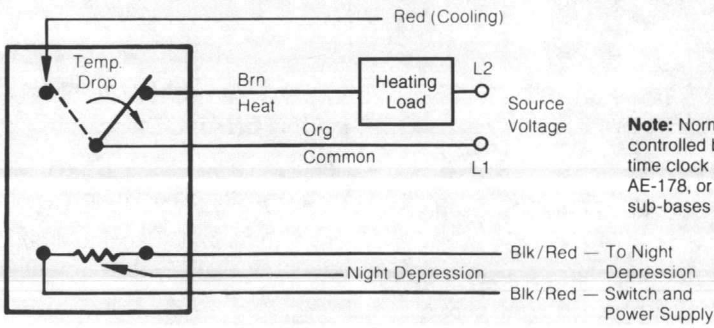


Figure 8. Typical of Parallel Cooling Anticipation (anticipator size determined by voltage)



Note: Normally, night depression is controlled by a centrally located time clock such as AE-174 or AE-178, or by selector switch sub-bases (AT-602 or AT-603).

Figure 9. Typical Night Depression

Barber-Colman Company
ENVIRONMENTAL CONTROLS DIVISION

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F-18785-4 BK

LITHO IN U.S.A.

AQ-1

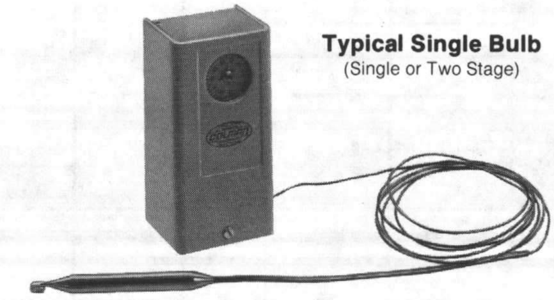
General Instructions

TC-4100 Series
TC-4200 Series
Bulb Thermostats
Return Air Thermostats

For on-off control of media temperature in ducts, tanks, liquid lines, etc.

TC-4100 Series **one stage** units control one electrical circuit. Available in single or dual bulb configurations. (See Performance Table.)

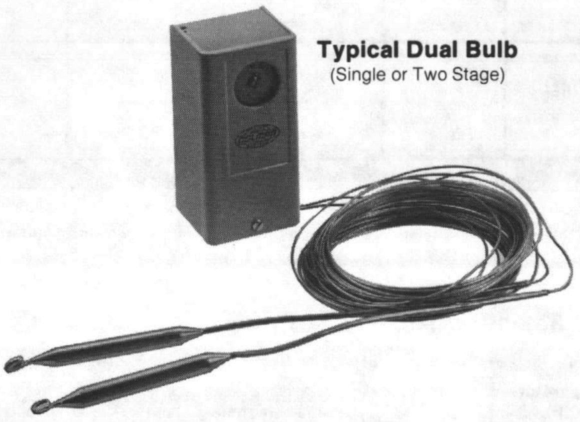
TC-4200 Series **two stage** units control two electrical circuits in sequence. Available in single or dual bulb configurations. (See Performance Table.)



Typical Single Bulb
(Single or Two Stage)

Dual bulb units are used to vary the control point of the controlled media as a function of outside air temperature. The ratio specified is outdoor to indoor. A unit with a 1 to 1-1/2 ratio will increase the water temperature 1-1/2°F for a 1°F decrease in outdoor temperature.

Air bulb units feature a coiled, fast responding air bulb. Used in return air control applications.



Typical Dual Bulb
(Single or Two Stage)

Device: Liquid filled thermal element actuates one snap acting SPDT switch per stage. Large color coded terminals. Setpoint adjustment dial plate is marked in °F on one side and °C on the other. The thermal differential is adjustable within the limits shown in the performance table. The mechanism is enclosed in a metal case and the cover, and has 1/2-inch to 3/4-inch conduit opening in the bottom of the case. Remote bulbs are suitable for immersion, duct, or outside air mounting.

Dimensions

Bulb Units: 2-1/4" (57 mm) Wide × 4-5/8" (117 mm) High × 2" (51 mm) Deep.

Air Bulb Units: 2-1/4" (57 mm) Wide × 9" (229 mm) High × 2" (51 mm) Deep.

Typical Air Bulb
(Single or Two Stage)

Electrical Rating: All Units Except TC-4115*

Switch Rating (50/60 Hz)	24V	120V	240V
Full Load Amps	9.8	9.8	8.0
Locked Rotor Amps	58.8	58.8	48.0
Pilot Duty VA	60	360	360
Non-Inductive Amps (Resistive)	—	—	—
Single Stage	22	22	22
Two Stage	16	16	8.0

*TC-4115 for System 8000 and dry circuit switching.
Electrical Rating: 1.0 amp at 24 Vac; .25 amp at 24 Vdc.

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AQ-1

Performance and Selection Table

Type	Part Number	Setpoint Adjustment Range	Dual† Bulb Ratio	Dimensions: Capillary (Copper)	Dimensions: Bulb (Copper) Indoor	Dimensions: Bulb (Copper) Outdoor	Differential: Factory Set	Differential: Adjustable	Maximum Safe Bulb Temperature	Case Ambient Temperature
Single Stage Single Bulb	TC-4111	-40 to 120°F		6′	3/8 × 4″		3°F	3 to 16°F	170°F	-40 to 150°F
	TC-4111-020			20′						
	TC-4112	100 to 260°F		6′					310°F	
	TC-4115*	-40 to 120°F							170°F	
	TC-4121			10′ Armored						
	TC-4122	100 to 260°F							310°F	
	TC-4123	190 to 350°F							400°F	
Single Stage Dual Bulb	TC-4151	70 to 120°F	1:1-1/2 **	30′ Each Bulb	3/8 × 4″	3/8 × 5-1/2″	3°F	1.5 to 10°F	Total of indoor and outdoor temperatures must not exceed 280°F	-40 to 150°F
	TC-4152		1:1		3/8 × 4″	3/8 × 4″		3 to 16°F		
One Stage Air Bulb	TC-4166	50 to 90°F		None	Coiled 2-1/2 × 2″		2°F Fixed		-40 to 145°F Safe Bulb Range	-40 to 150°F
Two Stage Single Bulb	TC-4211	-40 to 120°F		6′	3/8 × 4″		3°F	Per Stage Fixed Between Stages 2 to 10°F	170°F	-40 to 150°F
	TC-4221			10′ Armored						
	TC-4222	100 to 260°F							310°F	
	TC-4223	190 to 350°F							400°F	
Two Stage Dual Bulb	TC-4251	70 to 120°F	1:1-1/2 **	30′ Each Bulb	3/8 × 5-1/2″	3/8 × 4″	3°F	Per Stage Fixed Between Stages 1.5 to 6.5°F	Total of indoor and outdoor temperatures must not exceed 280°F	-40 to 150°F
	TC-4252		1:1		3/8 × 4″	3/8 × 4″		2 to 10°F		
Two Stage Air Bulb	TC-4266	50 to 90°F		None	Coiled 2-1/2 × 2″		3°F	Per Stage Fixed 2°F Between Stage Adj. 1 to 5°F	-40 to 145°F Safe Bulb Range	-40 to 150°F

*TC-4115 for System 8000 and dry circuit switching. Electrical Rating: 1.0 amp at 24 Vac; .25 amp at 24 Vdc.

**TC-4151 and TC-4251 — For 1-1/2:1 ratio reverse bulbs and use extra dial supplied with unit.

†First number of reset ratio typically indicates outdoor air temperature change required to increase the setpoint by the second number.

Ratio Selection Table

Outdoor Temperature (°F)	Ratio	Dial Set at 70°F	Dial Set at 80°F	Dial Set at 90°F	Dial Set at 100°F	Dial Set at 110°F	Dial Set at 120°F
		Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70°F to Design Temperature					
-30	1 to 1-1/2	70 to 220	80 to 230	90 to 240	100 to 250	110 to 260	120 to 270
	1 to 1	70 to 170	80 to 180	90 to 190	100 to 200	110 to 210	120 to 220
	1-1/2 to 1	70 to 137	80 to 147	90 to 157	100 to 167	—	—
-20	1 to 1-1/2	70 to 205	80 to 215	90 to 225	100 to 235	110 to 245	120 to 255
	1 to 1	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1-1/2 to 1	70 to 130	80 to 140	90 to 150	100 to 160	—	—
-10	1 to 1-1/2	70 to 190	80 to 200	90 to 210	100 to 220	110 to 230	120 to 240
	1 to 1	70 to 150	80 to 160	90 to 170	100 to 180	110 to 190	120 to 200
	1-1/2 to 1	70 to 123	80 to 133	90 to 143	100 to 153	—	—
0	1 to 1-1/2	70 to 175	80 to 185	90 to 195	100 to 205	110 to 215	120 to 225
	1 to 1	70 to 140	80 to 150	90 to 160	100 to 170	110 to 180	120 to 190
	1-1/2 to 1	70 to 117	80 to 127	90 to 137	100 to 147	—	—
+10	1 to 1-1/2	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 to 1	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1-1/2 to 1	70 to 110	80 to 120	90 to 130	100 to 140	—	—
+20	1 to 1-1/2	70 to 145	80 to 155	90 to 165	100 to 175	110 to 185	120 to 195
	1 to 1	70 to 120	80 to 130	90 to 140	100 to 150	110 to 160	120 to 170
	1-1/2 to 1	70 to 103	80 to 113	90 to 123	100 to 133	—	—
+30	1 to 1-1/2	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 to 1	70 to 110	80 to 120	90 to 130	100 to 140	110 to 150	120 to 160
	1-1/2 to 1	70 to 97	80 to 107	90 to 117	100 to 127	—	—

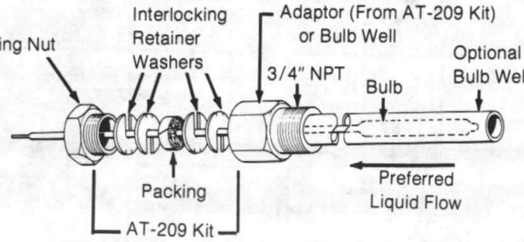


Figure 5. AT-201 or AT-203 Installation

Install bulb well or adaptor from AT-209 into 3/4" FNPT opening. Place packing nut, washers, and packing from AT-209 over bulb support section and insert bulb into well or AT-209 adaptor. Push interlocking washers and packing into well or adaptor and tighten packing nut until firmly seated.

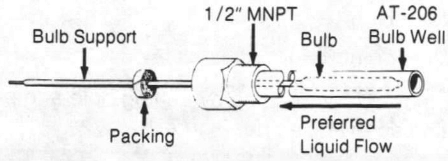


Figure 5A. AT-206 Installation

Install AT-206 bulb well into 1/2" FNPT opening. Place packing (included with AT-206) over bulb support section and insert bulb into well. Push packing into nut on well using a screwdriver.

Concealed Setpoint and Lock Cover Screw

Order AT-210 Concealed Adjustment Kit separately.

1. Peel off adhesive film from the concealed adjustment plate and place into the recess of cover.
2. Remove screw from cover.
3. Install lock cover screw provided with AT-210.

Wiring

The thermostat has one 1/2-inch to 3/4-inch conduit opening in bottom of housing. Make all electrical connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. Terminal coding and switch action is shown in Figure 6, and Figure 7 shows two stage switching sequence.

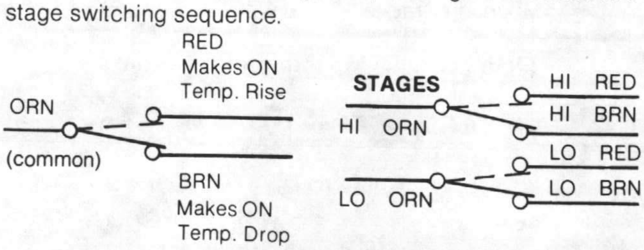


Figure 6. Terminal Coding and Switch Action

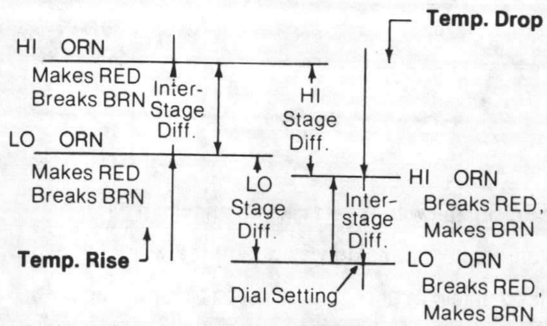


Figure 7. Two Stage Switch Sequence

Typical Applications

Figure 8 shows a typical heating or cooling application for single stage units. Figure 9 shows typical heating and cooling applications for two stage units.

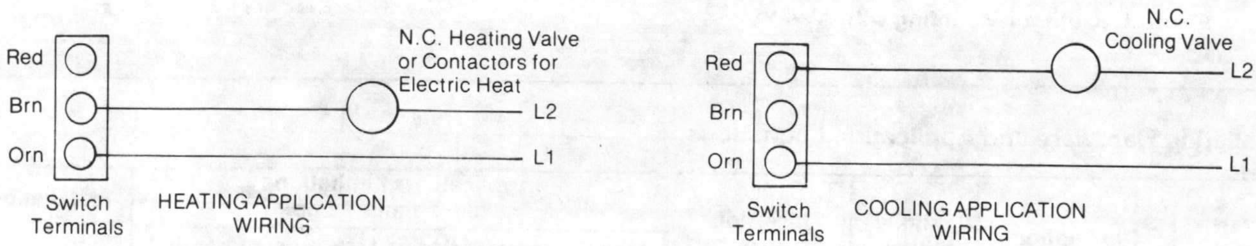
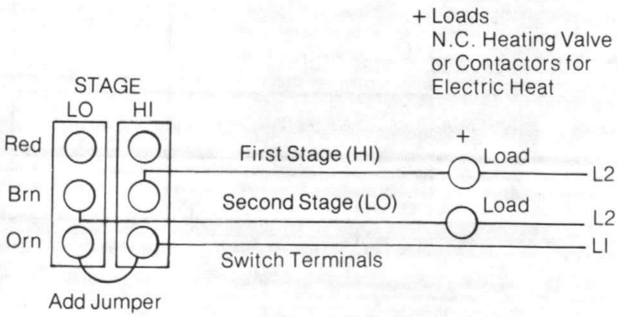
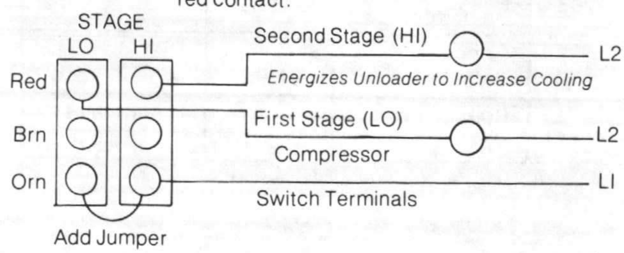


Figure 8. Typical Heating or Cooling Application for Single-Stage Units



TYPICAL HEATING APPLICATION WIRING FOR TWO-STAGE UNITS

NOTE: Some compressor unloaders must be de-energized to increase cooling capacity. Connect these to the hi stage brown contact instead of the red contact.



Two Compressor Packages May Be Sequenced With The Wiring Shown

TYPICAL COOLING APPLICATION WIRING FOR TWO-STAGE UNITS

Figure 9

Air Bulb Models

Mounting Outside of Return Air Duct

1. Prepare duct for mounting by cutting hole and providing mounting screw holes per Figure 1.
2. Fabricate a cover as shown in Figure 2.
3. Carefully roll bulbs toward back of unit and insert through 2-1/4″ × 2-1/2″ hole.
4. Remove cover and attach unit to duct with #10 screws.
5. Attach cover over 2-1/4″ × 2-1/2″ hole.

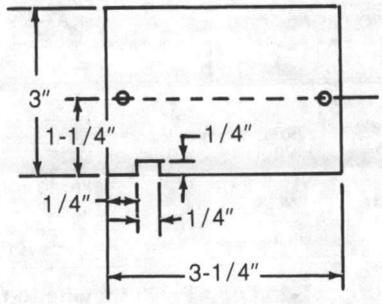


Figure 2. Field Supplied Duct Hole Cover Plate

Remote Bulb Mounting — Duct and Outdoor

Maximum insertion length (6 inches). Maximum safe bulb temperature above scale range. For dual bulbs, total of indoor and outdoor bulb temperatures must not exceed (280°F).

Duct: Install bulb with AT-208 kit as shown in Figure 3.

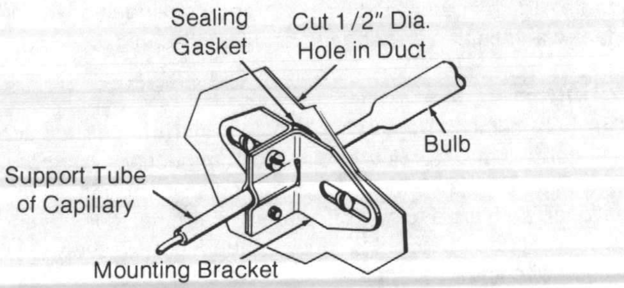


Figure 3. Duct Mounting with AT-208

Outdoor: Install with AT-211 kit as shown in Figure 4.

1. Mount bulb to outside wall or surface with bulb clip.
2. Place shield over bulb and fasten to mounting surface.

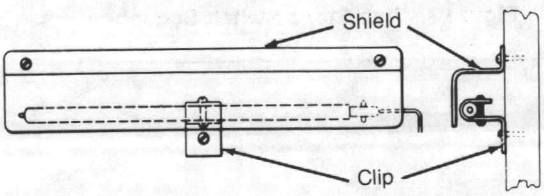
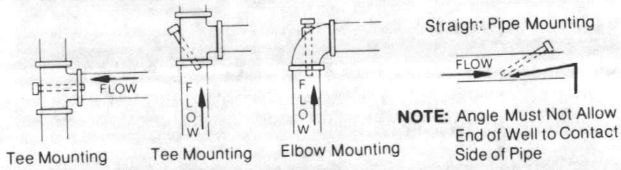


Figure 4. Outdoor Mounting with AT-211

Bulb Mounting — Liquid Line and Tank



Installation Hardware and Application Limitations

Part No.	Description	Mtg. Fitting	Insertion Size	Applications Limitations at 250°F Fluid Temp.*		Installation Per Figure
				Max. Recommended Velocity (FPS)	Max. Recommended Static Press. (PSIG)	
AT-201	Copper Bulb Well**	3/4″ MNPT	1/2″ Dia. O.D. 9-1/2″ Long	11	250	5
AT-203	Stainless Steel Bulb Well**			20	500	
AT-206	Copper Bulb Well	1/2″ MNPT	1/2″ Dia. O.D. 4-1/2″ Long	11	250	5A
AT-209†	Bulb Mounting Kit	3/4″ MNPT	Length of Bulb	4	150	5

*Max. Recommended Fluid Temperature is 350°F.

**Requires AT-209.

†Recommended Installation is with a Bulb Well.

Dual Bulb Selection

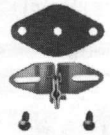
On the dual bulb units, indoor and outdoor bulbs are determined by the ratio selected. See Performance and Selection Table. Ratio refers to the outdoor air temperature change compared to the water temperature change. The dial setpoint is the water temperature setpoint when the outdoor temperature is 70°F.

