DIRECT GAS FIRED INDUSTRIAL AIR HEATER

TECHNICAL MANUAL

C390, C600, C900, C1200, C1900 & C2500

WARNING

IMPROPER INSTALLATION, ADJUSTMENT, ALTERATION, SERVICE OR MAINTENANCE CAN CAUSE PROPERTY DAMAGE, INJURY OR DEATH. READ THE INSTALLATION, OPERATING, AND MAINTENANCE INSTRUCTIONS THOROUGHLY BEFORE INSTALLING OR SERVICING THIS EQUIPMENT.

FOR YOUR SAFETY

THE USE AND STORAGE OF GASOLINE OR OTHER FLAMMABLE VAPORS AND LIQUIDS IN OPEN CONTAINERS IN THE VICINITY OF THIS APPLIANCE IS HAZARDOUS.

DESIGN CERTIFIED AMERICAN GAS ASSOCIATION

FOR YOUR SAFETY

IF YOU SMELL GAS:

1. OPEN WINDOWS.
2. DON'T TOUCH ELECTRICAL SWITCHES.
3. EXTINGUISH ANY OPEN FLAME.
4. IMMEDIATELY CALL YOUR GAS SUPPLIER.

FM

For Models With FM Suffix

CAMBRIDGE® ENGINEERING INC

March 1995

LIMITED WARRANTY

Cambridge Engineering, Inc., hear after referred to as Cambridge, warrants all C-Series products manufactured by Cambridge, including all components and sub components thereof, to be free from defects in material and workmanship for a period of twenty-four (24) months from the date of shipment, with the exception of the burner assembly which is warranted for five (5) years, provided the product is properly installed and operated under normal conditions in accordance with Cambridge's Technical Manual and any other applicable instructions and in conformance with national and local codes.

MISUSE OR MISAPPLICATION OF THE PRODUCT FROM ITS ORIGINAL DESIGN OR SPECIFICATIONS, OR CHANGES IN ORIGINAL SPECIFICATIONS OR OPERATING CONDITIONS, WITHOUT WRITTEN PERMISSION FROM CAMBRIDGE SHALL VOID THIS WARRANTY.

Cambridge's obligation hereunder shall be limited to the repair, or at its option, replacement of defective parts. The defective parts shall be returned to the Cambridge factory, tagged with original Shop Order reference and Serial Number of heater. Shipping charges should be prepaid. Replacement parts provided shall not extend this warranty for the part(s) or product(s). Cambridge shall have no responsibility under this warranty unless and until the product has been paid for in full, according to terms of sales contract, and then Cambridge's liability shall be limited to the cost of repair, but in no case in excess of the original purchase price of the defective product.

This warranty does <u>not</u> apply to field labor charges. Further, this warranty does not apply to products which have been abused, improperly operated, improperly maintained (as with belts and bearings), subjected to abnormal wear and tear, damaged as a result of improper gas or electric service, or damaged in transit, or by misuse, neglect or accident, or to products which have been repaired or modified without authorization from Cambridge. Cambridge does not warrant products manufactured by others. Any claims with regard to such products must be directed to the original manufacturer.

THE WARRANTIES HEREIN ARE MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, EXCEPT AS SET FORTH IN THE ABOVE WARRANTY. CAMBRIDGE SHALL HAVE NO LIABILITY TO CUSTOMERS/OWNERS/USERS FOR DIRECT, CONSEQUENTIAL, OR INCIDENTAL DAMAGE OF ANY KIND WHAT SO EVER INCLUDING WITHOUT LIMITATION, PERSONAL INJURY, PROPERTY DAMAGE, LOST PROFIT, OR OTHER ECONOMIC INJURY DUE TO ANY DEFECT OR UNAUTHORIZED MODIFICATION OF THE PRODUCT, ANY USE OR INABILITY TO USE THE PRODUCTS OR ANY OTHER BREACH BY CAMBRIDGE. CAMBRIDGE SHALL HAVE NO LIABILITY TO CUSTOMERS/OWNERS/USERS FOR ANY PRODUCT LIABILITY CONCERNING THE PRODUCTS TO INSTALL ANY SAFETY DEVICES WITH RESPECT TO THE PRODUCTS. SOME STATES DO NOT ALLOW A LIMITATION ON HOW LONG AN IMPLIED WARRANTY LASTS OR AN EXCLUSION OF CONSEQUENTIAL DAMAGE. SO THE ABOVE LIMITATION AND EXCLUSION MAY NOT APPLY. THIS WARRANTY GIVES SPECIFIED LEGAL RIGHTS, AND THERE MAY BE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

Cambridge Engineering, Inc.
P.O. Box 1010
Chesterfield, MO 63006

Effective 3/95

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HAZARD SUMMARY

The following safety precautions apply to the installation, operation, and maintenance of the equipment described by this technical manual.

WARNING
ANY UNAUTHORIZED MODIFICATION OF THIS EQUIPMENT SHALL VOID WARRANTY

Only qualified personnel should attempt installation, service, and repair of this equipment. Use extreme caution and observe safety regulations at all times.

Recirculation of room air may be hazardous in the presence of:

- Flammable solids, liquids and gases
- Explosive materials (i.e. grain dust, coal dust, gun powder, etc.)
- Substances which may become toxic when exposed to heat (i.e., refrigerants, aerosols, etc).

WARNING
Recirculation of room air is not recommended in uninsulated buildings where outside temperatures fall below 32°F.

WARNING
Recirculation of room air requires that outside ventilation air be provided to supply 4 CFM per 1000 Btu per Hour of rated input or 60% of the rated air throughput of the heater, whichever is greater. If the ventilation air is not incorporated as part of this heater, a separate mechanical means shall be provided and it shall be interlocked with the operation of this heater and sized to provide the required ventilation airflow.

The design of the installation shall include adequate provision to permit *direct gas-fired* industrial air heaters to operate at rated capacity by taking into account the structure's designed infiltration rate, providing properly designed relief openings or an interlocked power exhaust system, or a combination of these methods.

Installation in Aircraft Hangars

Refer to the Standard for Aircraft Hangars, ANSI/NFPA 409, for specific information on the installation requirements for these heaters in airplane hangars.

Installation in Parking Garages

Refer to the Standard for Parking Structures, ANSI/NFPA 88A, or the Standard for Repair Garages, ANSI/NFPA 88B, for specific information on the installation requirements for these heaters in public garages.

NOTE

If in doubt regarding installation application, contact Cambridge Customer Service Group at 1-800-473-4569 during the hours of 8:00 A.M. to 5:00 P.M. Central Time Monday through Friday.

TYPICAL SYSTEM DESCRIPTION

SPACE HEATING:

These heaters may be utilized to meet the space heating requirements of commercial or industrial buildings. The control system is usually designed to cycle the heaters ON and OFF in response to the rise and fall of the space temperature. The heater will discharge heated air at the temperature selected (up to 160°F). The operating thermostat is normally located near the perimeter of the building in a location which is out of the direct path of the heated discharge air, insulated from cold surfaces, and shielded from cold drafts created by air infiltrating the building.

MAKE-UP AIR:

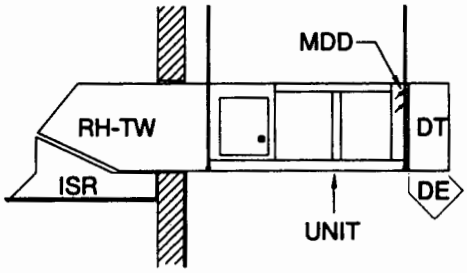
These heaters may be utilized to provide fresh air ventilation to a facility, provide tempered air to replace the air that is mechanically exhausted, or to address cold drafts from natural infiltration created by loose construction and/or stack effect of the building design. Heater operation is typically electrically interlocked with the mechanical exhaust fans, manually operated switches, programmable timers, or other process control systems by supplying a set of dry contacts to energize the heaters on a continuous basis. The discharge temperature on heaters with fixed discharge temperature controls is typically set 10 to 20°F above the desired space temperature. An entering air thermostat (**EAT**) is an optional control that is normally recommended for these applications to act as an economizer control by discontinuing burner operation during mild weather to further enhance the system efficiency.

COMBINATION MAKE-UP AIR AND SPACE HEATING:

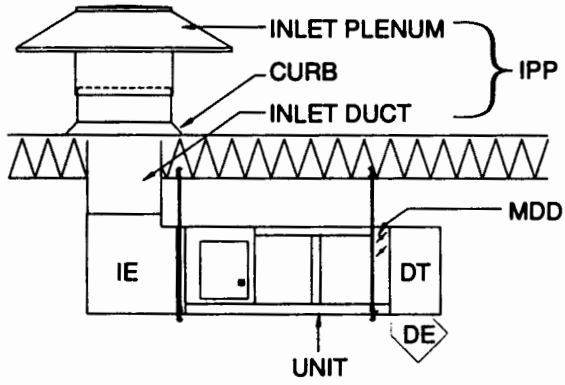
These heaters may be utilized to provide both the space heating and the make-up air requirements of a facility. Heater operation is normally continuous as described above for the make-up air application, although it can also be designed for the unit to cycle with the operating thermostat option when make-up air is not required or during unoccupied periods. The temperature control system for these heaters is normally specified as the electric discharge with space temperature modulation (**EDSM**) option. The space thermostat causes the discharge temperature to modulate in response to the space temperature. The **EAT** option is also normally recommended for these applications.