To select ratio, it is necessary to know only: (1) outdoor design temperature, (2) maximum water temperature at outdoor design temperature, and (3) desired water temperature at 70°F outdoors. Use the Ratio Selection Table to determine the required ratio based on this information and set the dial per item (3). NOTE: If a 1-1/2:1 ratio is selected, the extra dial supplied with the unit must be used.

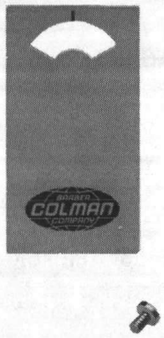
Example: Select ratio for an installation with a -10°F design temperature and estimated supply water temperatures of 75°F at 70°F outdoors and 125°F at -10°F outdoors. From Ratio Selection Table, -10°F for 1-1/2:1 ratio, note by interpolation (70°F to 123°F with dial at 70°F, 80°F to 133°F with dial at 80°F) that water temperature varies from 75°F to 128°F as outdoor temperature drops from 70°F to -10°F.

For this application, the 1-1/2:1 ratio should be selected. The extra dial supplied with the unit would be used, and the dial set at 75°F.

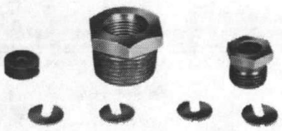
Immersion Well AT-20X



Bulb Duct Mounting Kit AT-208



Concealed Adjustment Kit AT-210



Liquid Line or Tank Bulb Mounting Kit AT-209 (Also Required with AT-201 or AT-203 Well)

Options

Single bulb units are available with optional capillary lengths of 20′ or 45′.

Accessories: (Order Separately)

Part No.	Description	
AT-201*	Bulb Well	Copper, 3/4″ MNPT 9-1/2″
AT-203*	Bulb Well	Stainless, 3/4″ MNPT 9-1/2″
AT-206	Bulb Well	Copper, 1/2″ MNPT 4-1/2″
AT-208	Duct Mounting Kit for Bulb	
AT-209	Liquid Line, or Tank, Bulb Mounting Kit. A Bulb Well is recommended. (Required with AT-201 or AT-203.)	
AT-210	Concealed Adjustment Kit. Includes plate to conceal setpoint adjustment and lock cover screw.	
AT-211	Outside Bulb Shield	

*Requires AT-209 Bulb Mounting Kit.

Pre-Installation

Refer to the INSTALLATION and Performance Data applicable to the part number of the device being installed. Make a visual inspection of the device for obvious signs of damage. Avoid locations where excessive moisture, corrosive fumes, vibration or high ambient exists.

Installation

Location

Locate the device allowing proper distance to the bulb location. The case can be mounted in any position. Refer to Figure 1 for case dimensions.

Procedure

Remote Bulb Models
Air Bulb Models — Mounting in Return Air Duct

1. Remove cover and provide 2 holes for #10 round head screws using the housing as the template or by using the dimensions shown in Figure 1.
2. Partially insert the mounting screws in the screw holes. Fit the housing over the screws, slide housing down on the screws and tighten the screws.

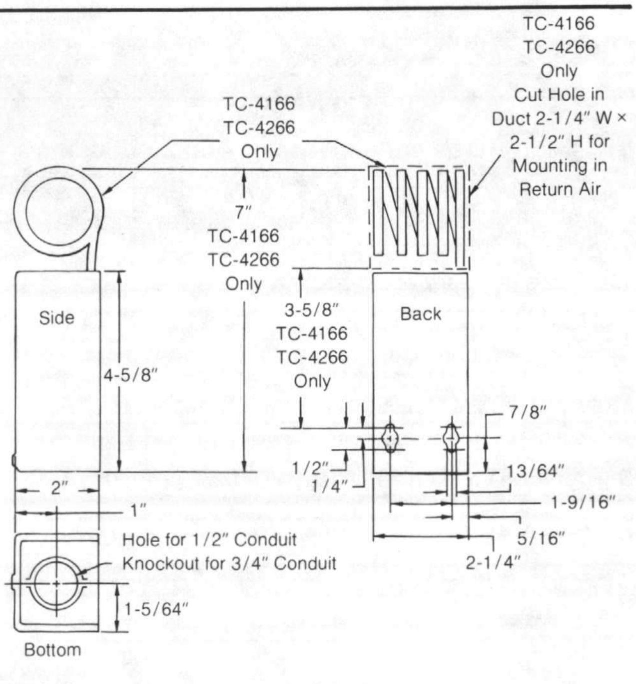


Figure 1. Case Dimensions

Checkout

After installing a thermostat, make an initial check of the switching action. Verify the switch action by listening to the switch contacts.

1. Turn the setpoint dial to a temperature above ambient. This should cause the thermostat to switch, making orange to brown.
2. Turn the setpoint dial setting down gradually. Orange to brown must break, making orange to red.
3. Compare the differential of the device to the differential shown on the performance charts by turning the dial. The differential of the devices is the difference in dial reading between the make of orange to brown and the make of orange to red on single switch units.

Run/Adjust

Setpoint

Screwdriver adjustment. Scales dual marked °F on front and °C on back. To change scale, remove spring retaining ring, select scale and replace retaining ring.

Differential Adjustment

The differential is adjustable by turning the adjustor located on side of device (see Figure 10).

Single stage: Each line represents approximately 3°F change.

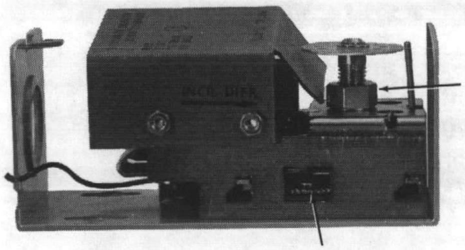


Figure 10

Two stage: Each notch represents approximately 2°F change between stages. (Differential per switch is fixed.)

To adjust differential:

1. Disconnect power to unit.
2. Remove cover.
3. Turn adjustor to approximately desired position.
4. Check out by turning dial and noting dial readings where switch contacts make.
5. After changing differential, recalibrate. See Service and Repair.

Service and Repair

Calibration

1. With all power disconnected, soak bulb(s) for 10 minutes at known temperature (must be 70°F for dual bulb).
2. Turn dial and note where switch contacts make.
3. Turn dial midway between click points.
4. Turn the calibration nut (located under dial) until the temperature of the bulb is indicated on the dial. (See Figure 10.)

NOTE

On two-stage units follow above procedure. "LO" switch is first stage on cooling applications. "HI" switch is first stage on heating applications.

Repair

Field repair is not recommended. Replace defective device.

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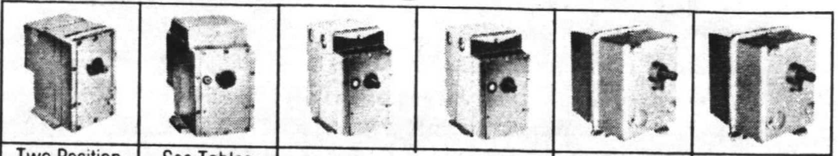
V-5

TABLE 2. Select **Actuator Type** or **Actuator Code (XXX)** series with correct Input Signal having sufficient close-off for the application. If selection Component Parts, select **Valve Linkage.**



Input Signal		Two Position SPST	See Tables 3C, 3D, 3E	See Tables 3B, 3C, 3D, 3E		See Table 3E	
Valve Linkage VB-9313	1/2" — 1-1/4"	AV-391	AV-391	AV-393	—	—	—
	1-1/2" — 2"	AV-392	AV-392	AV-394	—	—	—
	2-1/2" — 4"	—	AV-395	AV-396	AV-352	AV-357	—
	5" — 6"	—	—		AV-352	AV-357	AV-358
Valve Linkage VB-9323	1/2" — 1-1/4"	AV-391	AV-391	AV-393	—	—	—
	1-1/2" — 2"	AV-392	AV-392	AV-394	—	—	—
	2-1/2" — 3"	—	AV-329	AV-330	—	—	—
	4" — 6"	—	—	AV-352	—	—	—
Normal Position		See Table 3A	See Table 3C, 3E	None	None	None	None
Actuator Code (XXX)		3XX	3XX	40X, 41X, 42X	46X	903	951
Actuator Types		MA-318-XXX MA-418-XXX MA-419-XXX	MP-X6XX,X7XX MU-4610X, 4710X	MC-351, MC-4XX, MU-4810X MP-38X, 445, 48X, 48XX		MP-9750	MP-9810

				CLOSE-OFF PRESSURE RATING**											
Valve Assembly	Valve Body	P Code	Size	SU*	SD*	SU*	SD*	SU*	SD*	SU*	SD*	SU*	SD*	SU*	SD*
VA-9313-3XX-4-P VC-9313-4XX-4-P VP-9313-XXX-4-P VS-9313-XXX-4-P VU-9313-XXX-4-P	VB-9313-0-4-P	-2-4	1/2"	250	250	250	250	250	250						
		-6	3/4"	220	200	220	200	250	250						
		-8	1"	150	140	150	140	250	250						
		-9	1-1/4"	100	95	100	95	200	190						
		-10	1-1/2"	35	33	35	33	80	75						
		-11	2"	35	33	35	33	80	75						
VC-9313-4XX-5-P VP-9313-XXX-5-P VS-9313-XXX-5-P VU-9313-XXX-5-P	VB-9313-0-5-P	-12	2-1/2"			20	20	50	50	112	112				
		-13	3"			12	12	34	34	77	77				
		-14	4"			6	6	17	17	42	42	71	71		
		-15	5"							18	18	45	45	65	65
		-16	6"							11	11	31	31	46	46
VA-9323-3XX-4-P VC-9323-4XX-4-P VP-9323-XXX-4-P VS-9323-XXX-4-P	VB-9323-0-4-P	-4	1/2"	250	250	250	250	250	250						
		-6	3/4"	250	250	250	250	250	250						
		-8	1"	250	250	250	250	250	250						
		-9	1-1/4"	250	250	250	250	250	250						
		-10	1-1/2"	250	250	250	250	250	250						
		-11	2"	250	250	250	250	250	250						
VC-9323-4XX-5-P VP-9323-XXX-5-P VS-9323-XXX-5-P	VB-9323-0-5-P	-12	2-1/2"			125	125	125	125						
		-13	3"			125	125	125	125						
		-14	4"					125	125						
		-15	5"					125	125						
		-16	6"					125	125						

* SU — Stem Up; SD — Stem Down; See Table(s) 3 and 5 for flow pattern, port designations, and normal position.

** Close off ratings for mixing or sequencing valves: (SU = "A" port, SD = "B" port). "A" port (SU) ratings equal pressure at Port "A" minus pressure at port "B"; "B" port (SD) ratings equal pressure at port "B" minus pressure at port "A".

TABLE 3A. Two Position SPST Input, select exact **Actuator** or **Actuator Code (XXX)** is factory assembly is available. (VA-93X3 assemblies)

Input Signal	Normal Position	Wiring Figure Number	Voltage	Hz	VA	Switch	Actuator	Actuator Code (XXX) For Factory Available Assy
Two Position SPST	Stem Up	See Figure No. 2 on Page V65	24	60	92	No	MA-318	301
						Yes	MA-318-500	302
			120		108	No	MA-418	303
						Yes	MA-418-500	304
			208		104	No	MA-416	
						Yes	MA-416-500	
			240		120	No	MA-419	305
						Yes	MA-419-500	306

TABLE 3B. Two Position SPDT Input, select exact **Actuator** or **Actuator Code (XXX)** if factory assembly is available. (VC-93X3 assemblies)

Input Signal	Normal Position	Wiring Figure Number	Voltage	Hz	VA	Aux. Switch	Actuator	Actuator Code (XXX) For Factory Available Assy
Two Position SPDT	None (Non-Spring Return)	See Figure No. 5 on Page V66	24	60	53	Yes	MC-351	401
			120	60	96	Yes	MC-421	
			120	60	96	Yes	MC-431	413
			240	60	96	Yes	MC-4311	423*
			240	60	96	Yes	MC5-4311	424*

* Factory assemblies not available on 2-1/2" to 4" valves.

VALVES

TABLE 3C. 2-15 Vdc System 8000 input, select exact **Actuator** or **Actuator Code (XXX)** if Factory Assembly is available. (VS-93X3 asemblies)

Input Signal	Normal Position	Wiring Figure No.	Voltage	Hz	VA	Aux. Switch	Actuator	Actuator Code (XXX) For Factory Available Assembly
2-15 Vdc, System 8000, start 6 Vdc Factory Set Adj 2-12 Vdc, 3 Vdc Span, Positive Positioning	Stem Down	See Figure No. 13 on Page V69	120	60	50	Yes	MP-461-600	311
	Stem Up		120	60	50	Yes	MP-471-600	312
	None		120	60	50	Yes	MP-481-600	414
			120	60	50	Yes	MP-481-600	462

TABLE 3D. Temperature Input, select exact **Actuator** or **Actuator Code (XXX)** if Factory Assembly is available. (VU-93X3 Assemblies.)

Input Signal	Normal Position	Wiring Figure No.	Voltage	Hz	VA	Aux. Switch	Setpoint Range of Controller (°F)	Actuators	Actuator Code (XXX) for Factory Available Assembly
Temperature (Actuator has Built-in Temperature Controller)	Stem Down	See Wiring Figure No. 17 on Page V72	120	60	50	No	100-180	MU-46104	301*
			120	60	50	No	150-230	MU-46105	302
	Stem Up		120	60	50	No	10-90	MU-47102	303
	None		120	60	50	No	10-90	MU-48102	402*
			120	60	50	No	50-130	MU-48103	403
			120	60	50	No	100-180	MU-48104	404
			120	60	50	No	150-230	MU-48105	405

*Factory assemblies not available on 2-1/2" to 4" valves.

TABLE 3E. Multiple Input (see below) select exact **Actuator** or **Actuator Code (XXX)** if Factory Assembly is available. (VP-92X3 Assemblies.) See Wiring Figures on Pages V65 to V72.

Normal Position	INPUT SIGNAL								Voltage Vac (Hz)	Aux. Switch	Actuator Part Number	Actuator Code (XXX) for Factory Available Assembly
	Micro-therm® †	2-15 Vdc System 8000	4-20 mA etc.	Slidewire (Series 90)	SPST 9	SPDT Snap Acting 10	Pneumatic to Electric	SPDT Floating Direct Digital Control 11				
Stem Down	Yes	1	—	2	Yes	Yes	—	Yes	24 (60)	Yes	MP-361	301
	R.S.*	—	—	—	—	—	—	—	24 (60)	—	MP-367	303††
	—	—	—	Yes	—	—	—	—	24 (60)	Yes	MP-361-304	305††
	Yes	3	4	2	Yes	Yes	12	Yes	120 (60)	Yes	MP-465	313
	—	—	—	Yes	—	—	—	—	120 (60)	Yes	MP-465-304	315††
	Yes	5	4	2	Yes	Yes	12	Yes	240 (50)	Yes	MP5-4651	342††
Stem Up	Yes	1	—	2	Yes	Yes	—	Yes	24 (60)	Yes	MP-371	302
	R.S.*	—	—	—	—	—	—	—	24 (60)	—	MP-377	304††
	—	—	—	Yes	—	—	—	—	24 (60)	Yes	MP-371-304	306††
	Yes	3	4	2	Yes	Yes	12	Yes	120 (60)	Yes	MP-475	314
	—	—	—	Yes	—	—	—	—	120 (60)	Yes	MP-475-304	316††
	Yes	5	4	2	Yes	Yes	Yes	Yes	240 (50)	Yes	MP5-4751	344††
None Non-Spring Return	Yes	1	—	2	—	Yes	—	Yes	24 (60)	Yes	MP-381	401
	Yes	1	—	2	—	Yes	—	Yes	24 (60)	Yes	MP-382**	402
	R.S.*	—	—	—	—	—	—	—	24 (60)	—	MP-387	403
	—	—	—	Yes	—	—	—	—	24 (60)	Yes	MP-381-304	405††
	Yes	3	4	2	—	Yes	12	Yes	120 (60)	Yes	MP-485	415
	Yes	3	4	2	—	Yes	12	Yes	120 (60)	Yes	MP-486**	416††
	—	—	—	Yes	—	—	—	—	120 (60)	Yes	MP-445-304	419††
	—	—	—	Yes	—	—	—	—	120 (60)	Yes	MP-485-304	420††
	Yes	5	4	2	—	Yes	12	Yes	240 (60)	Yes	MP-4851	442††
	Yes	5	4	2	—	Yes	12	Yes	240 (50)	Yes	MP5-4851	443††
	Yes	1	—	2	—	Yes	—	Yes	24 (60)	Yes	MP-381	461
	Yes	3	4	2	—	Yes	12	Yes	120 (60)	Yes	MP-485	463
	Yes	3	4	2	—	Yes	12	Yes	120 (60)	Yes	MP-9750	903
	6	7	4	8	—	Yes	12	Yes	120 (60)	Yes	MP-9810	951

1. Requires CP-8301-024 ordered separately, see Wiring Figure No. 13.
2. Requires AE-504 ordered separately, see Wiring Figure No. 15.
3. Requires CP-8301-120 ordered separately, see Wiring Figure No. 13.
4. Requires CP-8391-716 ordered separately, see Wiring Figure No. 16.
5. Requires CP-8301-240 ordered separately, see Wiring Figure No. 13.
6. Requires AE-347 or AM-345 ordered separately, see Wiring Figure No. 11.
7. Requires AE-347 or AM-345 and CP-8301-120 ordered separately, see Wiring Figure No. 14.
8. Requires AE-347 or AM-345 and AE-504 ordered separately, see Wiring Figure No. 15.
9. See Wiring Figure Nos. 3 and 4.
10. See Wiring Figure Nos. 6 and 7.
11. See Wiring Figure Nos. 8 and 9.
12. Requires CP-8391-716 and PP-8311 ordered separately.

*Reversing series, sequencing of 2 actuators with Microtherm® input, see Wiring Figure No. 18.
**Adjustable speed actuator.
†Microtherm® Models TP-2XX, 3XX, 4XX, 10XX, 101XX; TPC-1010X; PP-22X, see Wiring Figure No. 10
††Factory assemblies not available 2-1/2" to 4" valves.

VALVES

TABLE 4. Dimensions

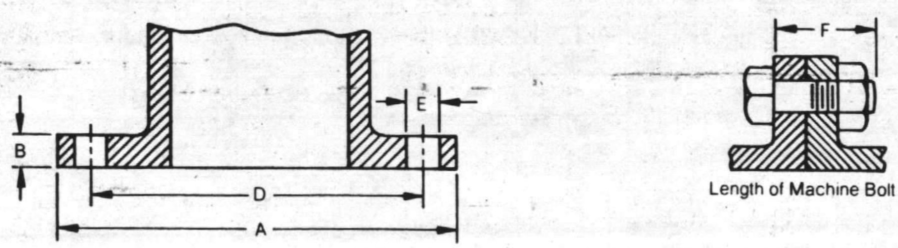
DIMENSIONS (Inches)							
	Valve Body			Actuator Series			
				300	40X, 41X, 42X	460	900
Part Number	Size	A	C	E*	E	E	E
VA-9313-XXX-4-P VC-9313-XXX-4-P VP-9313-XXX-4-P VS-9313-XXX-4-P VU-9313-XXX-4-P VA-9323-XXX-4-P VC-9323-XXX-4-P VP-9323-XXX-4-P VS-9323-XXX-4-P	1/2"	3	1-7/16	13-11/16	13-11/16		
	3/4"	3-5/8	1-7/8	14	14		
	1"	4-5/8	2-1/4	14-1/4	14-1/4		
	1-1/4"	4-5/8	2-3/4	14-1/4	14-1/4		
	1-1/2"	6-1/8	3-7/8	15	15		
	2"	6-1/8	3-7/8	15	15		
VC-9313-XXX-5-P VP-9313-XXX-5-P VS-9313-XXX-5-P VU-9313-XXX-5-P	2-1/2"	8-1/2	5-3/8	15-7/8	15-7/8	14-7/8	22
	3"	9-1/2	6-3/8	16-1/4	16-1/4	15-1/4	24-3/8
	4"	11-1/2	8-1/2	16-7/8	16-7/8	15-7/8	25-1/8
	5"	13	8-3/4			18-1/4	
	6"	14	9-3/4			19	
VC-9323-XXX-5-P VP-9323-XXX-5-P VS-9323-XXX-5-P	2-1/2"	9	7	17-1/2	17-1/2		
	3"	10	8	18	18		
	4"	12	10			24-1/8	
	5"	13	10-1/2			24-5/8	
	6"	14-1/8	11-1/8			25-1/4	

*Subtract 3/4" on VA assemblies.

TABLE 5. Flow Pattern

Body Part Number	Flow Type	Stem Up (SU)		Stem Down (SD)	
		Flow	Closed Port	Flow	Closed Port
VB-9313-0-X-P	Mixing	B to AB	A	A to AB	B
VB-9323-0-4-P	Diverting	B to AB	A	B to A	AB
VB-9323-0-5-P	Diverting	C to L	U	C to U	L

American Standard 125 lb. Cast Iron Pipe Flanges



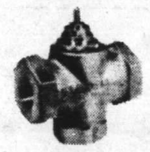
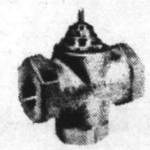
Flange Detail

Dimensions in Inches

Nominal Pipe Size	Flanges		Drilling		Bolting		Length of Machine Bolts F
	Flange Diameter A	Flange Thickness B	Diameter of Bolt Circle D	Diameter of Bolt Holes E	Number of Bolts	Diameter of Bolts	
2-1/2	7	11/16	5-1/2	3/4	4	5/8	2-1/2
3	7-1/2	3/4	6	3/4	4	5/8	2-1/2
4	9	15/16	7-1/2	3/4	8	5/8	3
5	10	15/16	8-1/2	7/8	8	3/4	3
6	11	1	9-1/2	7/8	8	3/4	3-1/4

VALVES

TABLE 1. Select **Valve Body** including **P Code** (Valve Size, Cv Rating, Port Code) or select **Valve Assembly** with correct Input Signal (see Table 3 also) less Actuator Code (XXX) including the **P Code** (Size, Cv Rating, Port Code). (See Pages V59-63 for Valve Sizing.)

		APPLICATION			
		Chilled or Hot Water			
		Screw	Flange	Screw	Flange
					
Sizes		1/2"—2"	2-1/2"—6"	1/2"—2"	2-1/2"—6"
Valve Body, Actuator Provides Normal Position†		VB-9313-0-4-P	VB-9313-0-5-P	VB-9323-0-4-P	VB-9323-0-5-P
Actuator Types	Input Signal	Factory Available Valve Assemblies			
MA-318-XXX, MA-418-XXX, MA-419-XXX	SPST (See Table 3A)	VA-9313-XXX-4-P	—	VA-9323-XXX-4-P	—
MC-351, 421, 431, 4311, MC5-4311	SPDT (See Table 3B)	VC-9313-XXX-4-P	VC-9313-XXX-5-P	VC-9323-XXX-4-P	VC-9323-XXX-5-P
MP-461-600, 471-600, MP-481-600	2-15 Vdc, System 8000 (See Table 3C)	VS-9313-XXX-4-P	VS-9313-XXX-5-P	VS-9323-XXX-4-P	VS-9323-XXX-5-P
MU-4610X, 4710X, 4810X	Temperature (See Table 3D)	VU-9313-XXX-4-P	VU-9313-XXX-5-P	—	—
MP-36X, 37X, 38X, 445, 46X, 47X, 48X, 46XX, 47XX, 48XX	(See Table 3E)	VP-9313-XXX-4-P	VP-9313-XXX-5-P	VP-9323-XXX-4-P	VP-9323-XXX-5-P
Flow Type		Mixing	Mixing	Diverting	Diverting
Material	Body	Bronze	Iron	Bronze	Iron
	Seat	Bronze	Bronze	Bronze	Bronze
	Stem	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
	Plug	Brass	Brass	Stainless Steel	Brass
	Packing	Spring Loaded Teflon "V" Rings	Spring Loaded Teflon "V" Rings	Spring Loaded Teflon "V" Rings	Grafoil
	Disc	None	None	None	None
		WATER			
Pressure (psig)	Static	250	125	250	125
	Recom. Diff.*	35	35	35	35
Fluid Temp. °F (°C)	Min.	40° (4°)	40° (4°)	40° (4°)	40° (4°)
	Max.	281° (138°)	300° (149°)	281° (138°)	300° (149°)

NOTE: These charts are color coded as shown below to assist valve selection. Note it is possible to select either a valve assembly or component parts (actuator, valve linkage, valve body).

ORDERING EXAMPLES:

1. **Valve Assembly** **VP-9313-301-4-10**
2. **Valve Body** **VB-9313-0-4-10**
   Actuator **MP-361**
   Linkage **AV-392**

■ **Valve Body** Data less P Code (Size, Cv Rating, Port Code) or **Valve Assembly** less Actuator Code (XXX) and less P Code (Size, Cv Rating, Port Code)

■ **P Code** (Size, Cv Rating, Port Code)

■ **Actuator** or **Actuator Code (XXX)** for Valve Assemblies

■ **Valve Linkage**

TO SELECT A PORT CODE (P)

P Code	Valve Size	Cv			Port	
					"U"	"L"
-2**	1/2"	2				
-4		4		6		
-6	3/4"	6.8		8		
-8	1"	12		12		
-9	1-1/4"	16		16		
-10	1-1/2"	33		30		
-11	2"	55		42		
-12	2-1/2"		74		68	75
-13	3"		101		85	95
-14	4"		170		160	180
-15	5"		290		195	220
-16	6"		390		250	275

*Maximum recommended differential pressure in full open position. Do not exceed recommended differential pressure (pressure drop) or integrity of parts may be affected.
NOTE: Do not exceed close-off rating.
**NOTE: Factory assemblies are not available for 2-position applications using reduced port valve bodies.
†See Tables 3 and 5 for flow pattern, port designations, and normal position.

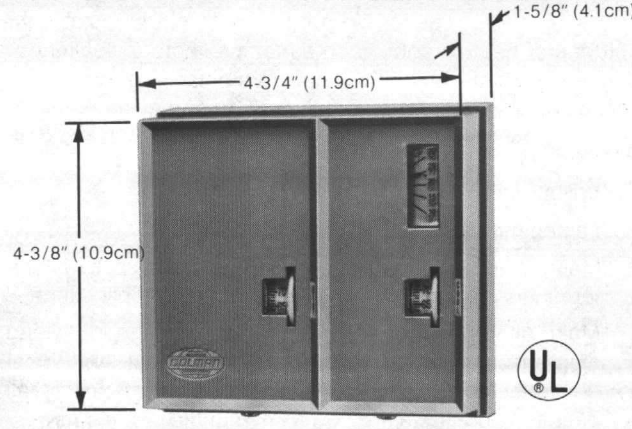
T-1

General Instructions

TC-1161 Series Two-Position Electric Duplex Room Thermostats

For on-off control applications requiring two individually adjustable thermostats under one cover, such as day/night control, night and warm-up control, summer/winter and other energy conserving systems.

Two complete thermostat mechanisms secured to a single base. Bimetal elements with enclosed silver contacts. Coded screw terminals. Differential 1-1/2°F. Units have plastic covers as standard. Metal cover options available (order TC2-1161-XXX) — CSA requirements. Mounts on flush single or 2-gang switch box or 4" × 4" surface box or directly to wall (24 volt only).

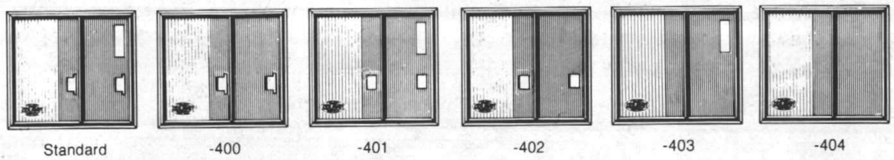


DIMENSIONS

4-3/8" high × 4-3/4" wide × 1-5/8" deep.

OPTIONS

Add "dash-number" (-XXX) suffix to base part number for desired option. Order TC2-1161-XXX for metal covers.



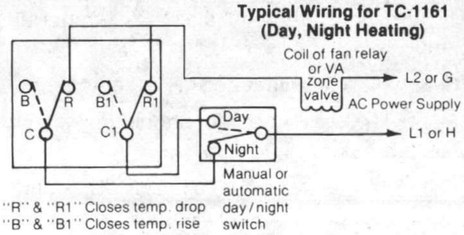
Part Number	Dial Scale† Left Side	Dial Scale† Right Side	Heat Anticipation**	Thermometer	Electrical Rating A-C Only	Thermostat Switch Action
TC-1161	55-85°F (13-29°C)	55-85°F (13-29°C)	No	Yes	*3 amp at 24V 3 amp at 120V 1.5 amp at 240V	2 SPDT
TC-1161-479	75-105°F (24-40°C)	45-75°F (7-23°C)	No	No		2 SPST
TC-1161-530	75-105°F (24-40°C)	45-75°F (7-23°C)	Fixed 3°F heat & cooling anticipators for 24 Vac, 41 amp load only	No	Determined by heater size	2 SPST
TC-1161-531	75-105°F (24-40°C)	45-75°F (7-23°C)	Fixed 3°F heat & cooling anticipators for 120V, .082 amp load only	No	Determined by heater size	2 SPST

Differential: 1-1/2°F (.8°C).
***Locked Rotor Currents:** 18 amps at 120V; 9 amps at 240V. Pilot duty rating 140VA at 120/240 Vac, 28 VA at 24 Vac.
****Heat Anticipation:** The heat anticipating type minimizes over and under-shoot by causing the thermostat to cycle more often, thereby maintaining a more stable space temperature.
†Unit dual marked in °F and °C, dial stop pins included to limit dial range.

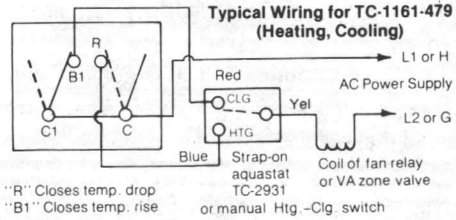
ACCESSORIES:

- AT-101 Lock cover kit (2 required per thermostat)
- AT-104 Dial stop pins (note: pins included with each unit)
- AT-136 Legend plates marked (day, night, heat, cool)
- AT-546 Auxiliary mounting plate
- AT-607 Selector switch sub-base DP4T switch
- AT-608 Selector switch sub-base one DP4T, one DPDT switch
- AT-1163 Wire guard
- AT-1155 Plastic guard
- AT-1165 Plastic guard
- Tool #11 Calibration wrench
- Tool #13 Contact burnishing tool

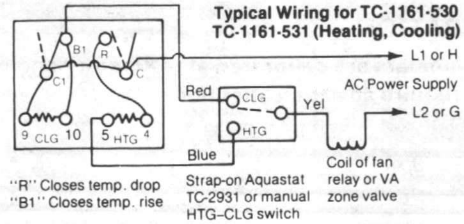
Typical Wiring for TC-1161 (Day, Night Heating)



Typical Wiring for TC-1161-479 (Heating, Cooling)



Typical Wiring for TC-1161-530 TC-1161-531 (Heating, Cooling)



INSTALLATION

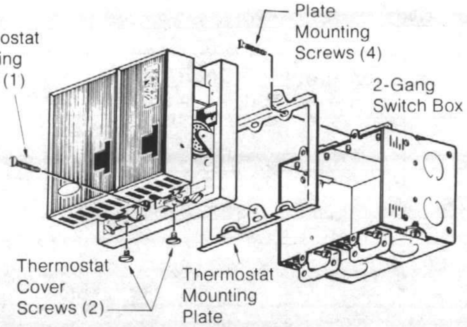
Requirements

Locate thermostat where it will be exposed to unrestricted circulation of air which represents the average temperature of the controlled space. Do not locate the thermostat near sources of heat or cold, such as lamps, motors, sunlight or concealed ducts or pipes. The thermostat is designed for service in any normally encountered human environment.

Procedure

1. Pull all wires (Use copper wire only).
2. Fasten mounting plate to box or wall.
3. Make electrical connections to thermostat screw type terminals. (See typical wiring diagrams for applications).

   Make all connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. Class I wiring is required unless all circuits to contacts are powered from a Class II source.
4. Hook thermostat on top of mounting plate and swing down into place.
5. Remove thermostat cover, attach thermostat to mounting plate with mounting screws, and attach thermostat cover.



CHECKOUT

After installing a thermostat, make an initial check of the switching action. Verify the switch action by listening to and watching the switch contacts, using a voltmeter between the proper sides of the switch, or observing the controlled device.

1. Slowly turn each setpoint dial to a temperature above ambient.
   a. TC-1161, "R" contact and "R1" contact should make.
   b. TC-1161-479, "R" contact should make. "B1" contact should break.
   c. TC-1161-530 and TC-1161-531, "R" contact should make. "B1" contact should break.
2. Slowly turn each setpoint dial to a temperature below ambient.
   a. TC-1161, "B" contact and "B1" contact should make.
   b. TC-1161-479, "R" contact should break. "B1" contact should make.
   c. TC-1161-530 and TC-1161-531, "R" contact should break. "B1" contact should make.

CALIBRATION

All thermostats are calibrated at the factory and normally will not require any such attention. However, if recalibration is necessary, proceed as follows:

1. Disconnect power to thermostat.
2. Set the adjusting dials to correspond to actual room temperature.
3. Remove thermostat cover, remove screw that secures right-hand of insulator, fold back insulator, and remove contact covers. (Figure 1.)

   Do not breathe on the thermostat or handle excessively as this will affect the accuracy of the final calibration.
4. If the right contact blade is not made to "R" contact, use a 3/16" open end wrench to turn dial calibration screw clockwise (looking at the head of screw) until element makes to "R" contact.

NOTE

Each complete revolution of screw changes calibration approximately 6°F (3.3°C).

5. Turn dial calibration screw counterclockwise until blade just breaks "R" contact.
6. If contact blade is originally made to "R" contact, turn calibration screw counterclockwise until blade just makes "B" contact.
7. Repeat steps 4 - 6 for the left contact blade. THERMOSTAT IS NOW PROPERLY CALIBRATED.
8. Replace contact covers, insulator and thermostat cover.
9. Recheck calibration about 30 minutes later to be sure heat from handling did not result in erroneous setting.

MAINTENANCE

Open areas at bottom and around base of thermostat should be kept clean and free from obstructions to allow proper flow of air. If switch contacts need cleaning, this may be done with a Tool-13 contact burnishing tool.

REPAIR

Field repair of the thermostat is not recommended. If the system is not operating correctly and the reason is traced to the thermostat, it should be replaced.

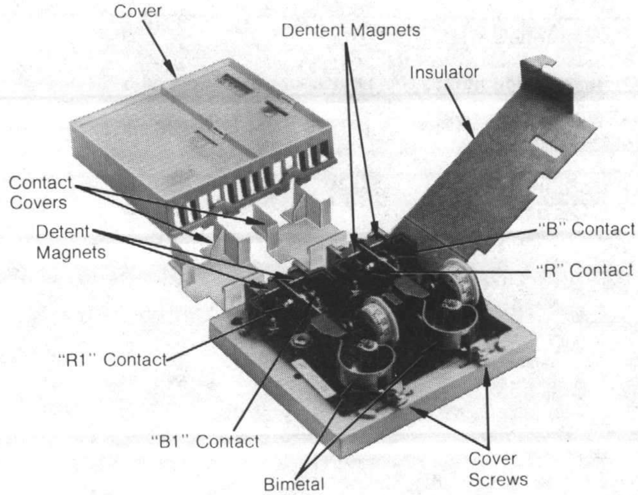


Figure 1

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ENVIRONMENTAL CONTROLS DIVISION

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LITHO IN U.S.A.

TS-2 ; TS-1

BARBER COLMAN COMPANY

General Instructions

Solid State Sensing
Temperature and Humidity
Series TS-8000 and HS-8000

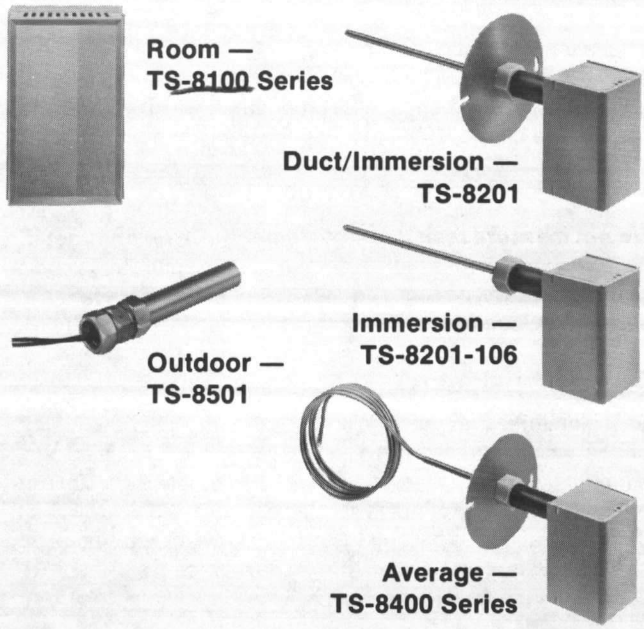
Temperature Sensing

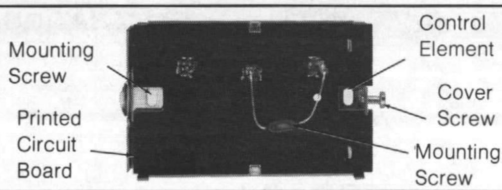
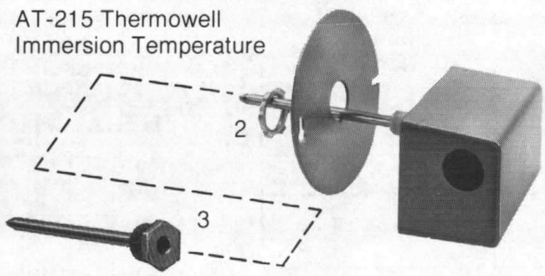
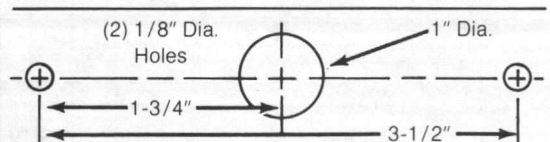
GENERAL INFORMATION

Sensing is accomplished by the use of a temperature sensitive Balco resistance wire packaged in the form of room, duct, averaging and outdoor type configurations. The design of the entire system is around a 1000 Ω sensing element at 70°F.