ACCESSORY IDENTIFICATION

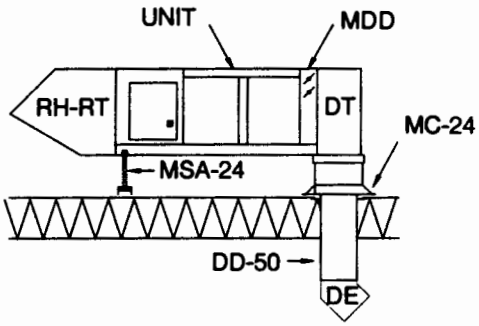
Thru Wall (TW) Mounting Option



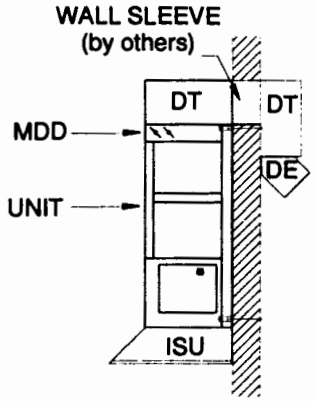
Under Roof Mounting Option



Roof Top (RT) Mounting Option



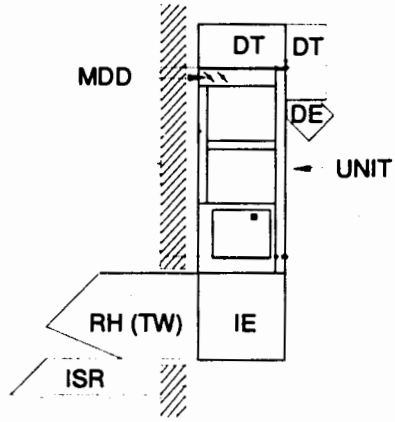
Outdoor Vertical Mounting Option



Component Identification:

MDD	Motorized Discharge Damper
RH-TW	Rain Hood - Thru Wall (Indoor Vertical only)
RH-RT	Rain Hood - Roof Top
DT	Downturn
DE	Directional Elbows
ISU	Inlet Skirt - Unit (Outdoor Vertical only)
MSA-24	Mounting Stand Assembly - 24" (Roof Top only)
MC-24	Mounting Curb - 24" (Roof Top only)
DD-50	Discharge Duct - 50" (Roof Top only)
IPP	Inlet Plenum Package (Under Roof only)
IE	Inlet Elbow
ISR	Inlet Skirt - Rain Hood (Thru Wall only)

Indoor Vertical Mounting Option



UNCRATING INSTRUCTIONS

A. Verify number of items on the Bill of Lading versus the number of items received.

B. Remove items from shipping cartons and check for damage. **If damage is found, immediately file a claim with carrier before proceeding any further.**

C. Check items received to make sure they agree with ordering information including verification of data on the unit nameplate.

NOTE: Do not discard any components or accessories.

GENERAL INSTALLATION INSTRUCTIONS

LOCATION AND MOUNTING HEIGHT:

On space heating applications, the mounting height of the specific equipment can significantly affect the performance of that equipment and the overall efficiency of the heating system. For this reason, it is extremely important that the installer comply with the instructions and or installation drawings provided. However, before proceeding with the installation, verify the feasibility of the location selected with respect to **accessibility** to the equipment for **service** and **maintenance** functions. Ensure the positioning of the heating equipment does not inhibit fork truck operation or storage rack locations. Ensure the heater inlet and outlet are not blocked or severely restricted, such that, it would affect the rated airflow through the heater or affect the desired air distribution pattern of the heater. If upon review of the proposed installation, a problem is discovered which may be considered detrimental to the performance of the equipment or restricts the service activity that may need to be performed or deviates from the instructions or drawings provided, it is the responsibility of the installer to communicate that information to the person responsible for providing the installation instructions or drawings, prior to proceeding with the installation.

NOTE: Where the mounting height of the heater is required to be above 20 feet, work platforms or service lifts should be provided for accessibility to the equipment for service and maintenance activities.

WALL OPENING:

Model	Wall Opening Inlet	Wall Opening Discharge (with Downturn)	Wall Opening Discharge (w/o Downturn)
C390/C600	25" H x 24½" W	12" H x 23" W	12" H x 23" W
C900/C1200	28" H x 41" W	14" H x 40" W	14" H x 40" W
C1900/C2500	38" H x 46½" W	23" H x 45½" W	19" H x 46" W

Use the **Inlet** wall opening dimensions for **indoor** horizontal or vertical thru-wall applications. Use the **Discharge** (w/o Downturn) wall opening dimensions for **outdoor** horizontal applications and the **Discharge** (with Downturn) wall opening dimensions for **outdoor** vertical thru-wall applications. Note: Directional Elbows do not interface directly to the outlet opening of the discharge duct for C1900/C2500 heaters without downturns. A downturn (optional) is normally supplied for mounting inside the facility for this application.

ROOF OPENING:

Model	Roof Opening Inlet (Under Roof Mounting)	Roof Opening Discharge (Roof Top Mounting)
C390/C600	27" L x 27" W	14½" L x 26½" W
C900/C1200	32" L x 43" W	16½" L x 43½" W
C1900/C2500	39" L x 49" W	26" L x 48" W

Use the **Inlet** roof opening dimensions for **indoor under roof** applications when used in conjunction with the Inlet Plenum Package option. Use the **Discharge** roof opening dimensions for **Roof Top** applications when used in conjunction with the downturn curb option.

HEATER WEIGHT/SUPPORT REQUIREMENTS:

The approximate weight of a heater including the standard accessories normally supplied with the heater (Downturn, Directional Elbows, Rain Hood or Inlet Elbow) is shown in the table below. Also shown is the size and number of threaded rods required to support suspended heaters.

	Weight	Qnty & Size Threaded Rod	
C390/C600	450#	(4)	⅜" dia.
C900/C1200	700#	(4)	⅜" dia.
C1900/C2500	1400#	(4)	½" dia.

A stabilizer bar may be required to secure the suspended heater from movement created during heater start-up and shutdown. No heater movement is permitted because of concern for the connecting gas line.

THRU-WALL INSTALLATION INSTRUCTIONS:

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions. Verify all heater access panels and the electrical enclosure are free from obstructions and can open fully.

A. Prepare wall penetration to the dimensions noted on page 7.

B. Connect inlet accessories to unit including filter section (optional) and rain hood prior to lifting the heater in place. Note that the inlet skirt for rain hood (ISR) (optional) is installed from the outside of the building. Refer to figures on page 9 and 18 for addition details of typical thru-wall installations.

C. Install hanging rods to adequate ceiling supports and align with hanging brackets on unit. Refer to hanging rod size shown on page 7. Make note of the distance from the back of the heater to the exterior wall surface such that the weep holes provided in the rain hood are located between 3 and 6 inches beyond the outside wall surface.

D. Remove the lag bolts used to fasten the unit to the skid. Do not remove the hanging brackets from the side of heater. On C390 and C600 model heaters, rotate the mounting brackets 180° to invert "L" and retighten securing hardware.

E. Use forklift or comparable lifting device to raise and position equipment. Take precautions to prevent equipment damage (dents and/or scratches) when the heater assembly is lifted into position.

F. Apply washer and double lock nuts to secure equipment on hanging rods. Note: Discharge end of the heater should be raised slightly (1/8" above level) to slope rain hood so any ingested moisture will run away from building.

G. Apply shims at bottom of rain hood to take up slack in opening leaving a small joint between top of the heater and wall.

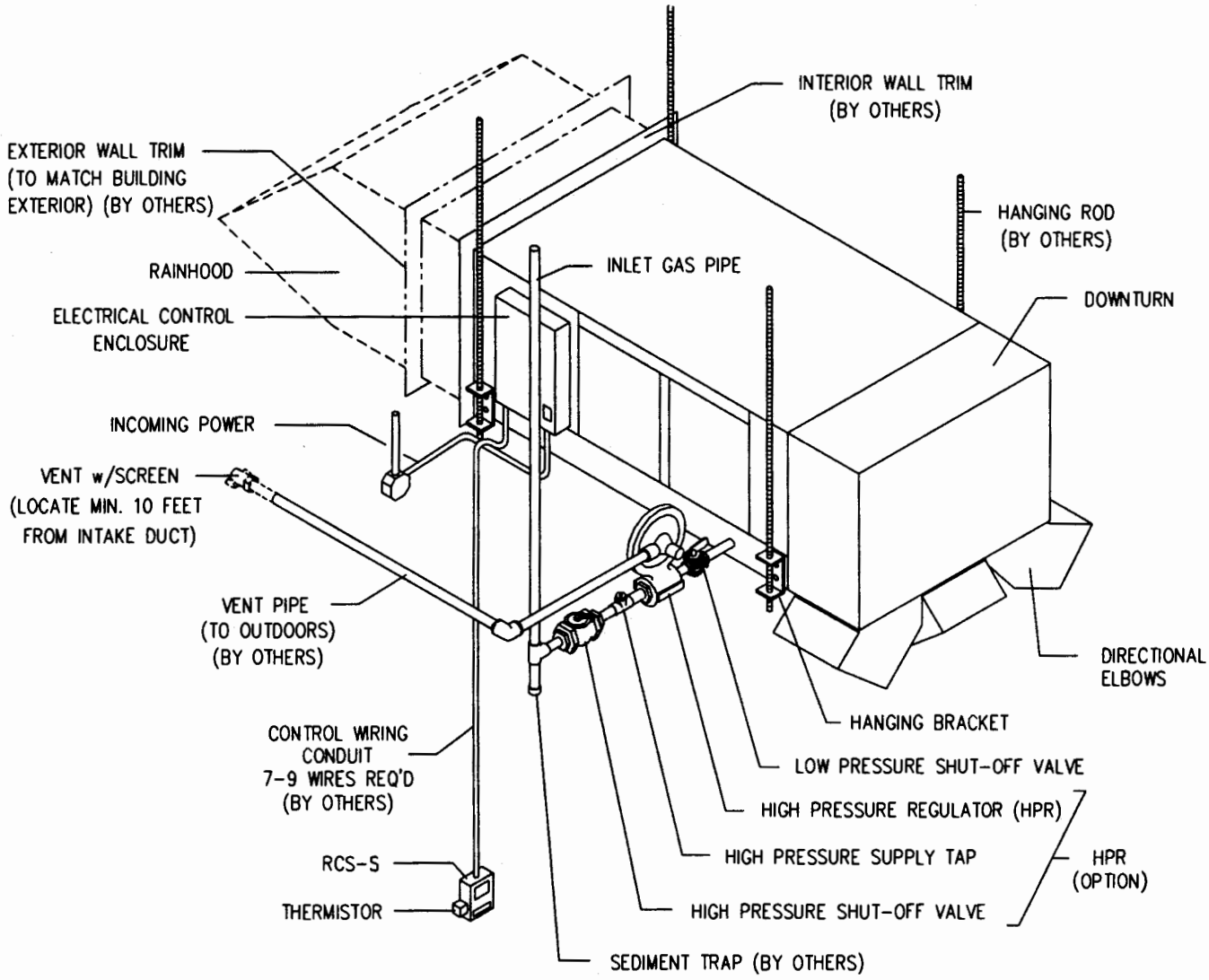
H. Install fiberglass insulation in gaps around wall opening and rain hood. Apply enough material to accommodate full thickness of wall.