WIRING

Make all electrical connections to the element in accordance with the installation and wiring diagram for the job. Comply with national and local electrical codes. Do not use the element box as a junction box for other control circuits. It is generally advisable to use flexible conduit for connecting box to rigid conduit. Restrict element leads to shortest length practical. Barber-Colman twisted cable or factory approved cable should be used.



Part No.	Use	Location	Mounting	Terminal Code Wiring
TS-8101	Room Sensor w/o Setpoint	Wall		⑦ ⑧ } Output Terminals
TS-8111	Room Sensor w/Setpoint	Wall		
TS-8201	Duct Immersion 7″ Immersion Length	Duct or Well AT-215 3/4″ NPT	AT-215 Thermowell Immersion Temperature 	Pigtails: Black } Black } (C) Controlling Black } Black } (L)* Controlling *Found only on the TS-8331
TS-8201 -106	Immersion 4″ Insertion Length	Well AT-225 1/2″ NPT		
TS-8331	Lagged Sensor	Duct	 Duct Mounting Dimensions	
TS-8405	5′ Average	Duct		
TS-8422	22′ Average	Duct		
TS-8241	Diffuser	Ceiling	Mount on Face of Ceiling Diffuser. See Instructions for B-C Models PB, PS or SFS, SFB. Pg. 2	Pigtails: Black Black
TS-8261	Light Fixture	Light Fixture	Mount in Return Grill of Light Fixture	Pigtails: Black Black
TS-8501	Outdoor Air	Outside of Building	Use Conduit Connectors	Pigtails: Black } Black } Controlling
TS-8531	Solar	Outside of Building		Orange } Orange } Element (Solar)
TS-8533	Econostat	Outside of Building		Red } Red } Heater (Econostat)

Solid State Humidity Sensing

Sensing is accomplished by the use of a nonorganic resistance type material which will be housed either in a room or duct type mounting base. Selection of the proper AH-100 series element will provide the capability of control over a 15% range. Elements are available through the span of 5% to 95% R.H.

The average resistance of each element at midrange is approximately 22,000 ohms; except the violet element, which is 50,000 ohms. A resistor of appropriate value may be substituted in the bridge circuit to verify the element resistance.

CAUTION

Do not measure resistance of element with an ohmmeter, as DC voltage across the element will cause polarization and a new element will be required. Basic element is not repairable. Order a replacement from the factory or local branch office.

CARE OF ELEMENT

The elements are wrapped with a moisture pervious cellophane, which actually is an air filter. On installations using duct elements, where air velocities are reasonably high **do not remove cellophane.** Always install element with wrapping so that perforations in cellophane are on downstream side of air currents. Punch more holes (only in downstream side of cellophane) to increase element sensitivity.

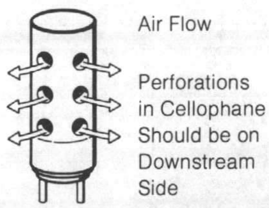


TABLE 1.

Part Number	Sensing Element Color	Relative Humidity Range
AH-100	Violet	85% to 95%
AH-101	Blue	70% to 85%
AH-102	Green	50% to 70%
AH-103	Yellow	40% to 55%
AH-104	Orange	30% to 45%
AH-105	Brown	10% to 30%

WIRING

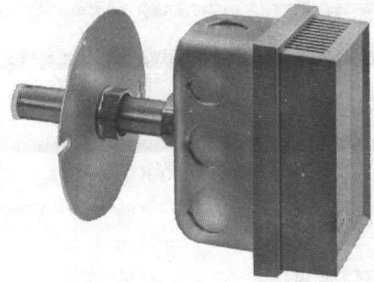
Make all electrical connections to the device in accordance with the installation wiring diagram for the job. Comply with national and local electrical codes. Restrict element leads to shortest length practical, using three conductor twisted cable, 18 gauge minimum.

CAUTION

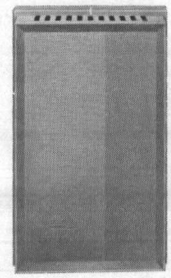
Power wiring must never be installed in the same conduit.

LOCATION

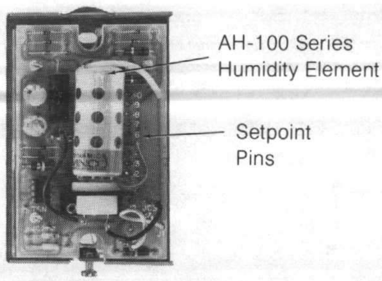
Locate the sensing element where it will be exposed to unrestricted natural air circulation and to the average conditions of the controlled space. Do not locate it near extreme sources of heat, cold, or moisture.



Duct — HS-8200 Series



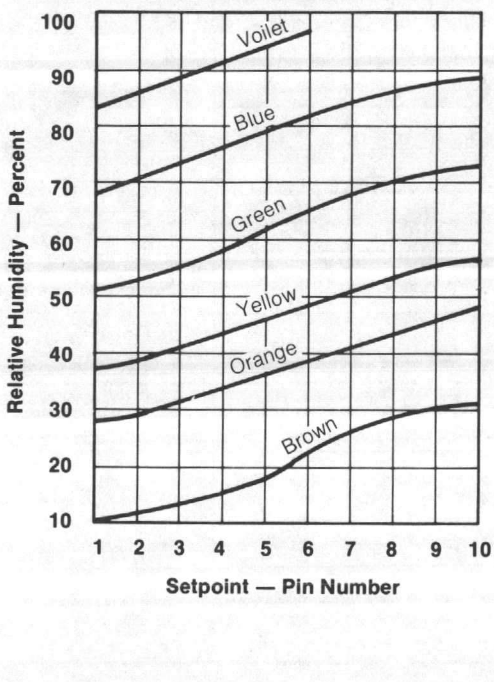
Room — HS-8100 Series



CALIBRATION

1. Place DC-VOM on output of CP-8102 controller, OP1 (+) and COM (-).
2. Read humidity at the sensor.
3. Place jumper on proper pin, per chart below.
4. Adjust the controller (CAL A) to 7.5 Vdc output.
5. Refer to CP-8102 literature if further details are required.

GENERAL INFORMATION



MOUNTING OF DIFFUSER SENSOR TS-8241

Sensor should be mounted to the face of the ceiling diffuser so that it projects downward into the room. See Figure 1. If the diffuser has an adjustable pattern, the discharge air direction must be adjusted to a horizontal pattern. This will insure a representative sample of room air over the element (Figure 2). The transmitter will not perform satisfactorily if the discharge is adjusted to a vertical pattern.

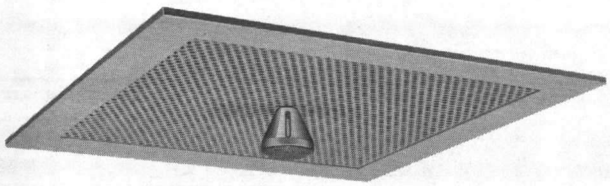


Figure 1.
Sensor Mounted in Perforated Face Ceiling Diffuser Model PB or PS

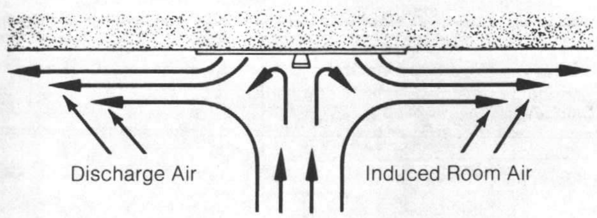


Figure 2.
Room Air Induced over Sensor by Discharged Air

A 7/16-inch hole is required in the diffuser face for mounting.

The SFS and SFB louver faced diffusers are available in nine air patterns, both in the square and rectangular design. For proper installation, use Table 2 which shows sensor location and the mounting figure referred to in the installation procedure. APNS-107 must be ordered separately.

SENSOR MOUNTING PROCEDURE ON SFS AND SFB USING APNS-107 KIT

1. Drill a 5/16" hole for sensor leads.
   a. Fig. 3. Locate hole center on an angled surface about 5/16" from an edge of the 1/2" square so as to avoid drill contact with the welded center plate mounting brackets.
   b. Fig. 4. Locate the hole center on one louver about 5/16" from junction of two center back to back louvers.
   c. Fig. 5. Locate hole center on an end louver about 1/2" from the junction of the louver and the mounting flange.
2. Bring field leads through the 5/16" hole. If required, remove the louver assembly from the mounting flange.
3. Center the APNS-107 bracket over the 5/16" hole (use as a template) and drill 1/8" holes for the mounting screws.
   a. Fig. 3. Drill two holes near edges of square center plate.
   b. Fig. 4. Drill two holes, one each on bottom edge of back to back louvers.
   c. Fig. 5. Drill one hole on end louver.
4. Assemble the sensor to APNS-107 bracket as shown in Figs. 3, 4, and 5.

   Fig. 5. Cut off one side of APNS-107 as shown.
5. Make field connections to sensor leads and push leads up through the 5/16" hole.

   Wrap friction or electrical tape around the leads and fill the 5/16" hole, preventing direct primary air passage over the sensor.
6. Attach APNS-107 as shown in Figs. 3, 4, and 5 using #6 screws.

   Fig. 5. Cover the crack between the end louver and mounting flange at least 12" on each side of the sensor. A 24" length of 3/4" tape stuck to mounting flange can be used.
7. The sensor installation is complete.

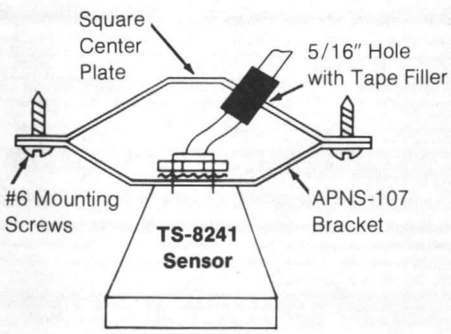


Figure 3

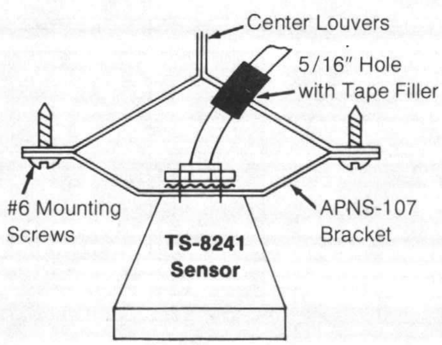


Figure 4

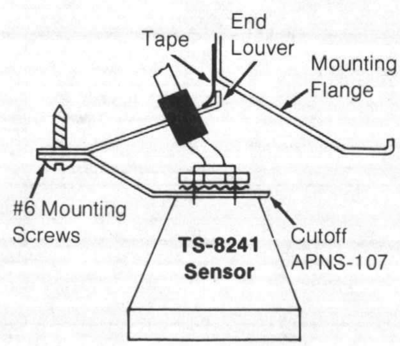


Figure 5

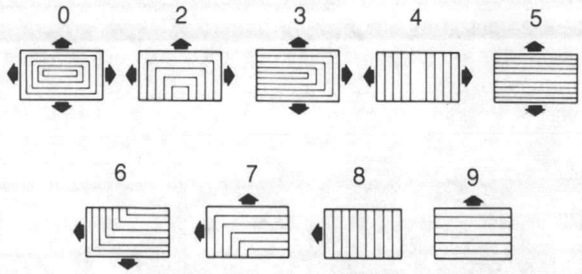
TABLE 2. SENSOR LOCATION AND FIGURE SHOWING MOUNTING DETAILS

Air Pattern	SENSOR LOCATION: Center of Diffuser		Center of Side with No Air Throw		Corner Opposite Air Throw		End Opposite Air Throw	
	Sq.	Rect.	Sq.	Rect.	Sq.	Rect.	Sq.	Rect.
0	Fig. 3	Fig. 4						
2			Fig. 4					
3								
4	Fig. 4							
5								
6								
7					Fig. 3	Fig. 5		
8								
9							Fig. 5	

TS-8241 must not be located nearer than 18" from a wall or corner of a room when used on air patterns 2, 6, 7, 8, or 9. This allows space for induced air to pass over TS-8241.

AIR PATTERNS (As Viewed from Diffuser Face)

Number is air pattern designation when ordering.



Specifications			Temperature Sensors: Room Light Fixture Diffuser*	Duct/ Immersion	Averaging	Selective Ratio Discharge	Humidity Sensors (Sensors must be ordered separately. Refer to Sensor Range Table 1.): Room	Duct
Package		Size**	4⅜×2¾×1⅝	4¾×3½×9⅛	4¾ × 3½ × †	4¾×3½×9⅛	4⅜×2¾×1⅝	4⅜×3½×9⅛
		Mounting	Wall	Duct/ Immersion	Duct	Duct	Wall	Duct
		Mounting Position	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
		Connection	Terminals	Pigtails	Pigtails	Terminals	Pigtails	Pigtails
		Ambient Temp. Limits	-40 to 250°	-40 to 250°	-40 to 250°	-40 to 250°	35 to 135°	35 to 135°
Sensor		Resistance	1000 Ω	1000 Ω	1000 Ω	1000 Ω		
		Sensitivity	2.2 Ω/°F	2.2 Ω/°F	2.2 Ω/°F	2.2 Ω/°F		
		Length		6"	5' or 22'	6"		6"
Input	Control Range							
	Impedance							
	Adjust	Setpoint Range	55 to 85°				Up to 20% R.H.	Up to 20% R.H.
		Calibration Range					±5%	±5%
		Throttling Range						
		Ratio				5 to 20/1		
Output	Voltage	Impedance						
		Range						
		Reference				Negative	Negative	Negative
	Power Supply	Voltage						
		Current						
		Regulation						
Load		Voltage						
		Current						
Power		Voltage				6.2 Vdc ±.4	24Vac±10%	24Vac±10%
		Current				1 mA	25 mA	25 mA

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F-14970-4 BK

LITHO IN U.S.A.

AQ-3

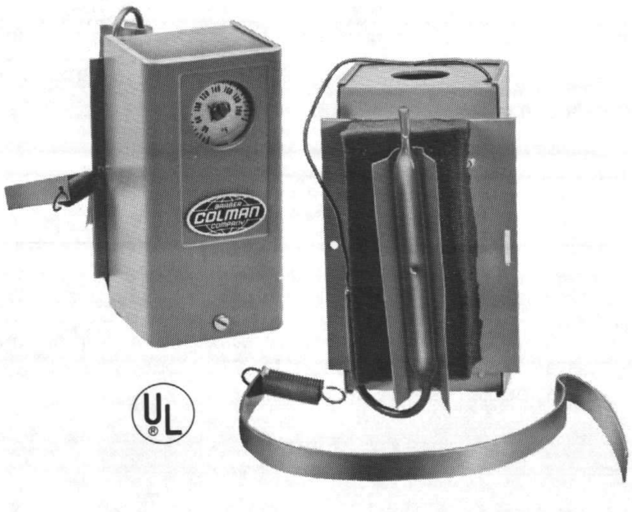
General Instructions

Strap-On-Thermostat
TC-2974

DEVICE INFORMATION

Identification

These thermostats are used to either open or close electrical circuits when the temperature of a pipe exceeds the thermostat setting. The orn-red circuit is often used on the unit heater installations to prevent operation of the fan unless heat is actually available. The orn-brn circuit is usually used for control on hot water boilers.



Pre-Installation

The thermostats are shipped with a metal strap and spring, which will fit supply lines up to 4-inch O.D. For dimensions see Figure 1.

Before installing the thermostat, look for bent or broken parts.

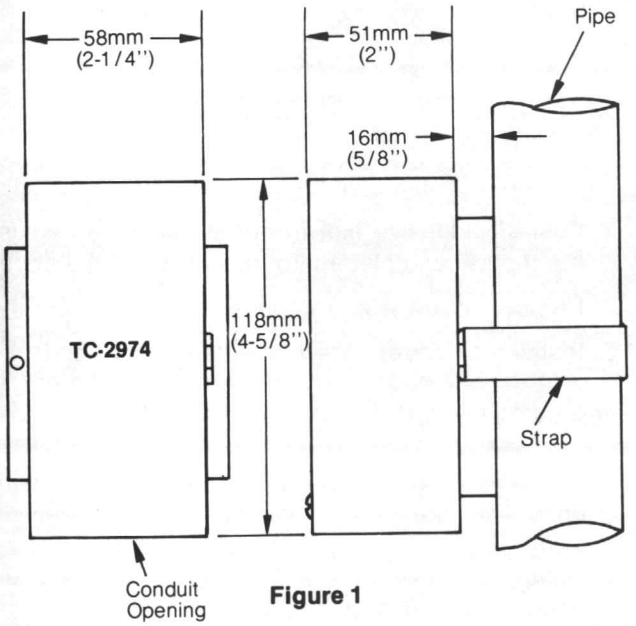


Figure 1

Scale* °C (°F)	Differential °C (°F)	SPDT Switch Ratings (ac Only)			
		Voltage (Vac)	FLA (amps)	LRA (amps)	Pilot Duty (VA)
10-99	Fixed 5.5	120	9.8	58.8	360
(50-210)	(Fixed 10)	240	8	48	360

*The scale is dual marked in degrees C and degrees F.

INSTALLATION

Requirements

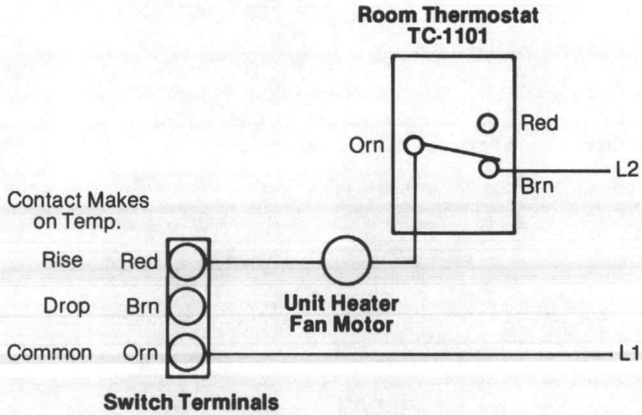
The thermostat can be mounted in any position on a smooth clean pipe. Be sure pipe is free of rust, scale or insulation material.

Ambient Rating: –40 to 60°C (–40 to 140°F).

Procedure

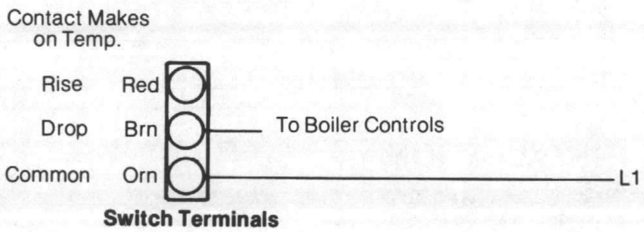
1. Insert the spring loops into the holes provided in the strap and in the side of the housing.
2. Wrap the strap around the pipe and thread through the opening provided in the housing.
3. Push the device against the pipe to compress the foam spacer until the bulb is 6 mm (1/4-inch) from the back of the housing.
4. Pull the strap tight and bend to lock the device in place.
5. Clip off or bend back the excess strap.