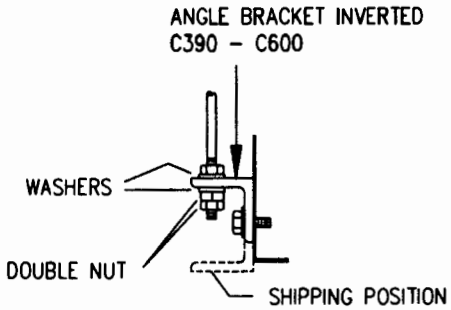
I. Install finish trim pieces (by others) to top, sides and bottom of the rain hood on both the inside and outside wall surfaces.

J. Apply bead of latex base polyurethane caulk that best matches the color of the exterior wall surface of the facility and/or the color of the heater accessories at joint between top of rain hood and outside wall surface. Make certain this is a continuous bead and that it runs the entire width of hood. Caulk all other exposed joints.

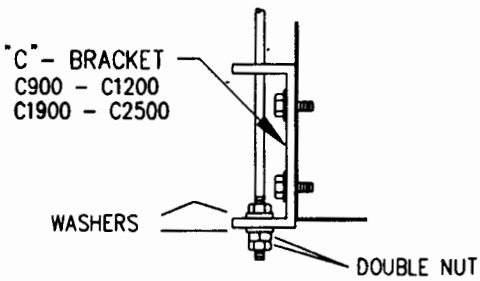
K. Install directional elbows on downturn. Consult job layout for direction of elbows.

TYPICAL THRU-WALL INSTALLATION:





(ROD, NUTS & WASHERS BY CONTRACTOR)



(ROD, NUTS & WASHERS BY CONTRACTOR)

UNDER ROOF INSTALLATION INSTRUCTIONS:

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions. Verify all heater access panels and the electrical enclosure are free from obstructions and can open fully.

NOTE:
Accurate measurements are critical and will affect installation process.

A. Prepare ceiling penetration to the dimensions noted on page 7.

B. Install the roof curb in accordance with roof manufacturer's recommendations. On built up roofing, use treated lumber that matches roof insulation thickness to properly spread the load on the roof deck. Ensure the curb is level. Shims may be required to accomplish this requirement. Refer to figures on page 11 for addition details of typical under roof installations.

C. From the roof, insert the inlet duct into curb and lower the duct assembly into the building until the flanges on the duct rest on the curb nailer.

D. Set the inlet plenum on top of the curb and secure the sides of the inlet plenum to the curb using hardware (1½ to 2" long screws or lag bolts into wood nailer) provided by the installing contractor.

E. Connect inlet accessories to unit including filter section (optional) and inlet elbow prior to lifting the heater in place.

F. Install hanging rods to adequate ceiling supports and align with hanging brackets on unit. Refer to hanging rod size shown on page 7.

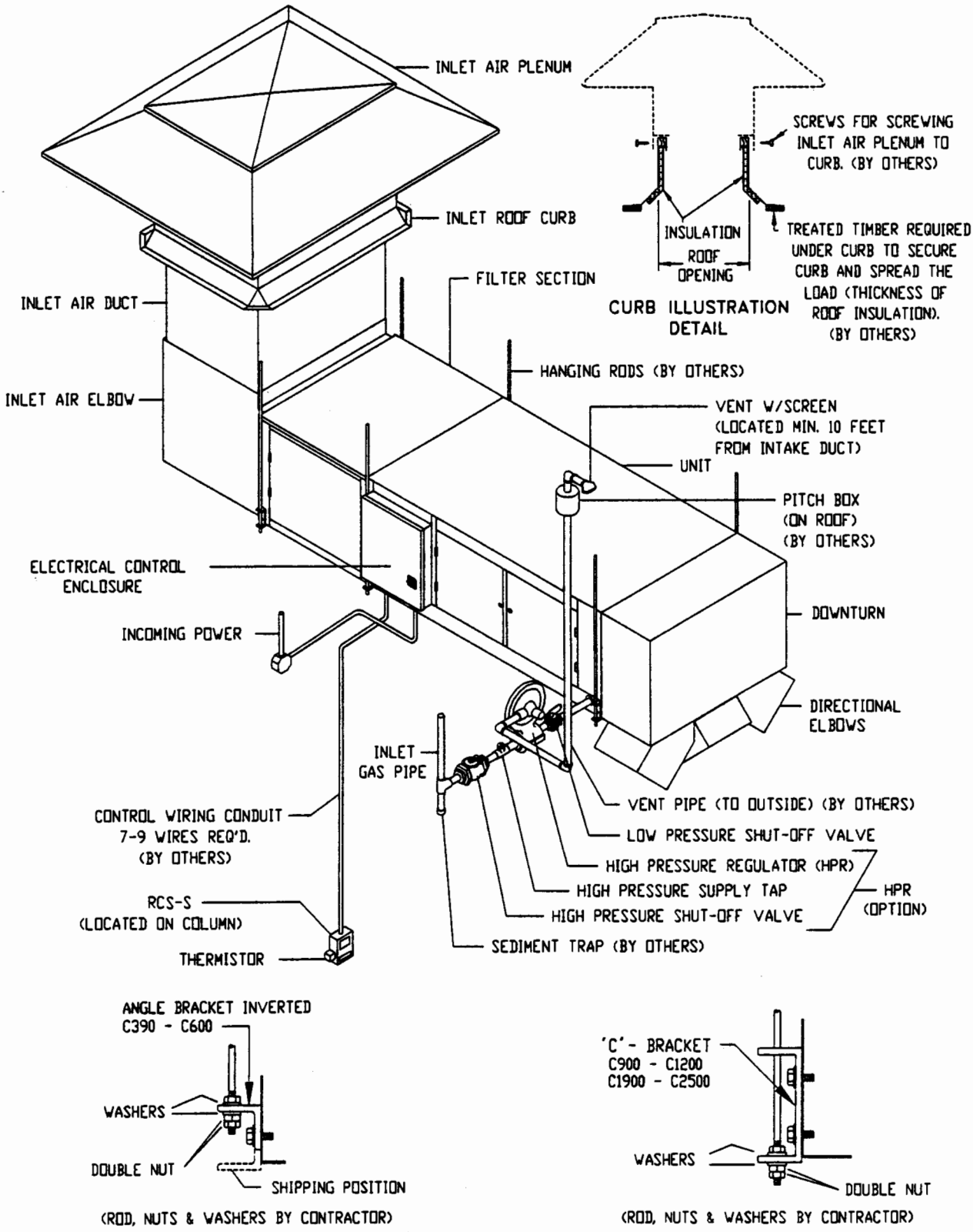
G. Remove the lag bolts used to fasten the unit to the skid. Do not remove the hanging brackets from the side of heater. On C390 and C600 model heaters, rotate the mounting brackets 180° to invert "L" and retighten securing hardware.

H. Use forklift or comparable lifting device to raise and position equipment. Take precautions to prevent equipment damage (dents and/or scratches) when the heater assembly is lifted into position.

I. Apply washer and double lock nuts to secure equipment on hanging rods. Note: Discharge end of the heater should be raised slightly (1/8" above level).

J. Install directional elbows on downturn. Consult job layout for direction of elbows.

TYPICAL UNDER ROOF INSTALLATION:



VERTICAL INDOOR INSTALLATION INSTRUCTIONS:

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions. Verify all heater access panels and the electrical enclosure are free from obstructions and can open fully.

A. Prepare wall penetration to the dimensions noted on page 7.

B. Connect inlet accessories to heater including filter section (optional), inlet elbow and rain hood prior to standing the heater upright. Note that the inlet skirt for rain hood (ISR) (optional) is installed from the outside of the building. Refer to figures on page 13 and 18 for additional details of typical vertical indoor installations.

C. Install hanging rods to adequate ceiling and/or wall supports and align with hanging brackets on heater. Refer to hanging rod size shown on page 7. Note the distance from the back of the heater to the exterior wall surface, such that, the weep holes provided in the rain hood are located between 3 and 6 inches beyond the outside wall surface.

D. Remove the lag bolts used to fasten the unit to the skid. Rotate the hanging brackets for the vertical application and retighten securing hardware.

E. Utilizing the lifting brackets on the front of the heater, use a forklift or comparable lifting device to raise equipment upright. Take precautions to prevent equipment damage.

F. Relocate the connection point of the slings to the lifting brackets which are located on the bottom of the heater. Ensure the heater is stabilized properly. Use a forklift or comparable lifting device to raise and position the equipment.

G. Apply washer and double lock nuts to secure equipment on hanging rods. Note: The rain hood should be sloped slightly (1/8" off level) so ingested moisture will run away from building.

H. Apply shims at bottom of rain hood to take up slack in opening leaving a small joint between top of the heater and wall.

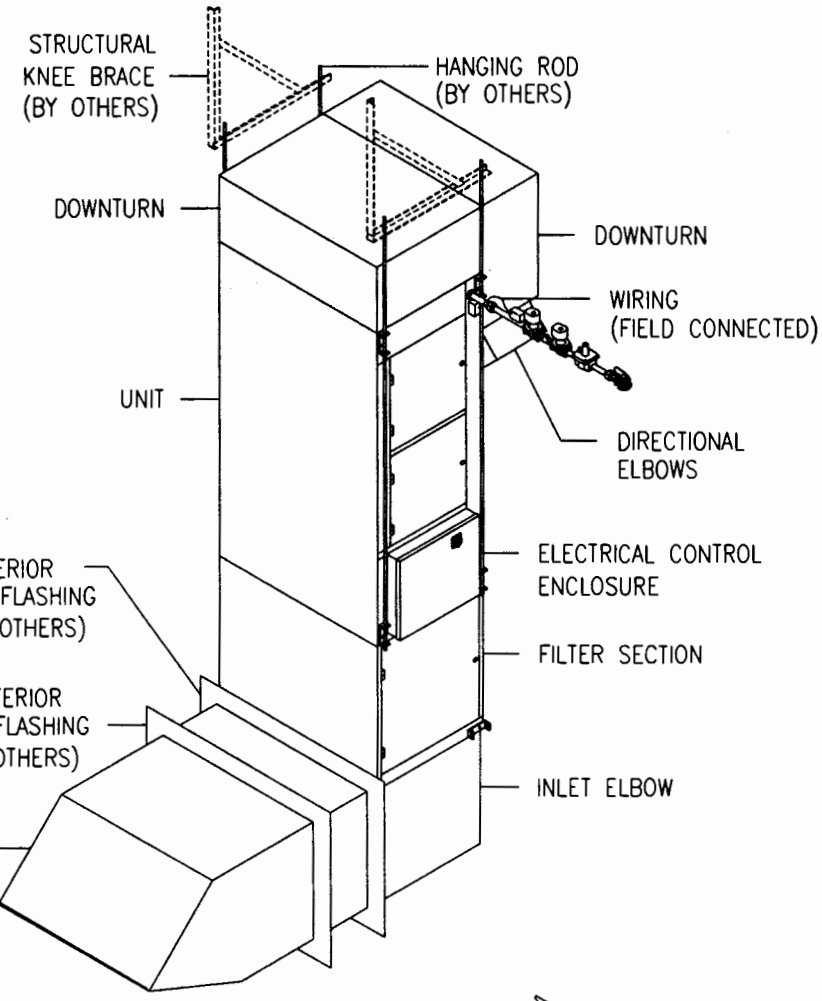
I. Install fiberglass insulation in gaps around wall opening and rain hood. Apply enough material to accommodate full thickness of wall.

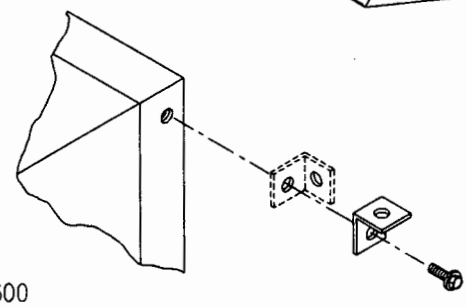
J. Install finish trim pieces (by others) to top, sides and bottom of the rain hood on both the inside and outside wall surfaces.

K. Apply bead of latex base polyurethane caulk that best matches the color of the exterior wall surface of the facility and/or the color of the heater accessories at joint between top of rain hood and outside wall surface. Make certain this is a continuous bead and that it runs the entire width of hood. Caulk all other exposed joints.

L. Install second downturn (optional) and/or directional elbows on downturn. Consult job layout for direction of elbows.

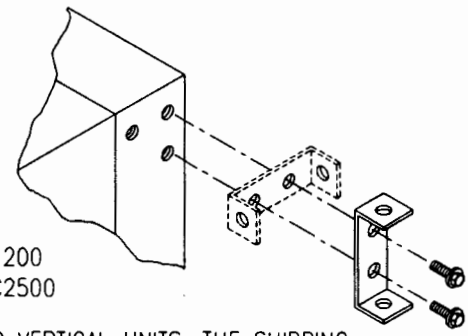
TYPICAL VERTICAL INDOOR INSTALLATION:





C390 – C600

NOTE: FOR VERTICAL UNITS, THE SHIPPING BRACKET MUST BE ROTATED 90° AS SHOWN.



C900 – C1200
C1900 – C2500

NOTE: FOR VERTICAL UNITS, THE SHIPPING BRACKET MUST BE ROTATED 90° AS SHOWN.

Warning:

The primary structural support element of a vertically mounted heater is the base. Any support to the heater cabinet should be considered secondary, more as a means to help stabilize the heater.

VERTICAL OUTDOOR INSTALLATION INSTRUCTIONS:

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions. Verify all heater access panels and the electrical enclosure are free from obstructions and can open fully.

A. Prepare wall penetration to the dimensions noted on page 7.

B. If applicable, connect any inlet accessories to heater including filter section (optional) prior to standing the heater upright. Note that the inlet skirt (optional) is to be installed after the heater is mounted. Refer to figures on page 15 for additional details of typical vertical outdoor installations.

C. Install structural uprights and associated wall supports.

D. Remove the lag bolts used to fasten the unit to the skid.

E. Utilizing the lifting brackets on the front of the heater, use a forklift or comparable lifting device to raise equipment upright. Take precautions to prevent equipment damage.

F. Install the discharge duct to downturn.

G. Relocate the connection point of the slings to the lifting brackets which are located on the bottom of the heater. Ensure the heater is stabilized properly. Use a forklift or comparable lifting device to raise and position the equipment.

H. Secure heater in place with contractor supplied hardware.

I. Install fiberglass insulation in gaps around wall opening and discharge duct. Apply enough material to accommodate full thickness of wall.

J. Install finish trim pieces (by others) to top, sides and bottom of the discharge duct on both the inside and outside wall surfaces.

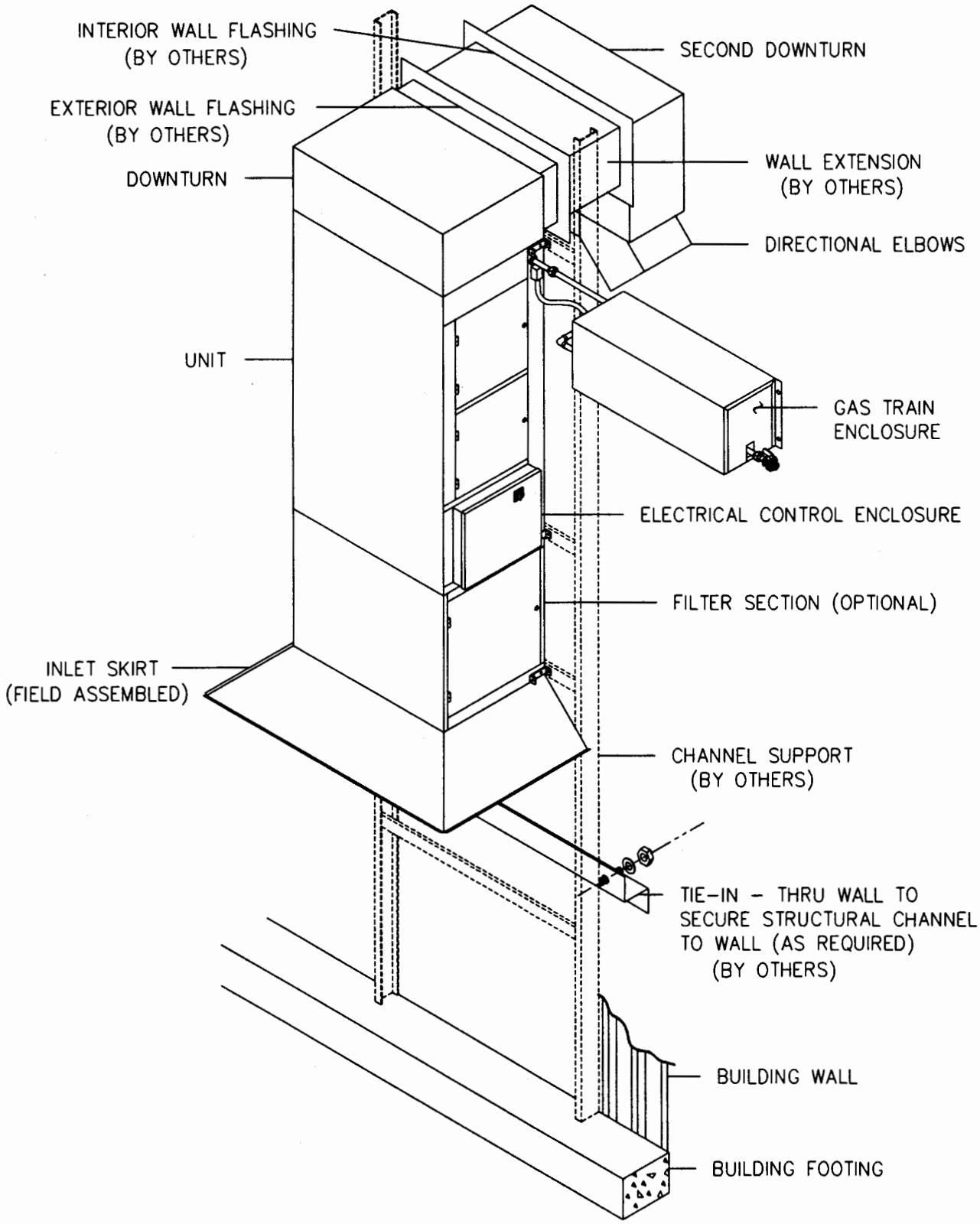
K. Apply bead of latex base polyurethane caulk that best matches the color of the exterior wall surface of the facility and/or the color of the heater accessories at joint between top of discharge duct and outside wall surface. Make certain this is a continuous bead and that it runs the entire width of hood. Caulk all other exposed joints.

L. Mount the gas train enclosure to wall structure and connect gas piping between the heater and the enclosure.

M. Install inlet skirt to heater inlet including the skirt extension to exterior wall.

N. Install downturn on discharge duct and directional elbows on downturn. Consult job layout for direction of elbows.

TYPICAL VERTICAL OUTDOOR INSTALLATION:



ROOF TOP INSTALLATION INSTRUCTIONS:

Before proceeding with the installation, verify the feasibility of the location selected with respect to accessibility to the equipment for service and maintenance functions.