Wiring: The thermostat has one 13mm (1/2)–19mm (3/4-inch) conduit opening in bottom of housing. Make all electrical connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. Device terminal coding, switch action, and wiring is shown in typical application (Figures 2 and 3).



Typical unit heater application wiring for strap-on thermostat TC-2974. Unit heater fan runs only when heating supply media is above the setpoint of TC-2974.

Figure 2



Typical hot water boiler application wiring for strap-on thermostat TC-2974. Boiler runs only when water temperature is below the setpoint of TC-2974.

Figure 3

CHECKOUT

After installing the thermostat, proceed as follows:

1. With electrical power on and hot water flowing through the pipe, rotate the setpoint dial from minimum to maximum and check fan operation. If wired orange and red, the fan will start at minimum dial setting and stop at maximum dial setting. The reverse will occur if wired orange to brown.

2. If no electrical power is available, contact closure may be checked with an ohmmeter.

3. The differential is factory set to provide the following switch action:

   a. At 5°F above the setpoint an orn-red circuit is made.

   b. At 5°F below the setpoint an orn-brn circuit is made.

RUN/ADJUST

Setpoint

Screwdriver adjustment. Scales dual marked °F on front and °C on back. To change scale, remove spring retaining ring, select scale and replace retaining ring.

Refer to **CHECKOUT** for manual operation.

CALIBRATION

1. Disconnect power to thermostat.

2. Soak the bulb for 10 minutes at a known temperature.

3. Turn the dial until the thermostat clicks, reverse the dial until it clicks again.

4. Turn the dial midway between the click points.

5. Turn the calibration nut (located under the dial) until the temperature of the bulb is indicated on the dial.

CONCEALED SETPOINT AND LOCK COVER SCREW

Order AT-210 Concealed Adjustment Kit Separately.

1. **Peel off adhesive film from the concealed adjustment plate and place into the recess of the cover.**
2. **Remove screw from the cover.**
3. **Install lock cover screw provided with AT-210.**

MAINTENANCE

If excessive corrosion develops between the sensing element and the pipe, clean the pipe and apply a silicone lubricant such as #6 compound from Dow Corning Company between the pipe and sensing element to prevent additional corrosion.

REPAIR

Field repair of the thermostat is not recommended. If the system is not operating correctly and the reason is traced to the thermostat, it should be replaced.

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LITHO IN U.S.A.

C-1

CP-8102

BARBER COLMAN COMPANY

General Instructions

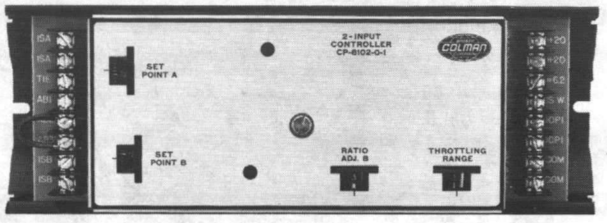
CP-8102 Electronic Two Input Temperature or Humidity Controller

FUNCTIONS

Electronic controller receives temperature or humidity sensor inputs and sends a variable electronic signal, 1 to 15 Vdc, to up to six System 8000® actuators or relays (controlled devices). Additional devices can be controlled with the use of adapters. These actuators or relays operate heating, cooling, humidification or dehumidification equipment in HVAC systems.

FEATURES AND BENEFITS

The reliable, easy to install CP-8102 electronic controller incorporates an amplifier with inputs for 1000ohm Balco® temperature sensors, humidity sensors or remote setpoint adjustor. Two setpoint dials, ratio authority dials, throttling range dials and calibration potentiometers are visable and accessible without removing controller cover allow for easy field adjustment. Coded screw terminals make sensor, remote setpoint, power supply and output signal wiring easy to install and change. The CP-8102 controller is used with other System 8000 devices.



CP-8102

Wiring Connections: Coded screw terminals for all control inputs and outputs.

Safe Ambient Temperature Limits:

Operation: 40 to 135°F (4.4 to 57°C)
Storage: -40 to 160°F (-40 to 71°C)

Dimensions: 4″ (102 mm) high × 11″ (279 mm) wide × 2-1/2″ (64 mm) deep

Table 1. Specifications

Part Number	Control Dial Range Setpoint "A"	Control Dial Range Setpoint "B"	Throttling Range for 3 Vdc Output Change	Authority Ratio Adjustment Setpoint "A" Setpoint "B"	Control Output Voltage†	Power Required	Power Supply Available
CP-8102	20 to 120°F	20 to 120°F	Adjustable 2 to 10°F by Dial*	.5:1 to 25:1 Adjustable by Dial	1 to 15 Vdc 10 mA Max. Factory Set for D.A.	20 Vdc 23 mA	6.2 Vdc 7 mA Max.
CP-8102-116	-6 to 48°C	-6 to 48°C	Adjustable 1 to 6°C by Dial*				

* See ADJUSTMENTS for additional throttling ranges.
† Units factory calibrated for 7.5 Vdc output with sensor at setpoint temperature.

Options: None.

ACCESSORIES:

AD-8122	Signal adaptor for dual outputs (two direct acting)
AD-8123	Signal adaptor for dual outputs (one direct, one reverse acting)
AD-8124	Signal adaptor for dual outputs (one reverse, one direct acting)
AD-8912	12″ enclosure
AD-8969-201	Off set resistor kit: 5, 10, 15 & 20°F
AD-8969-901	Extended throttling range jumper
ASP-301	Power supply required for HSP-6X81 humidity transmitter
ASP-581	Indication meter 20 to 80% RH
AT-8122	Remote setpoint adjuster, dual scale 20 to 120°F (-6 to 49°C)
AT-8155	Remote setpoint adjuster, dual scale 50 to 250°F (10 to 121°C)
AT-8158	Remote setpoint adjuster, dual scale 55 to 85°F (13 to 29°C)
AT-8222-101	Setpoint scale for humidity 20% to 100%
AT-8435	Remote setpoint adjuster, dual scale 50 to 450°F (10 to 232°C) for use with TS-8204 only
CN-8101	Multi-purpose bridge
HS-8101	Room humidity sensor
HS-8201	Duct humidity sensor
TS-8101	Room sensor
TS-8111	Room sensor with setpoint
TS-8131	Room button type sensor
TS-8201	Duct/immersion sensor
TS-8204	High temp. duct/immersion sensor requires AT-8435 remote setpoint for all applications except differential control
TS-8241	Diffuser sensor
TS-8261	Light fixture sensor
TS-8331	Lagged sensor (CN-8101 is required)
TS-8405	5′ averaging sensor
TS-8422	22′ averaging sensor
TS-8501	Outdoor sensor
TS-8531	Solar sensor (CN-8101 is required)
TS-8533	Econostat sensor
Tool-201	Calibration kit for system 8000

DEFINITIONS

Mode of Operation: Either direct-acting or reverse-acting.

Direct-acting (D.A.) means that an increase in temperature at the sensor(s) causes the voltage output (OP1) to increase.

Reverse-acting (R.A.) means that an increase in temperature at the sensor(s) causes the voltage output (OP1) to decrease.

Reset Control Action: The direction of reset determines whether input A setpoint is reset upward or downward on a temperature decrease at input B.

Direct reset: (D.R.) A temperature decrease on input B resets input A setpoint downward.

Reverse reset: (R.R.) A temperature decrease on input B resets input A setpoint upward.

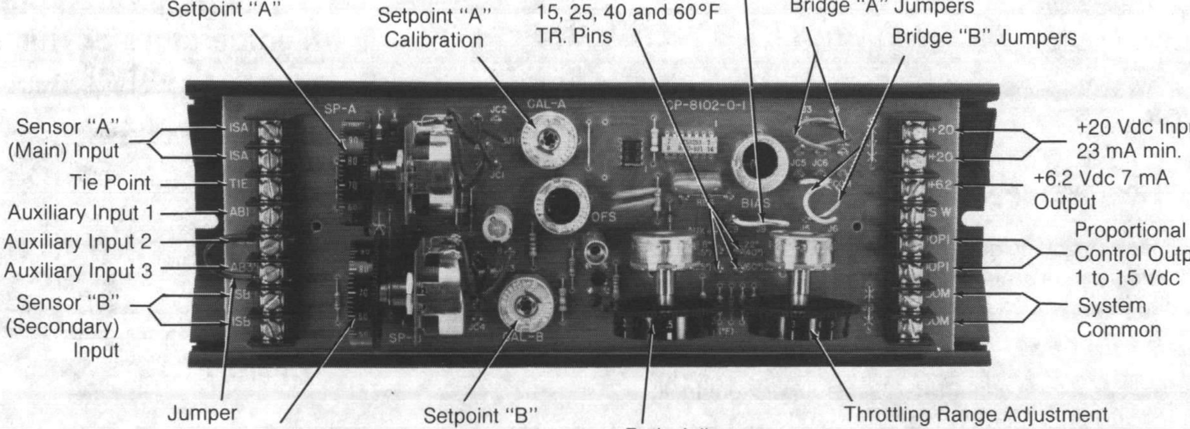


Figure 1. CP-8102

CONTROL TERMINAL INPUTS (See Figure 1)

ISA: Any TS-8000 Temperature Sensor (1000 ohm Balco)

ISB: Any TS-8000 Temperature Sensor (1000 ohm Balco)

AB1, AB2, AB3: Auxiliary inputs; any remote setpoint adjuster AT-8000 series, HS-8X01 humidity sensor, CN-8101 multipurpose bridge

CONTROL TERMINAL OUTPUT (See Figure 1)

OP1: 1 to 15 Vdc (10 mA maximum). Units factory calibration for 7.5 Vdc output with sensor at setpoint temperature.

ADJUSTMENTS: (See figure 1)

Temperature Setpoint "A": By dial 20 to 120°F (−6 to 48°C), or by remote setpoint adjuster (See Accessories).

Temperature Setpoint "B": By dial 20 to 120°F (−6 to 48°C), or by remote setpoint adjuster (See Accessories).

Setpoint "A" Calibration: By potentiometer.

Setpoint "B" Calibration: By potentiometer. For reset control, set Setpoint "B" at value where Setopint "A" will be reset. Adjust Setpoint "A" at control point required with no reset from sensor "B".

THOTTLING RANGE: By dial 2 to 10°F, 1 to 6°C. By pin selection 15, 25, 40 and 60°F (8, 14, 22, 33°C). Remove J9 jumper from JC9 and attach to required throttling range pin. By extended throttling range adjuster, AD8969-901 (order separately), 55, 65, 75, 85, 100, 115, 125 and 140°F (31, 36, 42, 47, 56, 64, 69 and 78°C). The throttling range is the sum of the T.R. pins connected.

AUTHORITY RATIO
ADJUSTMENT: By dial .5 to 25:1. Ratio is the number of degrees change at Sensor "B" required to reset Setpoint "A" one (1) degree. Example: 25:1 means a 25°F (14°C) change at Sensor "B" will reset Setpoint "A" 1°F (.5°C).

Table 2

Controller Function	Jumper Connections Required	
	Bridge "A"	Bridge "B"
Direct Acting*	J4 to JC6 J3 to JC5	J5 to JC5 J6 to JC6
Reverse Acting	J4 to JC5 J3 to JC6	J5 to JC6 J6 to JC5
Internal Setpoint Active*	J1 to JC1	J2 to JC3
Internal Setpoint Inactive for Remote Setpoint	J1 to JC2	J2 to JC4
Disable Bridge "B" for Single Sensor Input	Remove Jumper from AB2 to AB3	

* As supplied from factory.

To Obtain Reverse Reset: Both bridges should have the same action. Example: both direct acting, or both reverse acting.

To Obtain Direct Reset: Bridges should have different action. Example: one direct and one reverse acting.

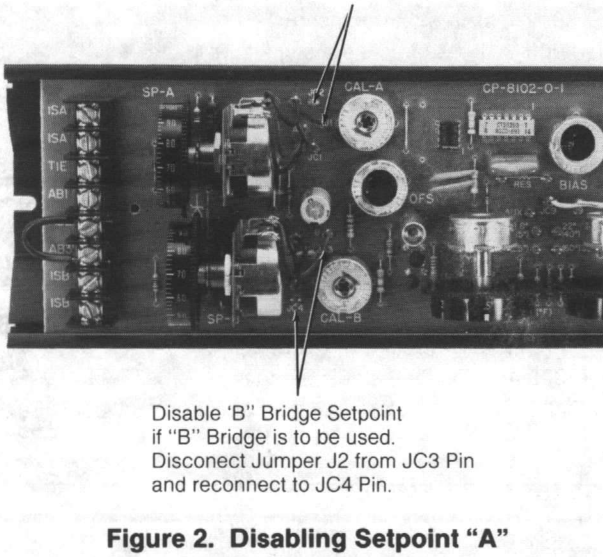


Figure 2. Disabling Setpoint "A" and/or Setpoint "B"

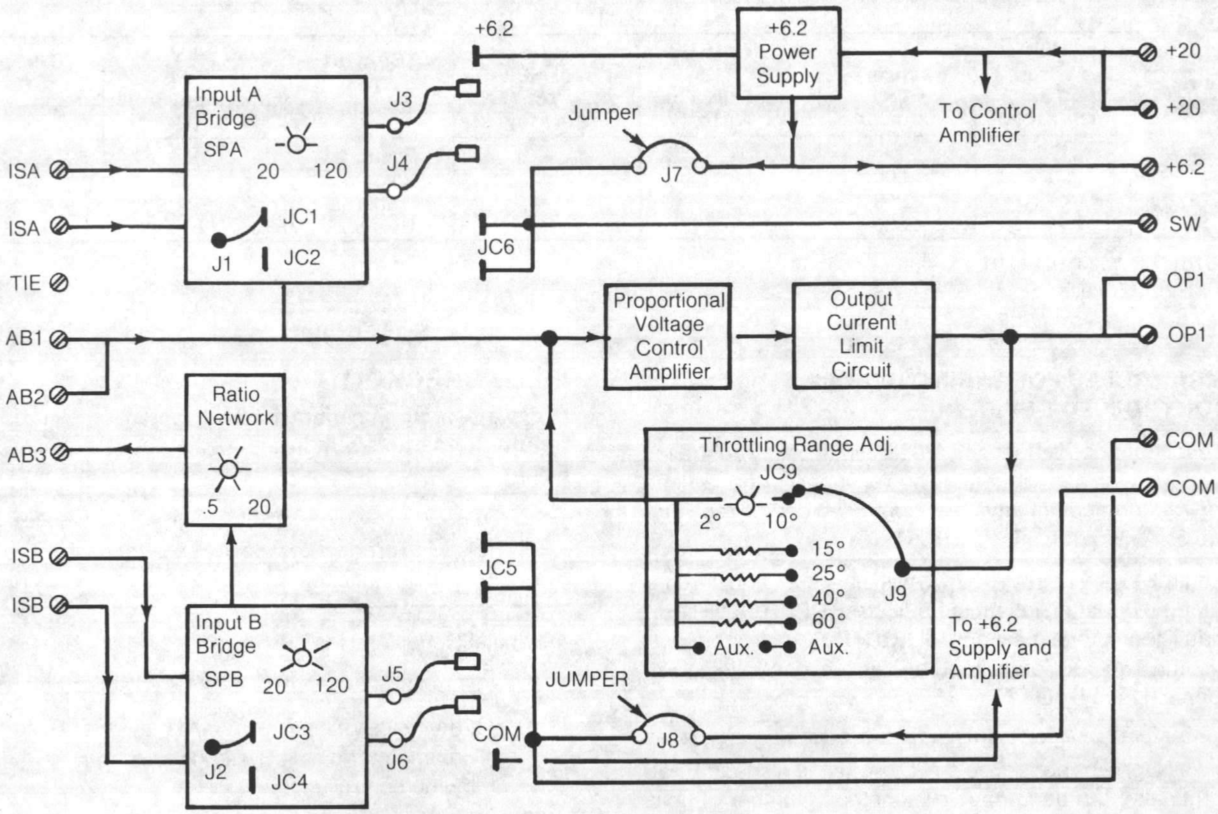


Figure 3. CP-8102 Controller Block Diagram

PRE-INSTALLATION: Open the carton and visually inspect the device for part number and obvious defects before proceeding with the installation.

NOTE

Mounting screws are not provided.

INSTALLATION: Device may be mounted, in any position, in an inside location near the controlled equipment using the two slots in the track. AD-8912 enclosures can be ordered separately for remote installations.

CAUTION

Avoid locations where excessive vibration, moisture, corrosive fumes or vapors are present, or where high radio frequency or electro-magnetic interference generating devices are near.

See Figure 4 for mounting dimensions.

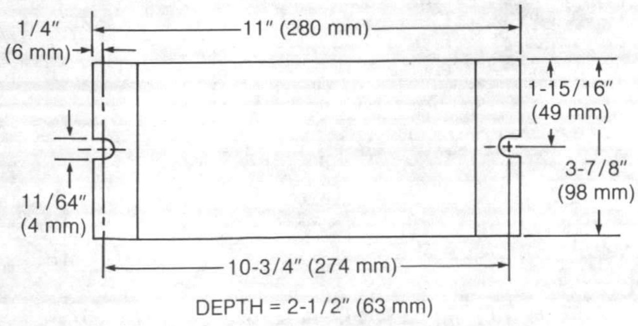


Figure 4. Mounting Dimensions

GENERAL WIRING INFORMATION

Make all connections according to job wiring diagrams and in compliance with national and local codes.

Two separate No. 18 twisted pair wires (six turns per foot [.3m]).
Class II, low voltage, are suitable for up to 1000 feet (300 m) for the sensor leads. See table 3 for longer runs.

CAUTION

Never run line voltage in the same conduit with unshielded sensing element leads. Use copper conductors only.

Shielded cable (Belden No. 8422 or equivalent) must be used when it is necessary to install the DC signal leads in the same conduit with power wiring, or when it is known that high RFI/EMI generating devices are near. Ground the shield at the controller only on the COM (-) terminal.

Table 3. Wiring Lengths

Wire Gauge	LENGTH OF RUN IN FEET** "HS" Sensor To CP-8102	"TS" Sensor To CP-8102	CN-8101, AT-81X4 TS-8601 To CP-8102	"HSP" Transmitter To CP-8102	TSP-8101 To CP-8102	CP-8102 To Controlled Device	CP-8102 To Adaptor*
22	125	—	—	—	Should be	—	—
18	300	1,000	1,000	250	in Same	1,000	1,000
16	—	2,250	—	—	Panel as	2,250	2,250
14	—	4,000	—	—	Controller	4,000	4,000

* AD-8101, AD-812X, AD-8201, AD-8301, AD-8501
**1 Ft. approx. .3 meter

GENERAL RULES FOR WIRING CP-8102 TO CONTROLLED DEVICE(S)

1. Never connect red lead (or +20 terminal) of any controlled device which has a regulated power supply to the red lead (or +20 terminal) of any other controlled device (see Figure 5).
2. Controlled devices (MP-52XX) with unfiltered and unregulated power supplies must be filtered. CP-8102 will provide filtering for a maximum of two MP-52XX by connecting the two red leads together at the controller's +20 terminal (see Figure 6).
3. Controlled devices with filtered and unregulated supplies: Up to six controlled devices with the red leads (+20 terminals) can be connected together. Number of units paralleled depends on the current (mADC) requirements of the controller or adaptor.