NOTE:
Accurate measurements are critical and will affect installation process.

A. Install roof curb and supports in accordance with roof manufacturer's recommendations. On built up roofing, use treated lumber that matches roof insulation thickness to properly spread the load on the roof deck. Shims may also be required to level the heater on roof. Treated lumber should also be utilized for support under the mounting stands. Refer to figure on page 17 for additional details of typical roof top installations.

B. The shipping brackets are not utilized on roof top installations.

NOTE:
Retain the shipping bracket bolts and washers to secure the rear mounting stands.

C. Use crane or comparable lifting device to raise and position equipment. Block the heater where necessary. Use a spreader bar to prevent damage and connect slings to lifting brackets.

NOTE:
Inlet accessories may be attached on the ground or on the roof depending on the method chosen by the installing contractor.

NOTE:
Cambridge recommends mounting the heater 24 inches off the roof surface. In special instances a 12 inch mounting height can be specified, however, not in areas where snow accumulation could impact heater operation.

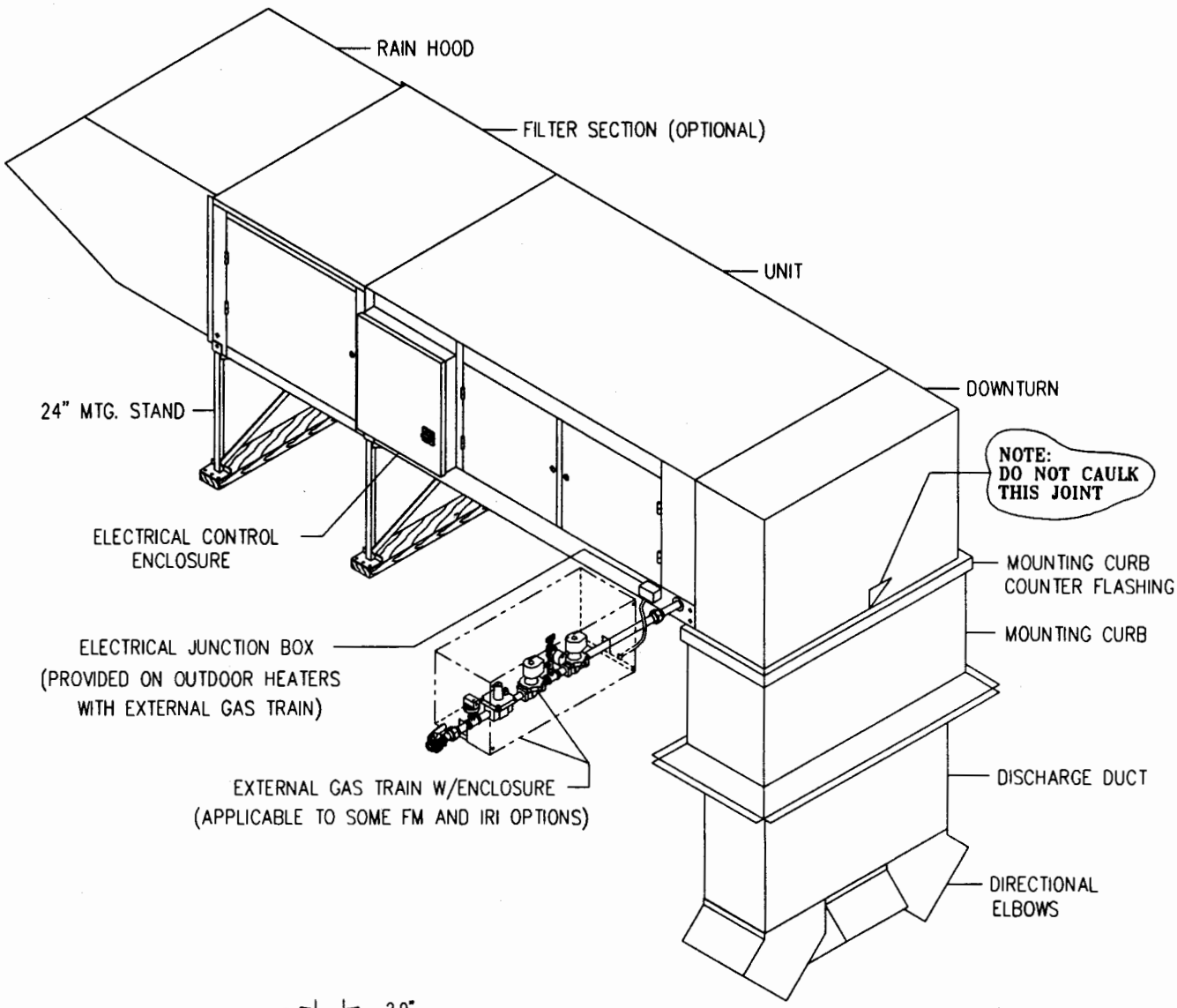
D. Caulk all joints on the heater and accessories except the interface between the downturn and the mounting curb counter-flashing with a clear or grey latex base polyurethane caulk to prevent water leaks.

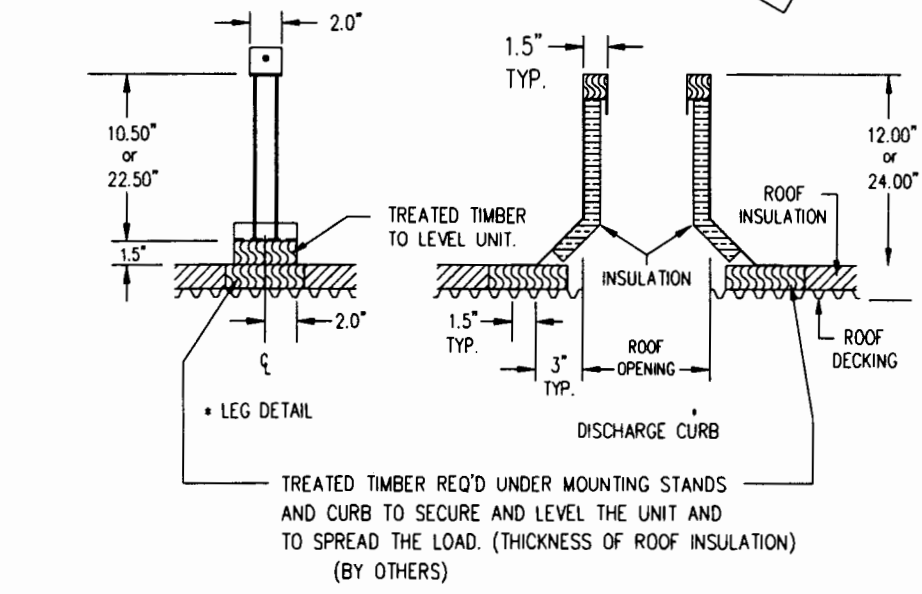
NOTE:
The downturn/counter-flashing for the curb interface should not be caulked.

E. Seal all roof penetrations to prevent roof leaks.

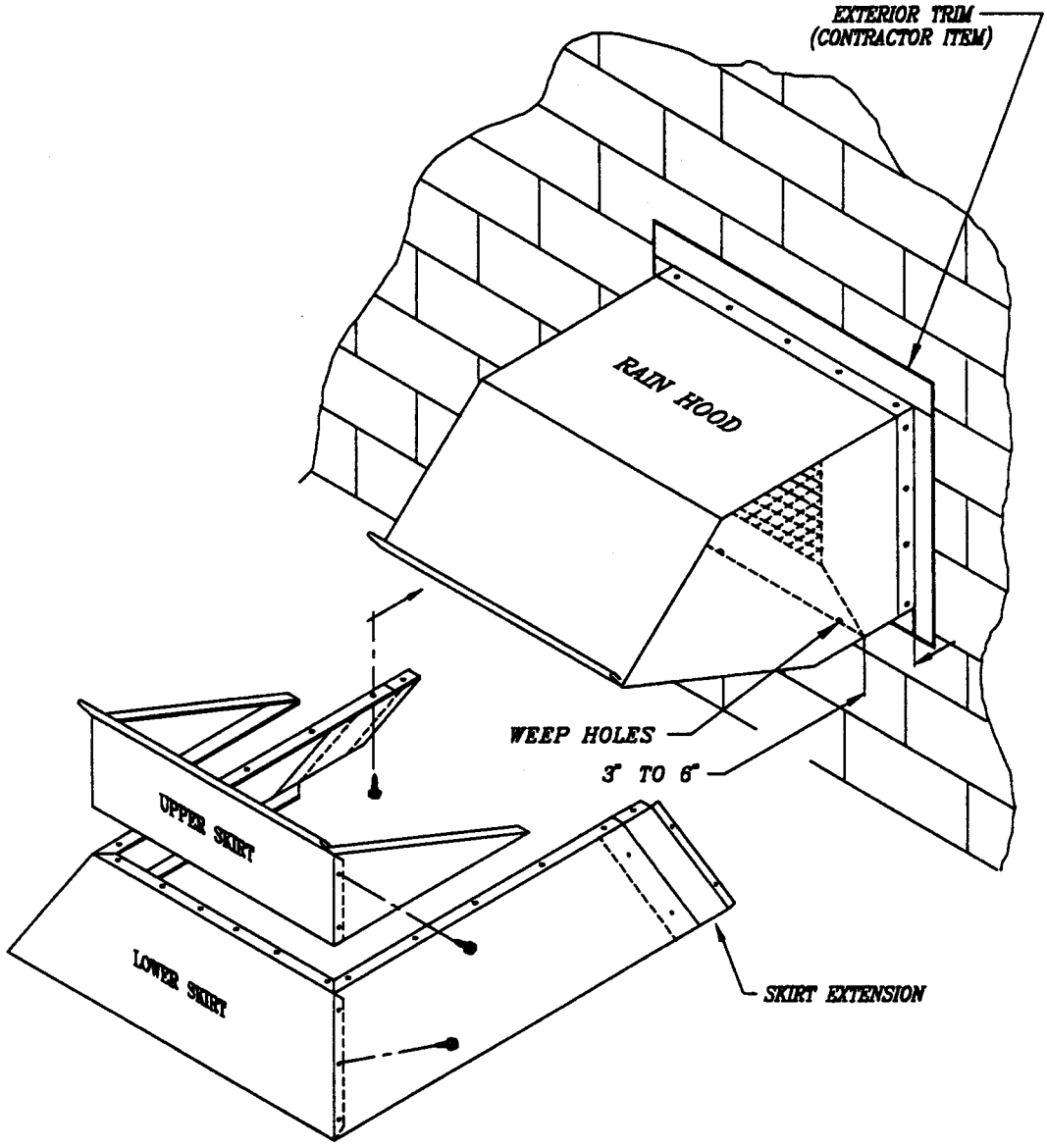
NOTE:
If the unit air intake is positioned over a low spot on the roof that is subject to standing water, additional gravel should be placed in low spot to disrupt the surface of the water, if applicable, or a rain hood water spout eliminator is required to minimize water ingestion. Consult factory for pricing and availability of this option.