Table 4. Controlled Device Power Supply Characteristics

Filtered & Regulated	Filtered & Unregulated	Unfiltered & Unregulated
CC-8101		
CC-8102		
CC-8103		
CC-8111 Series		
CC-8118 Series	MP-54XX	MP-52XX
CC-8218 Series	MS-8XXX	Actuators
CP-8161 Series	Actuators	
CP-8301 Series*		
CP-8425 Series		
CP-8501 Series		
CP-8502 Series		

* Except CP-8301-101 which does not have a power supply.

FIELD CHECKOUT

Units are factory calibrated and tested and should not require field checkout. If required, proceed as follows (see Figure 1):

NOTE

The following procedures can be used for either reverse or direct acting connected CP-8102 controllers.

1. Initial Conditions for CP-8102
   A. Jumper between AB2 and AB3 disconnected.
   B. 20 Vdc +1 - 1.5 Vdc (23 mA) applied to the +20 and common terminals. This power is normally supplied by the controlled device.
2. Connect a 20,000 ohm/volt DC VOM meter between the OP1 (+) terminal and COM (-) terminal of the CP-8102. Use a 20 Vdc or less range.
3. Disconnect the temperature sensing element "A" from the ISA terminals of the CP-8102. Short ISA terminals together and VOM reading should be 1 Vdc or less if bridge "A" is direct acting and more than 15 Vdc if bridge A is reverse acting.
4. Open ISA terminals and VOM reading should be greater than 15 Vdc if bridge "A" is direct acting and less than 1 Vdc if bridge "A" is reverse acting.
5. The CP-8102 is a good unit if it passes tests in steps 3 and 4. Replace the unit if tests 3 and 4 are not met.

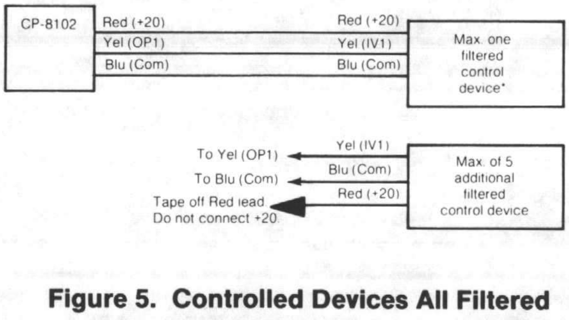


Figure 5. Controlled Devices All Filtered

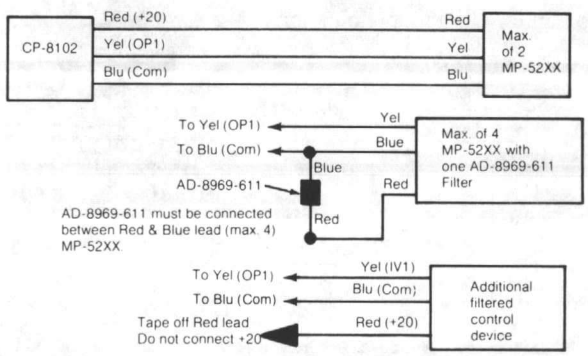


Figure 6. At Least One of the Controlled Devices in MP-52XX (Unfiltered)

FIELD CALIBRATION PROCEDURES FOR CONTROLLERS WITH ONE AND TWO INPUTS

(See Figures 7 and 9):

The following procedures can be used for either reverse or direct acting connected CP-8102 controllers.

The CP-8102 is factory calibrated and shipped with both inputs connected for direct acting output.

Normally, the CP-8102 (connected for either direct or reverse acting) requires no field calibration but if a field calibration check or recalibration becomes necessary, then proceed as follows:

1. Initial Conditions for CP-8102:

   A. Setpoint "A" set for: 70°F.

   B. Setpoint "B" set for: 70°F.

   C. Ratio adjustment set for: 1:1.

   D. Throttling range adjustment set for: 3°F.

   E. Jumper between AB2 and AB3 disconnected.

   F. 20 Vdc (23 mA) applied to the +20 and common terminals. This power is normally supplied by the controlled device.

2. Connect a 20,000 ohm/volt DC VOM meter between the OP1 (+) terminal and COM (-) terminal of the CP-8102. Use a 20 Vdc or less range.

3. Calibration of "A" input. Use one of the following two methods.

   A. Temperature measurement methods:

   Accurately measure the temperature at the temperature sensing element "A". Adjust setpoint "A" until the dial reading agrees with the temperature measured. Rotate setpoint "A" calibration potentiometer (located just to the right of setpoint "A" dial) until a VOM reading of 7.5±.2 Vdc is obtained.

   B. Sensing element substitution method:

   Disconnect the temperature sensing element "A" from the ISA terminals of the CP-8102. Reconnect a 1000 ohm ±.1% wire wound resistor (TOOL-203) to the ISA terminals. Adjust setpoint "A" for 70°F. Rotate setpoint "A" calibration potentiometer (located just to the right of setpoint "A" dial) until a VOM reading of 7.5±.2 Vdc is obtained.

NOTE

Method B above does not calibrate out any errors due to sensing element tolerances or wire lead resistance.

4. Calibration of "A" input complete.

   If "B" input is not being used (jumper between AB2 and AB3 removed) then proceed to step 7 below.

5. Reconnect jumper between AB2 and AB3.

6. Calibration of "B" input. Use one of the following two methods.

   A. Temperature measurement method:

   Accurately measure the temperature at the temperature sensing element "B". Adjust setpoint "B" until the dial reading agrees with the temperature measured. Rotate setpoint "B" calibration potentiometer (located just to the right of setpoint "B" dial) until a VOM reading of 7.5±.2 Vdc is obtained.

   B. Sensing element substitution method:

   Disconnect the temperature sensing element "B" from ISB terminals of the CP-8102. Reconnect a 1000 ohm ±.1%, wire wound resistor (TOOL-203) to the ISB terminals. Adjust setpoint "B" for 70°F. Rotate setpoint "B" calibration potentiometer (located just to the right of setpoint "A" dial) unti a VOM reading of 7.5±.2 Vdc is obtained.

NOTE

Method B above does not calibrate out any errors due to sensing element tolerances or wire lead resistance.

7. CP-8102 calibration is complete. Remove all test meters, test resistor, etc. Reconnect all elements, place setpoints, throttling range and ratio adjustments as required for the application.

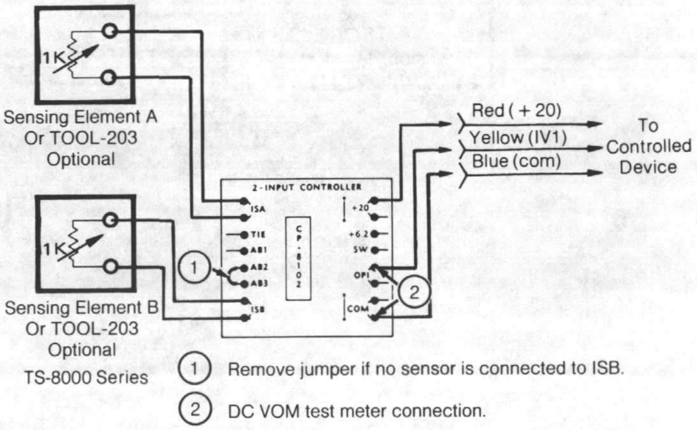


Figure 7. One or Two sensor Application

FIELD SERVICE

Units are factory calibrated and tested for direct acting control (D.A.) and reverse reset (R.R.) and should not require service. If required, proceed as follows (see Figure 8):

Power Supply

Apply +20; +1, −1.5 Vdc (23 mA) to the +20 and common terminals. Proper power supply is always required for unit to function properly. The +6.2 (±.3) Vdc should be available from the controller, if required.

Test

Connect a 20,000 ohm/volt DC VOM meter between +20 and common terminals. Controller power supply +20, +1 −1.5 Vdc (indicated by M1 in Figure 8) should be measured. Power supply is normally supplied by controlled device. Check +6.2 (±.3) Vdc power supply of controller with VOM.

Service

If the +20 Vdc level is not measured, service the (lead) controlled device, power supply or installation wiring as necessary to insure proper power supply.

Controller Output

See Field Calibration Procedures, on this page, for calibration of "A" setpoint using sensor element substitutes.

Test

With signal output measured between OP1 and COM at 7.5 ± .2 Vdc, rotate setpoint "A" dial several degrees (in increments of 1°F) each way from 70° setting to vary the M2 reading from 1 to 15 Vdc. The number of degrees that setpoint dial "A" is changed to vary the reading on M2 3 Vdc should be approximately 3°F (if T.R. is set at 5°F, 3 Vdc will change over 5°F).

Service

See Field Calibration Procedures, on page 5, for calibration of "B" setpoint using sensor element substitutes. (Make certain that jumper is connected to AB2 and AB3.)

Adjusting setpoint "B" several degrees from 70°F setting will cause the M2 reading to vary from 1 to 15 Vdc.

If output voltage cannot be made to vary over a 1 to 15 Vdc range, then replace the CP-8102 as defective.

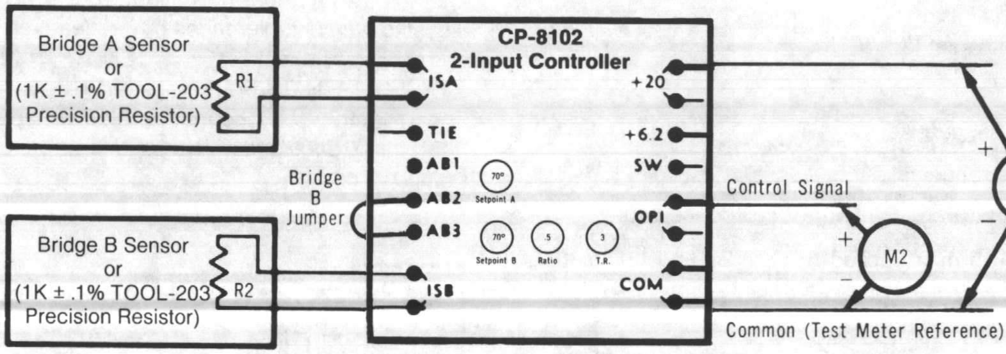


Figure 8.

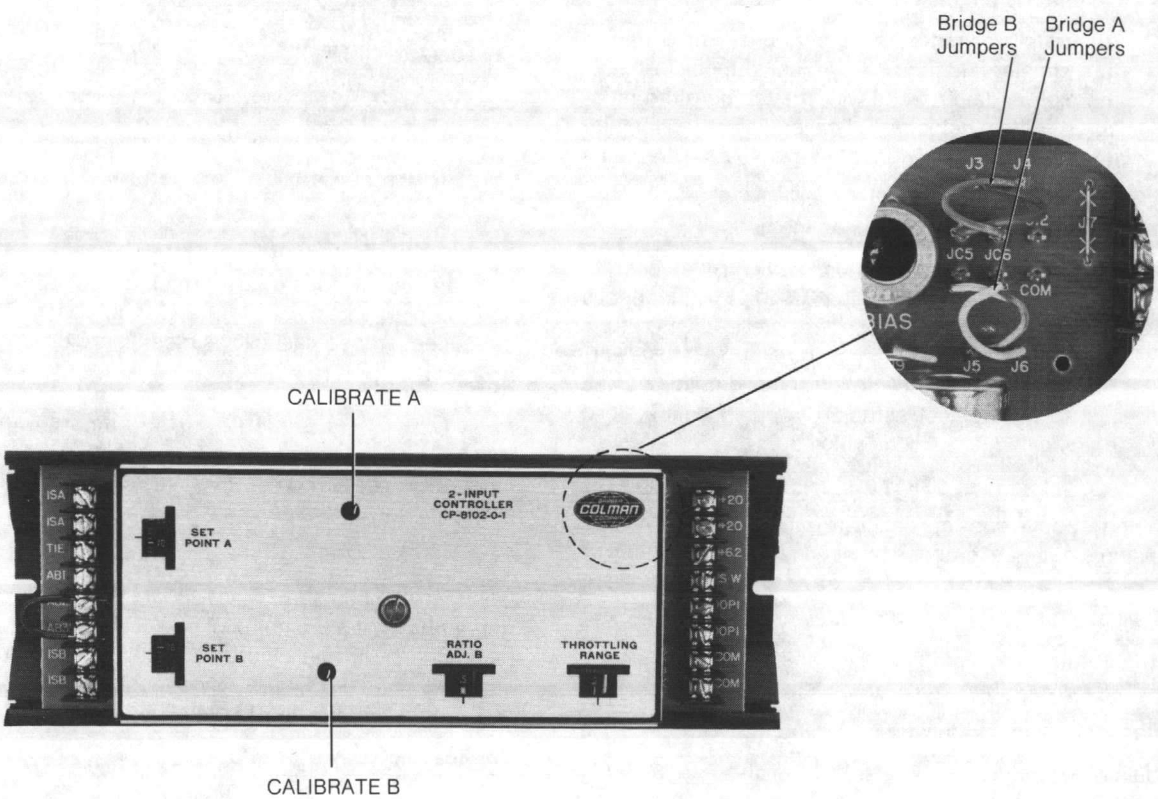


Figure 9.

MAINTENANCE

This is a quality product. Regular maintenance of the total system is recommended to assure sustained optimum performance.

TYPICAL APPLICATIONS

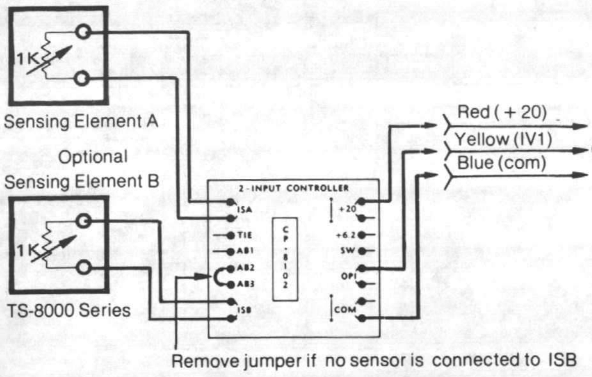


Figure 10. One or Two Temperature Sensor Application

Hot water reset is typical application for a two sensor application of the CP-8102. For example, perimeter radiation temperature, with hot water as a heating medium, is increased as the temperature of the outside air decreases. This method of control is known as reverse reset. A reset schedule shown below in table requires the hot water temperature to increase from 100° to 170°F, a change of 60°F, as the outside air temperature decreases from 60° to 0°F. If the throttling range of the CP-8102 controller is 10°F the setting of the CP-8102 will be as follows:

Setpoint "A": 110°
Setpoint "B": 60°
Ratio Adjustment: 1 (change in outside air temperature/ change in hot water temperature)
Throttling Range: 10°F
Note: Controller function is Direct Acting * (see table 2)
* Factory setting

Table 5. Reset Schedule

Outside Air Temp. (°F)	Water Temperature (°F)
60	110
0	170

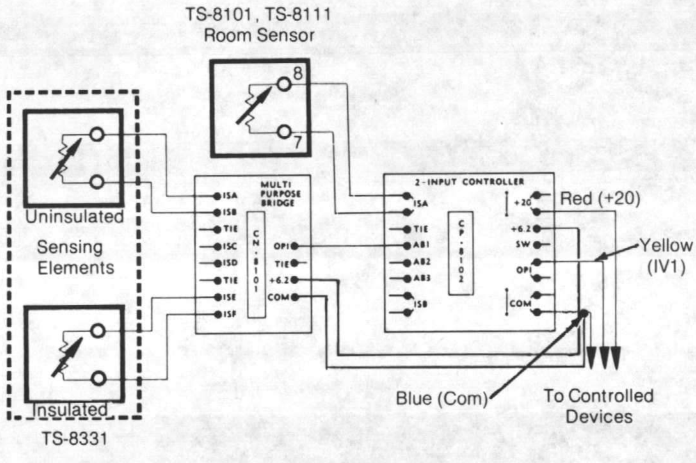
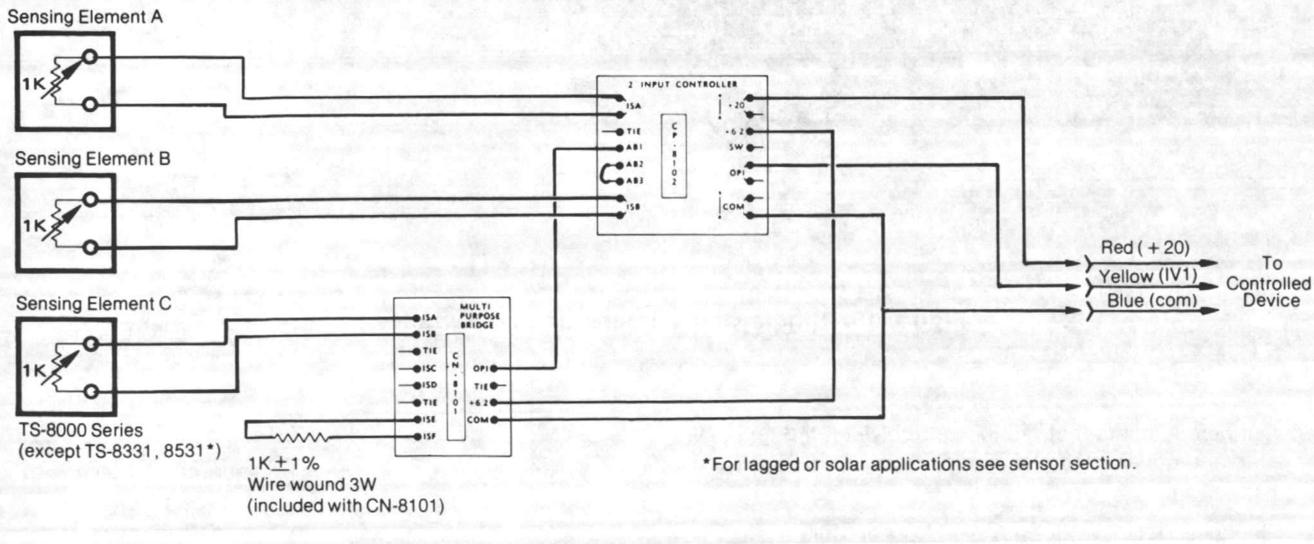


Figure 11. Derivative (Lagged) Sensor



*For lagged or solar applications see sensor section.

Figure 12. Three Temperature Sensor Application*

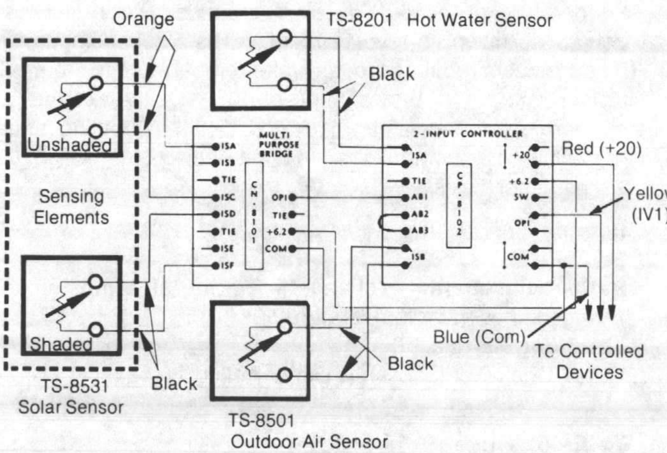
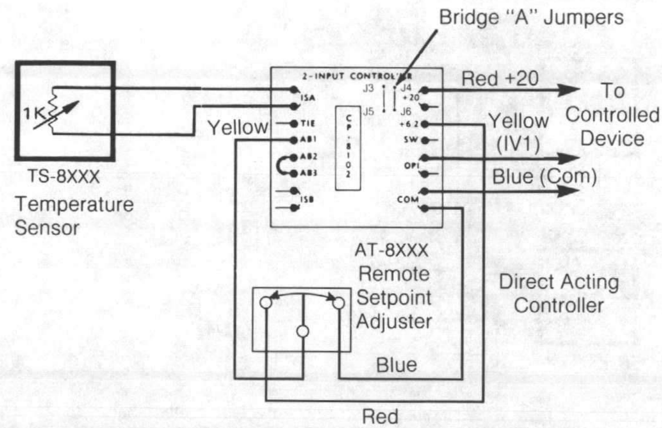


Figure 13. Solar and Outdoor Air Reset of Hot Water (Direct Acting Output)



NOTE: If the controller bridge is reverse acting, the red and blue wires at the AT-8XXX Series must be reversed (red to common, blue to +6.2).

Figure 14. Single Input with Remote Setpoint

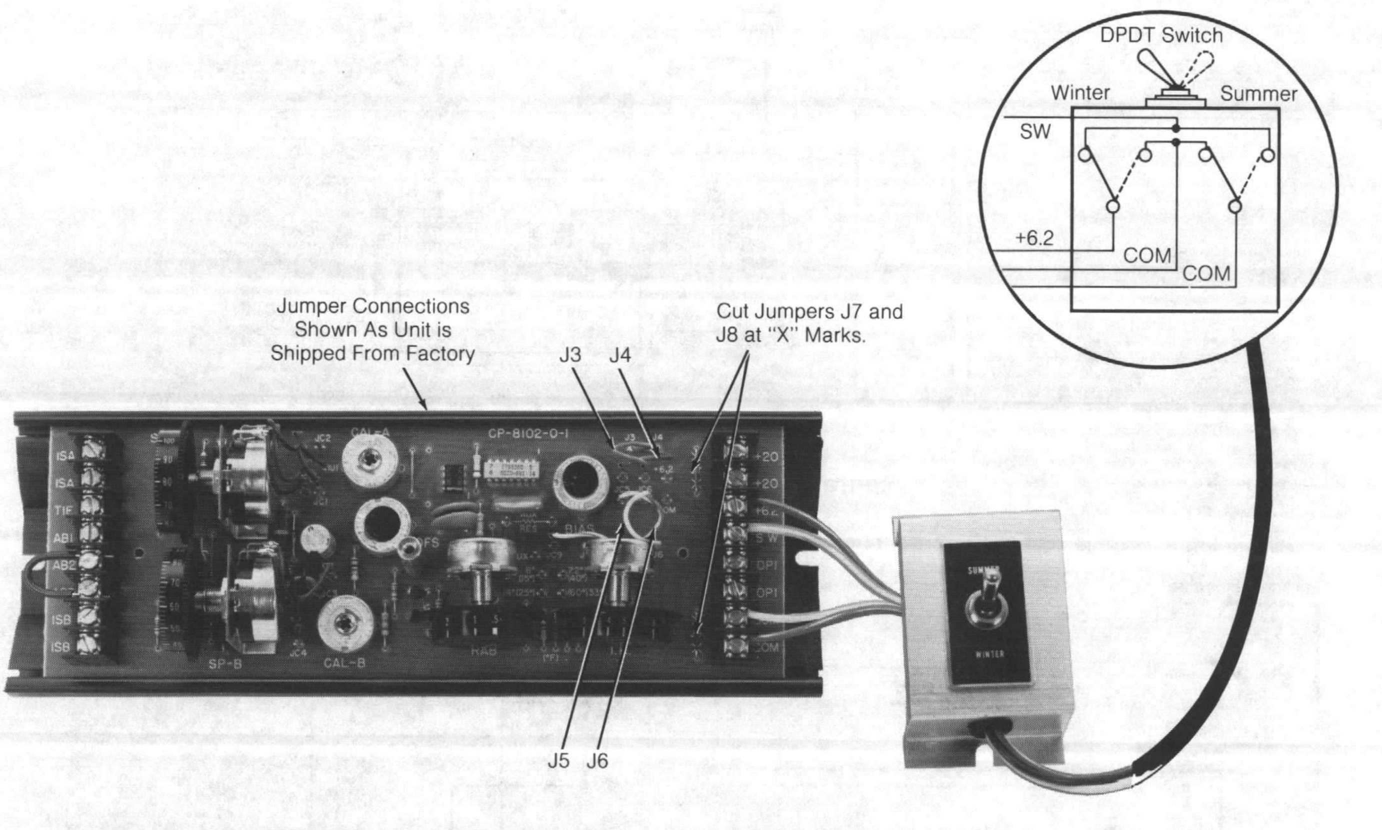


Figure 15. Single Unit Winter-Summer Switching

1. Cut both jumpers that are located between the terminal strip and cover on the left hand side of the device. (See Figure 15).
2. Connect D.P.D.T. Switch (CYZP-11 or equivalent) according to Figure 15.

NOTE

Switch contacts should have pilot duty ratings and maintain a 1 ohm or less contact rating over its normal life.

3. No recalibration of CP-8102 is required.

SINGLE UNIT SUMMER/WINTER SWITCHING (Continued):

Table 6. Bridge Connections for Summer/Winter (See Figure 15.)

BRIDGE "A" (MAIN SENSOR)		BRIDGE "B" (RESET SENSOR)		RESET OF SETPOINT "A"		JUMPER TO PIN CONNECTIONS			
Winter	Summer	Winter	Summer	Winter	Summer	J3	J4	J5	J6
D.A.	R.A.	D.A.		Reverse	Direct	JC5	JC6	COM	+6.2
R.A.	D.A.	D.A.		Direct	Reverse	JC6	JC5	COM	+6.2
D.A.	R.A.	R.A.		Direct	Reverse	JC5	JC6	+6.2	COM
R.A.	D.A.	R.A.		Reverse	Direct	JC6	JC5	+6.2	COM
D.A.		D.A.	R.A.	Reverse	Direct	COM	+6.2	JC5	JC6
R.A.		D.A.	R.A.	Direct	Reverse	+6.2	COM	JC5	JC6
D.A.		R.A.	D.A.	Direct	Reverse	COM	+6.2	JC6	JC5
R.A.		R.A.	D.A.	Reverse	Direct	+6.2	COM	JC6	JC5

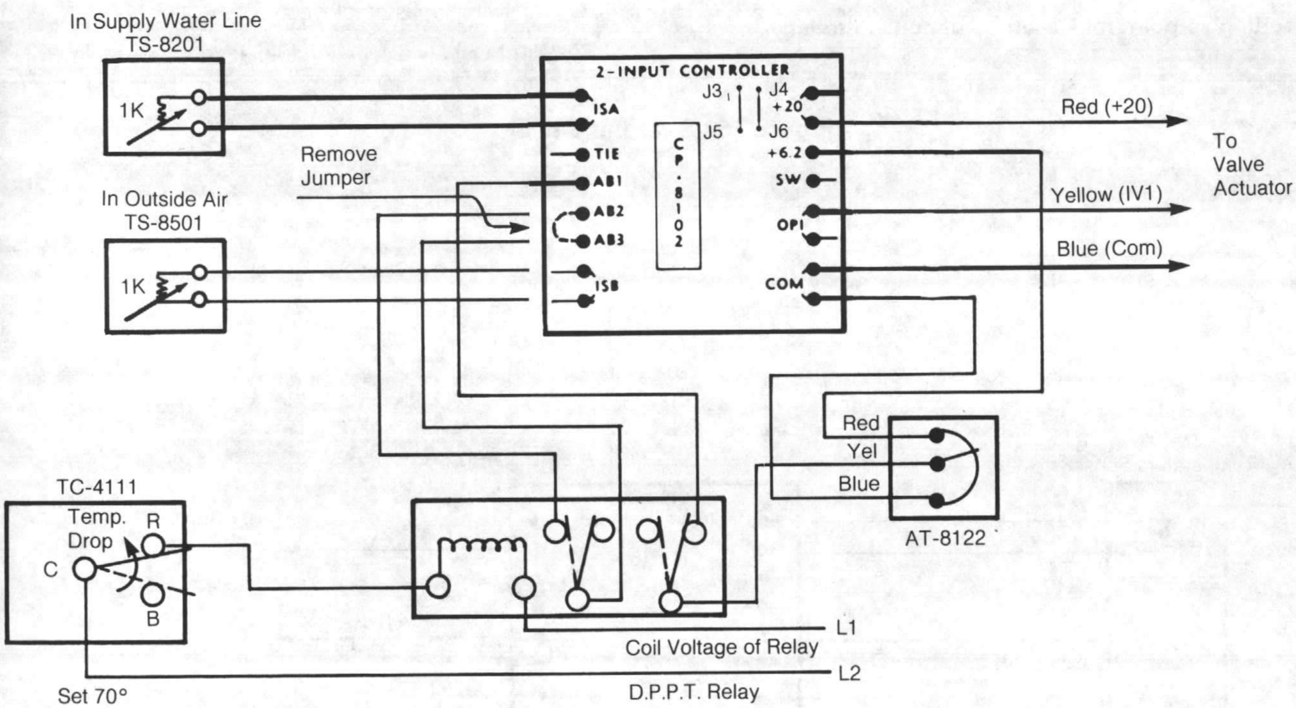


Table 7. Typical Reset Schedule

Outside Air Temp. (°F)	Water Temperature (°F)
70°	110°
0°	140°
Above 70°	85°

Outside air temperature reset of supply water temperature with fixed temperature of 85°F with outside air temperature of 70°F.

Setpoint "A": 110°F

Setpoint "B": 70°F

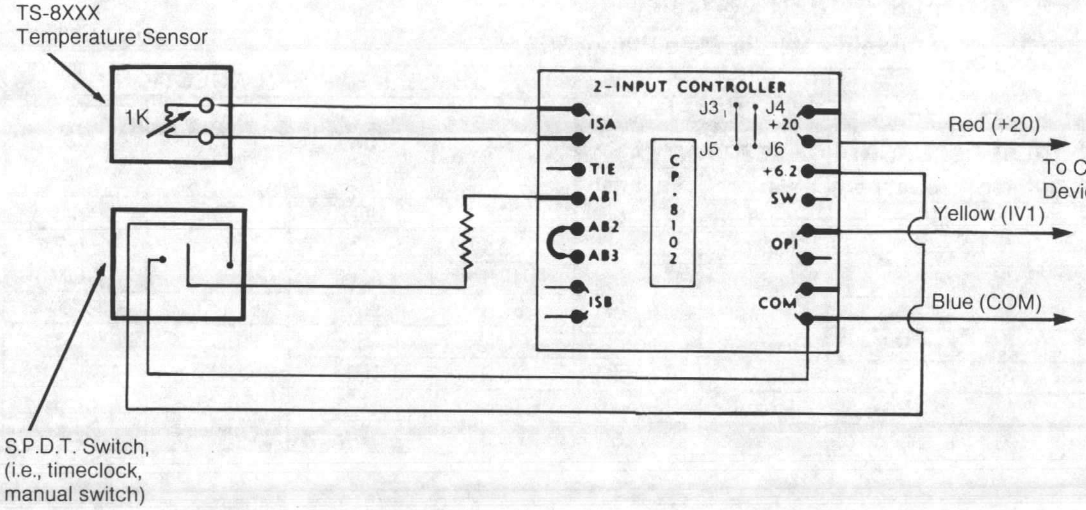
Ratio Adjustment: 2.33

Throttling Range: 10°F

AT-8122: Set 45°F for S.P. of 85 where O.A. is above 70°F.

Relay is energized with outside air temperature below 70°.

Figure 15. Outside Air Temperature Reset of Hot Water with Fixed Temperature with Outside Air Temperature Above Selected Value



Resistor (5, 10, 15, 20°F offset) use AD-8969-201 kit.

Offsetting setpoint for Direct Acting Controller:

Raise, connector resistor to +6.2 terminal.

Lower, connect resistor to COM terminal.

Offsetting setpoint for Reverse Acting Controller:

Raise, connect resistor to COM terminal.

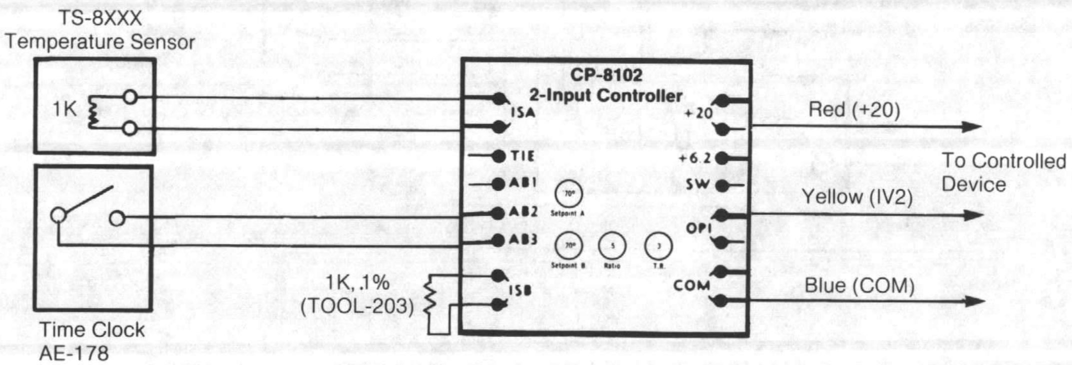
Lower, connect resistor to +6.2 terminal.

NOTE

Standard two conductor twisted wire should be used if remote switching is employed.

Resistor must always be located at stat.

Figure 16. Setpoint Offset

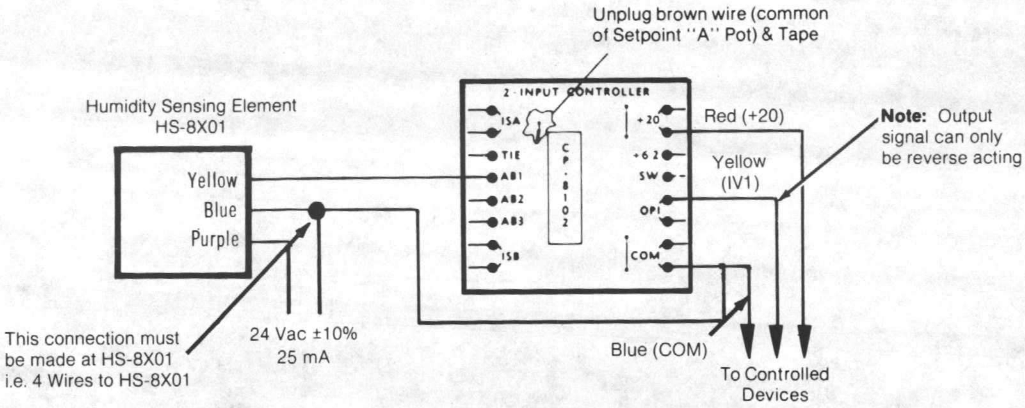


Install 1000 ohm 1% (TOOL-203) resistor in ISB. Install AE-178 7 day time clock. Set setpoint "B" as desired for night setback.

Table 8.

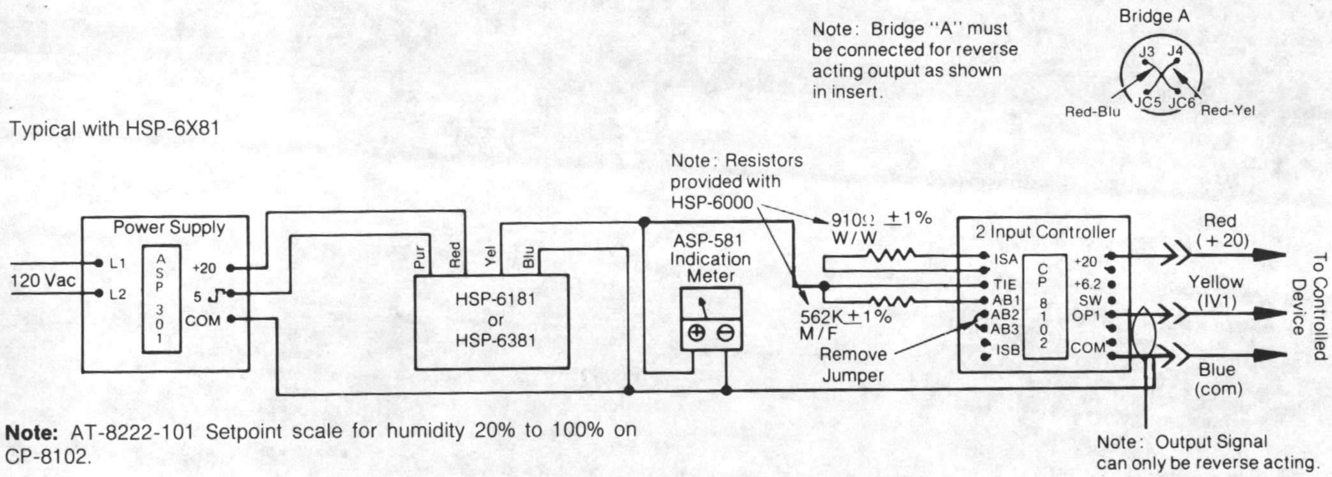
Setpoint "B"	Night Setback
70°F (21.1°C)	No Setback
65°F (18.3°C)	5°F (2.8°C) Setback
60°F (15.6°C)	10°F (5.6°C)Setback
55°F (12.8°C)	15°F (8.3°C) Setback

Figure 17. Night Setback



Note: Settings of 2-6 throttling range result in 2-6% RH throttling range for 3 Vdc output change. 6 TR is maximum setting.

Figure 18. Humidity Control



Note: AT-8222-101 Setpoint scale for humidity 20% to 100% on CP-8102.