TYPICAL ROOF TOP INSTALLATION:

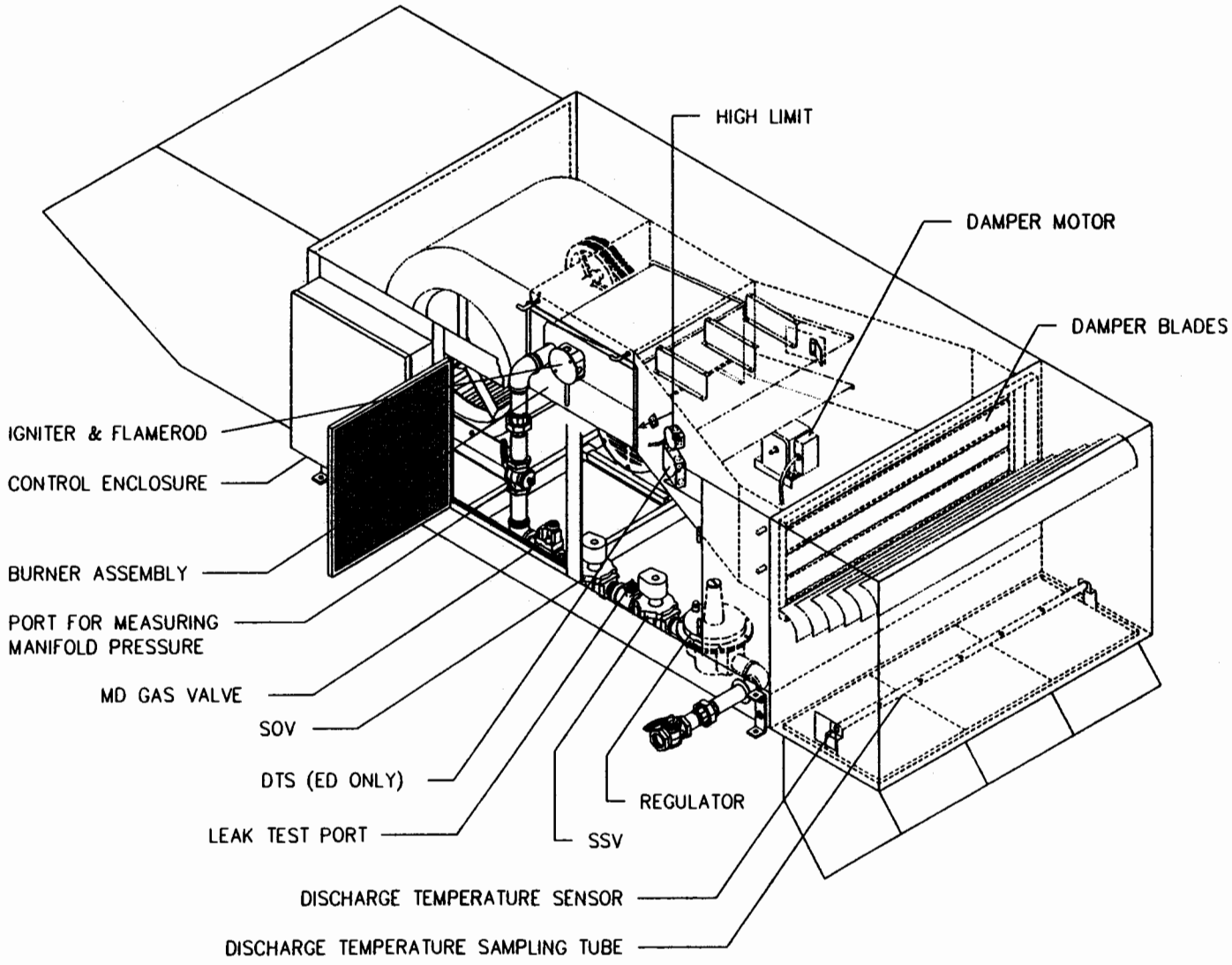




THRU-WALL RAIN HOOD AND INLET SKIRT INSTALLATION:



ISOMETRIC VIEW OF HEATER:



GAS PIPING INSTALLATION INSTRUCTIONS:

NOTE:

Refer to the heater rating plate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which this heater is specified.

DIRECT GAS FIRED INDUSTRIAL AIR HEATER

ANS Z83.18 – [ ] DIRECT INDUSTRIAL AIR HEATER

FOR INDUSTRIAL / COMMERCIAL USE

FOR EITHER INDOOR OR OUTDOOR INSTALLATION

MINIMUM CLEARANCE TO COMBUSTIBLES:

TOP	FRONT	REAR	BOTTOM
0 in.	0 in.	0 in.	0 in.

NOTE: SIDES ACCESS REQUIRED FOR SERVICE ACTIVITY (21")

MODEL NO. [ ] SERIAL NO. [ ]

THIS UNIT IS SPECIFICALLY DESIGNED FOR THE FOLLOWING OPERATING PARAMETERS:

	NAT. GAS
MAX. INPUT RATE (BTU/HR)	[ ]
MIN. INPUT RATE (BTU/HR)	[ ]
MAX GAS SUPPLY PRESSURE (IN W.C.)	14.0
MIN. GAS SUPPLY PRESSURE (IN. W.C.)	1.0
MIN. GAS SUPPLY PRESSURE FOR THE PURPOSE OF MAX. INPUT ADJUSTMENT (IN. W.C.)	[ ]
MANIFOLD DIFFERENTIAL PRESSURE (IN. W.C.)	[ ]

ELECTRICAL [ ] VOLTS [ ] PHASE [ ] HERTZ [ ] AMPERES [ ] H.P.

A. Check with local utility or gas supplier for gas supply pressure.

NOTE:

If the gas supply pressure is in excess of the maximum pressure indicated (14" W.C., or 1 psig, or 5 psig) on the heater nameplate, a separate positive shutoff high pressure regulator must be added upstream of the heater's individual manual shutoff valve. This regulator must be vented to outside of building at least 10 feet form any intake opening. The vent pipe should be designed to prevent the entry of water, snow, insects or other foreign material that could cause blockage. There must be no reduction in size of the vent piping. If vent piping exceeds 50 feet, increase piping diameter to next larger size.

B. Properly size gas supply piping for rated capacity, per local codes, and/or the National Fuel Gas Code, ANSI Standard Z223.1-1992.

C. Make sure supply piping is free of foreign matter and purged.

D. Verify that the gas piping, when installed, will not restrict or block the unit access door from fully opening.

E. Install gas piping to unit in accordance with local codes or in their absence in accordance with the National Fuel Gas Code, ANSI Standard Z223.1-1992.

NOTE:

A ⅛" NPT tap is supplied with the heater for measuring the gas supply pressure. If the gas supply pressure exceeds that indicated on the nameplate, the installer must install a ⅛" NPT tap and high pressure manual shutoff valve upstream of the high gas pressure regulator.

NOTE:

An adequate sediment trap must be installed prior to all gas controls for the heater and as close to the inlet of the heater as practical.

NOTE:

On double block and vent gas trains, the vent solenoid must be vented to the outside of the building at least 10 feet from any intake opening. There must be no reduction in size of the vent piping. The vent pipe should be designed to prevent the entry of water, snow, insects or other foreign material that could cause blockage.

NOTE:

Units with external gas trains shall be installed, such that, the distance from the last safety shut-off valve to the heater shall not exceed 4 feet.

F. Check for leaks in supply piping system. Use liquid gas detector. **Do not use flame.**

CAUTION

If the test pressure is in excess of 1/2 PSIG (3.45 KPA), the heater and its manual shutoff valve must be disconnected from the gas supply system during pressure testing.

If the test pressure is less than or equal to 1/2 PSIG (3.45 KPA), the heater must be isolated from the gas supply piping by closing its manual shutoff valve during pressure testing.

*** WARNING ***

Do not attempt to start unit at this time. Premature start-up can result in damage to equipment and components.

ELECTRICAL INSTALLATION INSTRUCTIONS:

Before attempting electrical installation, review the following instructions and wiring diagrams to make sure you have a thorough understanding of what is required.

WARNING
High voltage electrical input to this equipment is required.
Extreme caution should be exercised.
This equipment must be electrically grounded in accordance with local codes or in accordance with National Electrical Code ANSI/NFPA No. 70-1993

A. Check the heater nameplate to determine the voltage and amperage requirements.

Note:
If supply voltage does not agree with nameplate voltage, notify your local agent or Cambridge Engineering's Customer Service Group of the discrepancy.

B. Supply wiring and adequate Branch Circuit Protection in accordance with the National Electric Code ANSI/NFPA 70-1993.

C. Mount Remote Control Station (RCS/RCS-S/TSS). This panel should be located inside of building and convenient to operator without being susceptible to damage.