Figure 19. Humidity Control & Indication

Barber-Colman Company
ENVIRONMENTAL CONTROLS DIVISION

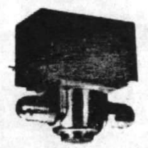
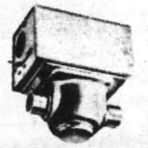
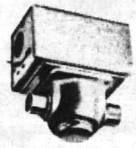
1354 Clifford Avenue
P.O. Box 2940
Loves Park, IL U.S.A. 61132-2940

VALVES ELECTRIC — ZONE, 2-WAY

V-7

VALVES

TO SELECT A VALVE BODY

APPLICATION			HOT OR CHILLED WATER		
Fitting			SAE FLARED	SWEAT	SWEAT
Complete Assembly					
Note: XXX (See Actuator Codes)			VA-1203-XXX-4-4	VA-1403-XXX-4-4	VA-1403-XXX-4-5
Size			5/8" O.D.	5/8" O.D.	7/8" O.D.
Flow Type			Two-Position	Two-Position	Two-Position
Material	Body		Brass	Brass	Brass
	Seat		Brass	Brass	Brass
	Stem		Stainless Steel	Stainless Steel	Stainless Steel
	Plug		E.P. Rubber	E.P. Rubber	E.P. Rubber
	Packing		"O" Ring	"O" Ring	"O" Ring
Flow Coefficient — Cv			3.5	3.5	3.5
Maximum Pressure (PSIG) °F (°C)					
Static			200	200	200
Close-Off			20	20	20
Ambient Rating °F (°C)					
Operating			40-200 (4-93)	40-200 (4-93)	40-200 (4-93)
Shipping			-40 to 200 (-40 to 93)	-40 to 200 (-40 to 93)	-40 to 200 (-40 to 93)
Maximum Water Temperature Without Auxiliary Switch		200 (90)	200 (93)	200 (93)	200 (93)
Maximum Water Temperature With Auxiliary Switch		200 (90)	125 (51)	125 (51)	125 (51)
		185 (85)	185 (85)	185 (85)	185 (85)

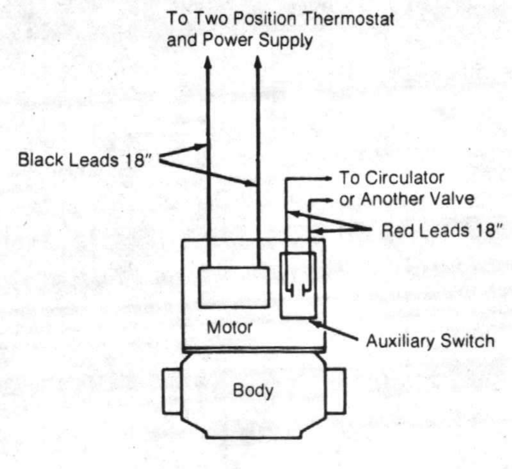
TO SELECT AN ACTUATOR CODE

ACTUATOR CODES

Input to Motor	Voltage 50/60 Hz	24	120	220-240
	Amp	.32	.07	.03
N.O.	Without Auxiliary Switch	301	311	321
	With Auxiliary Switch*	302	312	322
N.C. With Manual Opener	Without Auxiliary Switch	201	211	221
	With Auxiliary Switch*	202	212	222

Add actuator code to the assembly number for the complete part number. Example: To VA-1203-XXX-4-4 (5/8" flared) add 311 (for a 120 volt actuator without an auxiliary switch) to get VA-1203-311-4-4.

*SPST moisture sealed, makes at energized position. Rating: 5 amp running current at 120/240 Vac, 30 amp locked rotor at 120/240 Vac, 250 VA pilot duty rating.



CONTINUED ON NEXT PAGE

V-1

TABLE 2. Select **Actuator Type** or **Actuator Code (XXX)** series with correct Input Signal having sufficient close-off for the application. If selecting Component Parts, select **Valve Linkage.**

Normal Position	Factory Available Valve Assy	Valve Body	P Code	Size	Two Position SPST	2-15 Vdc System 8000	2-15 Vdc System 8000**
Input Signal					Two Position SPST	2-15 Vdc System 8000	2-15 Vdc System 8000**
Valve Linkage 1/2" — 1-1/4" Valve					AV-600	AV-600	—
Valve Linkage 1/2" — 2" Valve					—	—	AV-430
Valve Linkage 2-1/2" — 4" Valve					—	—	AV-495
Actuator Code (XXX)					2XX	2XX	35X
Actuator Code					MA-521X-XXX	MP-5X1X	MS-8XX1X-XXX
					CLOSE-OFF PRESSURE RATING*		
Normally Open	VA-9213-2XX-4-P	VB-9213-0-4-P	-1-2-3-4	1/2"	180	190	250
	VA-9253-2XX-4-P	VB-9253-0-4-P	-5-6	3/4"	75	85	250
	VA-9273-2XX-4-P	VB-9273-0-4-P	-7-8	1"	40	45	150
	VS-9213-XXX-4-P		-9	1-1/4"	25	30	90
	VS-9253-XXX-4-P		-10	1-1/2"			65
	VS-9273-XXX-4-P		-11	2"			35
Normally Open	VS-9213-35X-5-P	VB-9213-0-5-P	-12	2-1/2"			20
			-13	3"			12
			-14	4"			6
Normally Closed	VA-9223-2XX-4-P	VB-9223-0-4-P	-1-2-3-4	1/2"	250	220	250
	VA-9263-2XX-4-P	VB-9263-0-4-P	-5-6	3/4"	140	90	250
	VA-9283-2XX-4-P	VB-9283-0-4-P	-7-8	1"	75	50	150
	VS-9223-XXX-4-P		-9	1-1/4"	45	30	90
	VS-9263-XXX-4-P		-10	1-1/2"			65
	VS-9283-XXX-4-P		-11	2"			35
Normally Closed	VS-9223-35X-5-P	VB-9223-0-5-P	-12	2-1/2"			20
			-13	3"			12
			-14	4"			6

* Close-off pressure ratings apply when valves are installed with pressure under the seat.
** Certain models have built-in controller.

TABLE 3. Select exact **Actuator** or **Actuator Code (XXX)** if Factory Assembly is available.

Input Signal	Wiring Figure No.	Voltage Vac 50/60 Hz	VA	Aux. Switch	Actuator Part No.	Actuator Code (XXX) For Factory Available Assy
Two-position SPST	See Figure 1 on Page V65	24	18	No	MA-5213	201
		24		Yes	MA-5213-500	202
		120		No	MA-5210	211
		120		Yes	MA-5210-500	212
		208		No	MA-5212	
		208		Yes	MA-5212-500	
		240		No	MA-5211	221
		240		Yes	MA-5211-500	222
2-15 Vdc, System 8000, Stroke occurs 6-9 Vdc approx, Non-positive positioning	See Figure 1 on Page V68	24	18	No	MP-5213	201
		24		Yes	MP-5213-500	202
		120		No	MP-5210	211
		120		Yes	MP-5210-500	212
		208		No	MP-5212	
		208		Yes	MP-5212-500	
		240		No	MP-5211	221
		240		Yes	MP-5211-500	222
2-15 Vdc, System 8000, start 6 Vdc factory set, Adjustable 2-12 Vdc, 3 Vdc span, Positive positioning	See Figure 12 on Page V68	24	18	No	MP-5413	
		120		No	MP-5410	
		208		No	MP-5412	
		240		No	MP-5411	
	See Figure 12 on Page V68	24	36	No	MS-83013	351
		120	37	No	MS-83010	353
		120	37	Yes	MS-83010-500	
		240	39	No	MS-83011	
		240	39	Yes	MS-83011-500	
Built-in System 8000 controller, Uses TS-8XXX sensor	See Figure 19 on Page V72	120	37	No	MS-84110	354
		120	37	No	MS-84110-011*	
		120	37	Yes	MS-84110-500	
		24	36	No	MS-8413	

* Includes TS-8201-105 sensor.

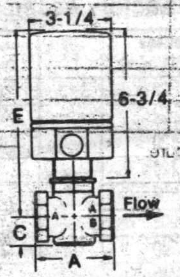
TABLE 4. Dimensions

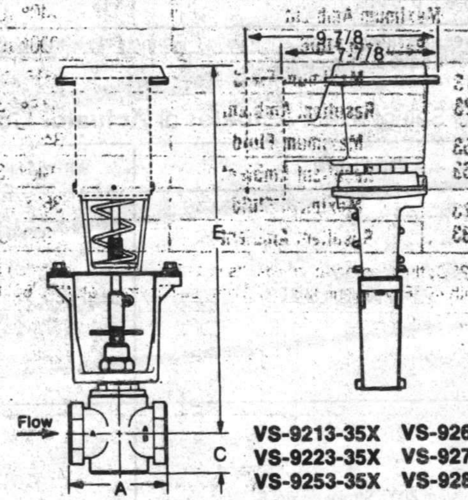
Part Number	DIMENSIONS (Inches) Valve Body: Size	A	B	C	Actuator Series 200: E	Actuator Series 350: E
VA-9213-2XX-4-P VA-9253-2XX-4-P VA-9273-2XX-4-P VS-9213-XXX-4-P VS-9253-XXX-4-P VS-9273-XXX-4-P	1/2"	3		1	8-3/16	17-1/2
	3/4"	3-5/8		1-3/8	8-11/16	18
	1"	4-5/8		1-1/2	9	18-3/8
	1-1/4"	4-5/8		1-5/8	9	18-3/8
	1-1/2"	6-1/8		2-1/2		19-1/8
	2"	6-1/8		2-1/2		19-1/8
VS-9213-35X-5-P	2-1/2"	8-1/2		3-1/2		19-13/16
	3"	9-1/2		3-3/4		20-3/16
	4"	11-1/2		4-1/2		21-7/16
VA-9223-2XX-4-P VA-9263-2XX-4-P VA-9283-2XX-4-P VS-9223-XXX-4-P VS-9263-XXX-4-P VS-9283-XXX-4-P	1/2"	3		1-7/16	8-3/16	17-5/16
	3/4"	3-5/8		1-3/4	8-11/16	17-5/8
	1"	4-5/8		2	9	17-7/8
	1-1/4"	4-5/8		2	9	17-7/8
	1-1/2"	6-1/8		3-3/16		18-5/8
	2"	6-1/8		3-3/16		18-5/8
VS-9223-35X-5-P	2-1/2"	8-1/2		4-1/8		19-7/16
	3"	9-1/2		4-1/8		19-13/16
	4"	11-1/2		5-1/16		20-7/16

Dimensions in Inches

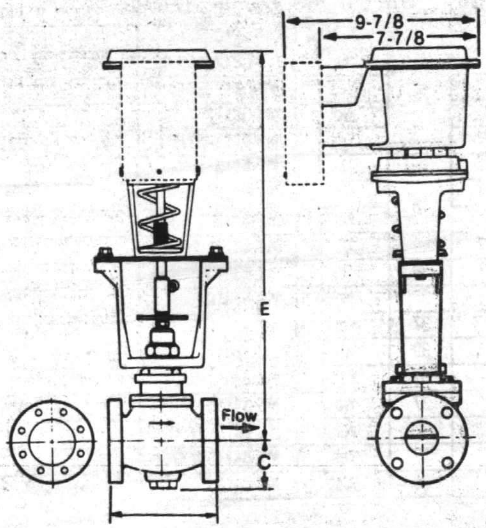
NOTE: Allow 3 inches clearance above actuator for removal.

VS-9213-2XX VA-9213-2XX
VS-9223-2XX VA-9223-2XX
VS-9253-2XX VA-9253-2XX
VS-9263-2XX VA-9263-2XX
VS-9273-2XX VA-9273-2XX
VS-9283-2XX VA-9283-2XX

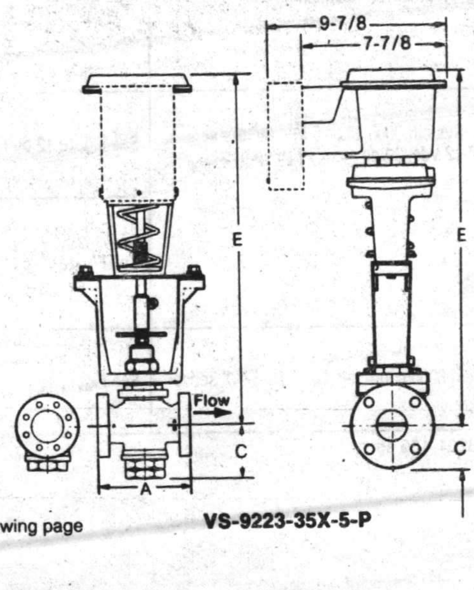




VS-9213-35X VS-9263-35X
VS-9223-35X VS-9273-35X
VS-9253-35X VS-9283-35X



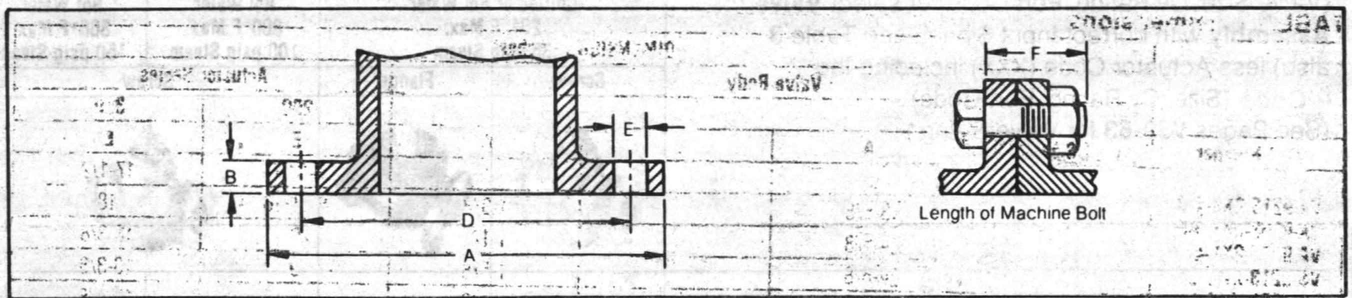
VS-9213-35X-5-P



VS-9223-35X-5-P

See Flange Detail Table on following page

American Standard 125 lb. Cast Iron Pipe Flanges



Flange Detail

Dimensions in Inches

Nominal Pipe Size	Flanges		Drilling		Bolting		Length of Machine Bolts
	Flange Diameter A	Flange Thickness B	Diameter of Bolt Circle D	Diameter of Bolt Holes E	Number of Bolts	Diameter of Bolts	F
2-1/2	7	11/16	5-1/2	3/4	4	5/8	2-1/2
3	7-1/2	3/4	6	3/4	4	5/8	2-1/2
4	9	15/16	7-1/2	3/4	8	5/8	3

TABLE 5. Fluid Temperature Versus Ambient Temperature

		TEMPERATURES °F (°C)			
Actuator Code (XXX)		20X, 21X, 22X			35X
Actuator		MA-521X-XXX	MP-521X-XXX	MP-541X*	MS-8XX1X-XXX
Maximum Ambient		140° (60°)		140° (60°)	140° (60°)
Resultant Fluid		200° (93°)		150° (65°)	281° (138°)
VB-9213 VB-9223	Maximum Fluid	281° (138°)		281° (138°)	281° (138°)
	Resultant Ambient	115° (46°)		60° (15°)	140° (60°)
VB-9253 VB-9263	Maximum Fluid	340° (171°)		—	340° (171°)
	Resultant Ambient	100° (38°)		—	122° (50°)
VB-9273 VB-9283	Maximum Fluid	366° (180°)		—	366° (180°)
	Resultant Ambient	90° (32°)		—	114° (35°)

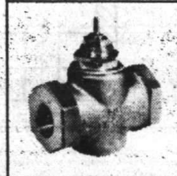
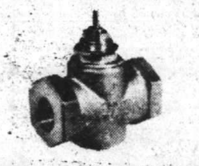
*180°F (82°C) fluid temperature results in 115°F (46°C) maximum ambient temperature.
NOTE: With 40°F water the minimum dew point temperature is 68°F.

VALVES

V-1

VALVES

TABLE 1. Select **Valve Body** including **P Code** (Valve Size, Cv Rating, Port Code) or select **Valve Assembly** with correct Input Signal (see Table 3 also) less Actuator Code (XXX) including the **P Code** (Size, Cv Rating, Port Code). (See Pages V59-63 for Valve Sizing.)

		APPLICATION			
		Chilled or Hot Water 281°F Max. 35 psig Steam		Hot Water 300°F Max. 100 psig Steam	Hot Water 366°F Max. 150 psig Steam
		Screw	Flange	Screw	
					
Size					
Normally Open Valves	Valve Body	VB-9213-0-4-P	VB-9213-0-5-P	VB-9253-0-4-P	VB-9273-0-4-P
	Valve Assembly 2-15 Vdc Input, System 8000	VS-9213-XXX-4-P	VS-9213-35X-5-P	VS-9253-XXX-4-P	VS-9273-XXX-4-P
	Valve Assembly, Built-In System 8000 Controller	VS-9213-35X-4-P	VS-9213-35X-5-P	VS-9253-35X-4-P	VS-9273-35X-4-P
	2-Position SPST Valve Assembly	VA-9213-2XX-4-P		VA-9253-2XX-4-P	VA-9273-2XX-4-P
Normally Closed Valves	Valve Body	VB-9223-0-4-P	VB-9223-0-5-P	VB-9263-0-4-P	VB-9283-0-4-P
	Valve Assembly 2-15 Vdc Input, System 8000	VS-9223-XXX-4-P	VS-9223-35X-5-P	VS-9263-XXX-4-P	VS-9283-XXX-4-P
	Valve Assembly, Built-In System 8000 Controller	VS-9223-35X-4-P	VS-9223-35X-5-P	VS-9263-35X-4-P	VS-9283-35X-4-P
	2-Position SPST Valve Assembly	VA-9223-2XX-4-P		VA-9263-2XX-4-P	VA-9273-2XX-4-P
Flow Type		Equal %	Equal %	Equal %	Equal %
Material	Body	Bronze	Cast Iron	Bronze	Bronze
	Seat	Bronze	Bronze	Stainless Steel	Stainless Steel
	Stem	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
	Plug	Brass	Brass	Stainless Steel	Stainless Steel
	Packing	Spring Loaded Teflon "V" Rings	Spring Loaded Teflon "V" Rings	Spring Loaded Teflon "V" Rings	Spring Loaded Teflon "V" Rings
	Disc	Composition	Composition	Teflon	None
STEAM					
Pressure (psig)	Static	250	125	250	250
	Inlet	35	35	100	150
	Recom. Diff.*	20	20	35	50
Fluid Temp. °F (°C)	Max.	281° (138°)	281° (138°)	340° (171°)	366° (180°)
WATER					
Pressure (psig)	Static	250	125	250	250
	Recom. Diff.*	35	35	35	50
Fluid Temp. °F (°C)	Min.	40° (4°)	40° (4°)	40° (4°)	40° (4°)
	Max.	281° (138°)	281° (138°)	300° (149°)	366° (180°)

NOTE: These charts are color coded as shown below to assist valve selection. Note it is possible to select either a valve assembly or component parts (actuator, valve linkage, valve body).

ORDERING EXAMPLES:

1. **Valve Assembly** **VS-9223-212-4-8**
2. **Valve Body** **VB-9223-0-4-8**
   Actuator **MP-5210-500**
   Linkage **AV-600**

■ **Valve Body** Data less P Code (Size, Cv Rating, Port Code) or **Valve Assembly** less Actuator Code (XXX) and less P Code (Size, Cv Rating, Port Code)

■ **P Code** (Size, Cv Rating, Port Code)

■ **Actuator** or **Actuator Code (XXX)** for Valve Assemblies

■ **Valve Linkage**

TO SELECT A PORT CODE (P)

P Code	Valve Size	Cv			
-1**	1/2"	.4		.4	.4
-2**		1.3		1.3	1.3
-3**		2.2		2.2	2.2
-4		3.6		3.6	3.6
-5**	3/4"	5.0		5.0	5.0
-6		6.2		6.2	6.2
-7**	1"	8.2		8.2	8.2
-8		11.0		11.0	11.0
-9	1-1/4"	16.0		16.0	16.0
-10	1-1/2"	25.0		25.0	25.0
-11	2"	40.0		40.0	40.0
-12	2-1/2"		56		
-13	3"		85		
-14	4"		145		

*Maximum recommended differential pressure in full open position. Do not exceed recommended differential pressure (pressure drop) or integrity of parts may be affected.
NOTE: Do not exceed close-off rating.
**NOTE: Factory assemblies are not available for 2-position applications using reduced port valve bodies.