D. The Operating Thermostat (O.T.), Space Temperature Selector (STS) Thermostat and/or the Thermistor used in conjunction with the RCS-S and TSS options, is (are) normally located along a perimeter wall and out of the direct path of the discharge air or air infiltration. Consult the design drawing and/or Cambridge's Customer Service Group for placement assistance. Do not locate the remote mounted temperature sensors immediately adjacent to overhead doors because the infiltration air can affect the sensor when the door is closed and may not adequately sense the temperature when the door is open. In this application, the sensor should be located on the first column in from the outside wall.

CAUTION

Observe special notes and instructions on Wiring Diagrams including the following:

The wiring for the Space Temperature Selector (STS) thermostat must be "shielded, twisted-pair" wiring and must run separate from the other "AC" wiring. This also applies to other remote mounted controls utilized in the Maxitrol Series 14 and 44 control systems. (Ref. ED, EDR, EDS, and EDSM control options)

When the thermistor is mounted remote from the Remote Control Station, the connecting wiring should be "shielded, twisted-pair" wiring.

Shielded wire which is routed to the control enclosure should extend beyond the high voltage section of the enclosure before the shielding is terminated and the wiring is distributed to its ultimate destination.

Shielding must be grounded on one end only.

NOTE:

Conduit connections for power and control wiring must be caulked in outdoor applications to ensure a tight seal and prevent moisture accumulation.

E. Wire Remote Control Station and other temperature control options (using Class II wiring per Cambridge wiring diagram and National Electrical Code Article 725 or local codes.

F. Run conduit and primary wiring to disconnect switch inside of control cabinet on heater per N.E.C., Article 430, ANSI/NFPA 70-1993.

G. Return wiring diagram to the manual holder. Replace and fasten all access covers.

WARNING

Do not attempt to start unit at this time. Premature start-up can result in damage to equipment and components.

START UP INSTRUCTIONS
C390, C600, C900, C1200, C1900 & C2500

Job Name:_____ **Model No.** _____ **Date:**_____

Service Technician's Name_____ **Company Name**_____

Serial Number _____ **Heater No./Location**_____

NOTE:

Read the following instructions carefully. Any unauthorized modifications to, or deviations from these instructions may void warranty.

_____1. VISUAL INSPECTION OF EQUIPMENT

a. Check for any physical damage from shipping or installation that could render the heater inoperable.

b. Verify that all heater accessories have been properly installed.

c. Check for loose components (belts, plugs, terminal screws, etc.).

NOTE:

Proper belt tension is attained when a force of 6-9 pounds applied at the center span between the pulleys results in: a 1/4"deflection for the C390, C600, C900, C1200; and a 7/16" deflection for the C1900 and C2500. Periodic belt adjustments may be required. Indications of loose belts include barking or squealing when the blower starts.

d. Verify that the access doors and control enclosure are free from obstructions, such that they can be fully opened.

e. On units with external gas trains, verify the distance from the last safety shut-off valve to the heater does not exceed four feet.

f. Verify the field wiring, both primary and control, has been installed according to the Cambridge wiring diagram and the National Electrical Code.

g. Verify that a sediment trap has been provided before other gas train components.

h. Verify that the high pressure regulator and/or vent valve, if applicable, has been vented to the outside.

i. Verify the factory supplied low pressure manual gas shut-off cock is installed external to the heater and down stream of the high pressure regulator, if applicable.

j. Verify that the unions in the gas piping are tight. One is located at the burner and the other is located just external to the heater housing.

____2. ELECTRICAL SUPPLY VOLTAGE VERIFICATION:

a. Check electrical supply voltage at the disconnect switch.

Nameplate Volts _____ Actual Volts _____

Note:

Do not proceed with start-up unless supply voltage agrees with nameplate voltage. If supply voltage does not agree with nameplate voltage, check with your local agent or Cambridge Engineering's Customer Service Group to determine what changes are required.

____3. GAS SUPPLY PRESSURE VERIFICATION:

a. Verify that the gas supply pressure complies with heater nameplate.

Nameplate Maximum Gas Supply Pressure _____" w.c.
Actual Gas Supply Pressure _____" w.c.

Note:

Do not proceed with start-up unless the gas supply pressure agrees with nameplate pressure requirements. If the gas supply pressure is in excess of the maximum pressure indicated, a separate positive shut-off high pressure regulator must be added upstream of the heater's individual low pressure manual shut-off valve. If a high pressure regulator is needed and has not been installed, check with your local agent or Cambridge Engineering's Customer Service Group to determine the size and capacity requirements that is required.

____4. BLOWER ROTATION CHECK

a. Open the access door on the electrical control enclosure side and turn the disconnect switch to the ON position.

WARNING:

When disconnect switch is activated with enclosure open, there is live power present. Only experienced technicians with knowledge and respect for live power should proceed beyond this point.

b. Turn the blower service switch to the "LOCAL" position. Blower motor will start after the motorized discharge damper opens. Then, turn the service switch to the OFF position and verify that the blower is rotating clockwise from the control enclosure side.

NOTE:

On a three phase system, rotation direction of blower may be reversed by switching any two wires located on the downstream side of the service disconnect.

_____5. MOTOR AMP DRAW CHECK:

NOTE:
The heater access doors must be closed for this test.

b. Check motor current at the overload on all three legs.

L1_____ L2_____ L3_____ Average_____

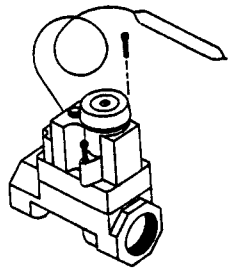
NOTE:
Average amps must not exceed Motor Nameplate FLA.
High amperage may indicate excessive blower RPM.

_____6. HEATER CAPACITY VERIFICATION:

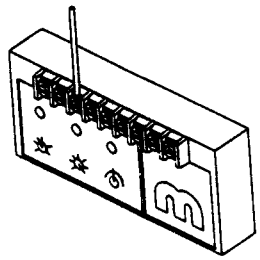
The heater capacity has been pre-set at the factory to the **specified** airflow, static pressure, and temperature rise. The actual operating conditions may require minor adjustments to the control settings to ensure the heater functions within the operating parameters of its listing.

a. Turn the disconnect switch to the OFF position and open the control enclosure door.

b.1 For MD (Mechanical Discharge) Control Systems only, open the access door on the control enclosure side to expose the gas train components. Remove the two Phillips-head screws on the MD valve. This will cause the MD valve to fully open. Close access door.



b.2 For **ED**, **EDR** and **EDSM** (Electronic Discharge) Control Systems only, disconnect wire #3 from the amplifier to drive the modulating valve (MV) to full open.



c. Units with an Entering Air Thermostat (**EAT**), adjust **EAT** to 90°F to prevent the burner from locking out during start-up. If ambient temperature exceeds 90°F, a jumper wire will be required to jump out this thermostat.

Note:
The heater access doors must be closed for the remaining portion of this test.

The **preferred method** for verifying the heater's capacity is the "Temperature Rise" method, since the control regulator is set in direct response to the variables that are normally encountered in field applications (ie, airflow, external static pressure, voltage, etc.). An alternate method for obtaining the heater capacity is the "Manifold Pressure" method. This method sets the heater capacity based on the specified information and does not directly sense the actual operating parameters with respect to static pressure and/or airflow delivery.

TEMPERATURE RISE METHOD:

d. Remove the access cover from the side of the downturn and verify the temperature sensor is securely mounted in the sampling tube bracket. Refer to the Individual Component Description Section for details of sensor mounting. Replace access cover. Heaters furnished without a downturn are not supplied with a sampling tube. In this event, the service technician will need to provide a means for precisely measuring the discharge temperature.

e. Refer to the heater nameplate for the temperature rise for which the heater was specified. Temperature Rise = _____°F.

f. Turn the disconnect switch to the ON position and turn the blower service switch to the "LOCAL" position. The blower motor will start after the motorized discharge damper opens.

g. Monitor the temperature on the Temperature Display Module (**TDM**) to determine the ambient discharge temperature. Refer to the Electrical Control Enclosure Isometric Drawing, page 38, for the location of the **TDM** and the Individual Component Description Section for information on its operation. (Note: You may need to shine a flashlight at the photocell to activate the display.) Verify the **TDM** switch is in the "DISCHARGE" position. Record the **TDM** reading. Ambient Temperature = _____ °F.

h. Using the formula below, determine the required discharge temperature.

Temp. Rise ____°F + Ambient Temp. ____ °F = Discharge Temp. _____°F

i. Turn the burner service switch to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

j. Monitor the discharge temperature until it stabilizes and compare to the discharge temperature calculated above. If the actual discharge temperature does not equal this value, adjust the control regulator until the proper discharge temperature is obtained.

NOTE:

The high limit may trip on warm or mild temperature days. A jumper may be necessary to complete the control regulator pressure adjustment.

k. Turn blower and burner service switches to the "OFF" position.

If you performed the Temperature Rise Method, proceed to step 7.

MANIFOLD PRESSURE METHOD: (Alternate Method)

d. Connect a zero to 10 inches water column manometer to the ⅛ inch NPT tapped fitting on the manual shut-off valve located just prior to the burner for the purpose of measuring the manifold pressure.

e. Refer to the heater nameplate for the Manifold Differential Pressure (**MDP**) (In.W.C.) for which the heater was specified. Nameplate Manifold Differential Pressure (**MDP**) = _____ Inches W.C..

f. Turn the disconnect switch to the ON position.

g. Turn the blower service switch to the "LOCAL" position. Blower motor will start after the motorized discharge damper opens. Monitor the pressure reading on the manometer. The manometer may read positive or negative. If a negative reading is obtained, the hose connection to the manometer may need to be switched to the other port on the manometer in order to ascertain the magnitude of that reading. Manifold Static Pressure (Blower Only) (±) = _____ Inches W.C..

h. Using the formula below, determine the required manifold pressure reading for the manometer. Note: A negative manifold static (Blower Only) will result in the manifold pressure being set lower than the nameplate **MDP**.

Nameplate Manifold Differential Pressure _____ (In. W.C.)
+ Manifold Static (Blower Only) (±) _____ (In. W.C.)
= Manifold Pressure Reading _____ (In. W.C.)

(Note: A negative manifold static (blower only) will result in the Manifold Pressure Reading being lower than the Nameplate Manifold Differential Pressure)

i. Turn the burner service switch to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

j. Observe the manometer reading and compare to the calculated manifold pressure above. If the manifold pressure reading does not equal this value, adjust the control regulator until the proper manifold pressure is obtained.

k. Turn blower and burner service switches to the "OFF" position, remove the manometer from the manual shut-off valve and re-install the ⅛ inch plug.

NOTE:

The high limit may trip on warm or mild temperature days. A jumper may be necessary to complete the control regulator pressure adjustment.

_____ 7. DISCHARGE TEMPERATURE CONTROL SYSTEM CALIBRATION CHECK:

The discharge temperature control system and high limit have been calibrated at the factory to the **specified** airflow, static pressure, and temperature rise. The actual operating conditions may require minor adjustments to the control or duct deflector settings to ensure the heater functions within the operating parameters of its listing. Before proceeding with the calibration of the temperature control system, a quick check of the high limit temperature is required to ensure proper high limit operation.

Note:
The heater access doors must be closed for the remaining portion of this test.

a. Turn the blower and burner service switches to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

b. Using the manual shut-off valve mounted external to the unit, throttle the gas flow **until** the discharge temperature has **stabilized** to 160 °F as shown on the Temperature Display Module (**TDM**) or measured separately by the service technician. Refer to the Electrical Control Enclosure Isometric Drawing, page 38, for the location of the TDM and the Individual Component Description Section for information on its operation. (Note: You may need to shine a flashlight at the photocell to activate the display.)

c. When the discharge temperature has **stabilized**, change the **TDM** switch from the **Discharge** to the **Hi Limit** position. The high limit reading should be within the range of 140 to 160 °F with the discharge temperature set to 160 °F. If adjustment is required, refer to the Calibration Procedures for the High Limit and Discharge Temperature Control Systems, Page 34.

d. Turn the blower and burner service switches to the "OFF" position.

e. Open the manual shut-off valve to the full open position.

f.1. On MD (Mechanical Discharge) Control Systems re-install the two Phillips-head screws removed in step 6.b.1. Be very careful not to pinch the capillary tube with the valve housing. Then, set the MD knob to the #9 setting.

f.2. On ED, EDR, EDSM (Electronic Discharge) Control Systems, reconnect wire #3 to the amplifier which was previously removed in step 6.b.2.

g.1. On MD (Mechanical Discharge) Control Systems, heaters with the suffix "**LTR**" (see nameplate) and the #9 setting on the MD valve should produce a discharge temperature of 120 °F. On all other heater models, the #9 setting on the MD valve should produce a discharge temperature of 160 °F.

g.2. On ED, EDR, EDSM (Electronic Discharge) Control Systems, the series of the control system and configuration of the accessory components and wiring will determine the discharge temperature. The ED and EDSM control systems both utilize the Maxitrol Series 44 control system. EDR control systems utilize the Maxitrol Series 14 control system, however, these systems may have different Remote Heat Adjust (**RHA**) controls. Refer to Individual Component Description Section for additional information. The series of controls (Series 14 or Series 44) can be easily determined from the manufacturer's part number on the amplifier (A1014 for Series 14 and A1044 for Series 44).

On Series 44 control systems, the discharge temperature should match the temperature shown on the **MAX** dial on the amplifier when the Space Temperature Selector (**STS**) is set to its highest setting. If the space temperature is warm, a test potentiometer, 0 to 10,000 Ω, should be connected in the circuit in place of the **STS** and set at 6,750 ± 250 Ω. On heaters with the suffix "**LTR**" (see nameplate), the **MAX** dial on the amplifier should be preset to 120 °F. On all other heater models, the **MAX** dial on the amplifier should be preset to 140 °F.

On Series 14 control systems (EDR), jumper terminals 21 and 22 and turn the dial on the Remote Heat Adjust to its highest setting to utilize the full temperature range of the control system. On heaters with a single temperature selection dial on the face of the control, (Maxitrol part number TD114), set the dial to 90°F and verify the override temperature selector dial which is visible from the top of the control is set at 30 °F. The combination of these two settings should control the discharge temperature to 120 °F. On heaters with dual temperature selection dials on the face of the control, set the discharge temperature to 160°F.

Note:

The heater access doors must be closed for the remaining portion of this test.

h. Turn the blower and burner service switches to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

i. Change the **TDM** switch from the "HI LIMIT" position to the "DISCHARGE" position and monitor the discharge temperature on the **TDM** until it **stabilizes**.

j. The **TDM** should display a discharge temperature of 120 ± 3 °F for units that are setup for 120 °F; 140 ± 3 °F for heaters that are setup for 140 °F; and 160 + 0/- 5 °F for heaters setup for 160 °F. If the discharge temperature complies with the above requirement, proceed to step 8. If the discharge temperature does not equal the expected value, refer to the Calibration Procedures for the High Limit and Discharge Temperature Control Systems, Page 34.

____ 8. GAS VALVE LEAK CHECK

All heaters should be evaluated for the gas tightness of the gas valve seat. Heaters rated over 400,000 Btu/hr are equipped with a leak test facility to assist in checking this seal. A momentary switch and a gas port for measuring pressure between valves are provided as the leak test hardware. Refer to the Individual Component Description Section for more information regarding the leak test switch. Heaters supplied with a vent valve are also furnished with a second momentary switch for energizing the vent valve during evaluation of the first valve in the gas train. The procedures for the gas valve leak check are as follows:

a. Connect a 0 to 10 inches water column (" W.C.) manometer to the ⅛ inch NPT tapped fitting on the manual shut-off valve located just prior to the burner for the purpose of monitoring an increase in pressure.

b.1. On single redundant valve applications (heaters rated less than 400,000 Btu/hr), close the manual shut-off valve and wait 30 seconds to read the manometer. If reading is greater than 0" W.C., replace the gas valve and retest. If reading is 0" W.C., remove manometer and install pipe plug.

b.2. On separate redundant valve applications **without a vent valve**, close the manual burner shut-off valve, hold the momentary leak test switch in the closed position, and wait 30 seconds to read the manometer. If reading is greater than 0" W.C., refer to the Maintenance Instruction Section for information on Gas Valve Cleaning for the second gas valve and retest. If reading is 0" W.C., remove manometer and install pipe plug.

To check the gas tightness of the first valve in the gas train, connect the manometer to the leak test port between the valves and wait 30 seconds to read the manometer. If reading is greater than 0" W.C., refer to the Maintenance Instruction Section for information on Gas Valve Cleaning for the first gas valve and retest. If reading is 0" W.C., remove manometer and install pipe plug.

b.3. On separate redundant valve applications with a vent valve, close the manual burner shut-off valve, hold both momentary switches (leak test switch and vent valve switch) in the closed position, and wait 30 seconds to read the manometer. If reading is greater than 0" W.C., refer to the Maintenance Instruction Section for information on Gas Valve Cleaning for the second gas valve and retest. If reading is 0" W.C., remove manometer and install pipe plug.

To check the gas tightness of the first valve in the gas train, connect the manometer to the leak test port between the valves, hold the vent valve switch in the closed position, and wait 30 seconds to read the manometer. If reading is greater than 0" W.C., refer to the Maintenance Instruction Section for information on Gas Valve Cleaning for the first gas valve and retest. If reading is 0" W.C., remove manometer and install pipe plug.

____ 9. GAS TRAIN LEAK CHECK

a. Turn blower and burner service switches to the "LOCAL" position.

b. With the burner operating, spray the complete gas train with leak detector solution, checking all pipe connections and plugs.

c. Turn blower and burner service switches to the "OFF" position.

Note:
Any gas leak detected must be repaired before unit is placed into service.

____ 10. FINAL HEATER PREPARATION:

a. If optional Entering Air Thermostat (**EAT**) is being used, adjust to the specified temperature setting. Refer to the Individual Component Description Section for additional information. Remove jumper wire, if one was used.

b. Remove jumper wire from high limit, if one was used.

c.1 For MD (Mechanical Discharge) Control Systems only. Adjust the MD knob to the desired discharge temperature. For a typical space heating application, the discharge temperature is normally set at 145° (#8 setting).

c.2 For ED, EDR and EDSM (Electronic Discharge) Control Systems only. Ensure the discharge temperature setting(s) comply(ies) with the application specifications.

d. For EDSM (Electronic Discharge) Control Systems only. Re-connect the wire removed from terminal #3 on the amplifier.

e. Place the blower and burner service switches in the "REMOTE" position.

f. Return Technical Manual and Wiring Diagram to manual holder.

g. Perform visual inspection of all wiring and **gas valve plugs** to ensure they have been properly replaced.

Note:
Turn the disconnect handle to the "OFF" position before closing the control enclosure door.

i. Replace and fasten all covers and panels. Close the control enclosure and latch the door.

j. Turn the electrical disconnect switch to "ON" position.

____ 11. REMOTE CONTROL STATION OPERATIONAL CHECK:

a. Identify the type of Remote Control Station (**RCS**), if applicable, that is utilized on this application. Refer to Individual Component Description Section for additional information.

b.1. If the **RCS** utilized is the type Remote Control Station - Security (**RCS-S**), refer to the Operating Instructions for the Operating Electronic Thermostat (**OET**). (P. 64)

b.2. If the **RCS** utilized is the type Temperature Setback System (**TSS**), refer to the Operating and Programming Instructions for the **TSS** Controller. (P. 66)

b.3. If the **RCS** utilized is the type Remote Control Station (**RCS**) and is equipped with an Operating Thermostat (**OT**), proceed with Step c. below: If another interlock device controls the operation of the heater, activate this device in lieu of the turning **OT** to its highest setting.

b.4. If the unit is not equipped with a Remote Control Station, activate that part of the control system which will initiate blower and burner operation.

c. Turn the mode selector switch to the "Heating" position and set the operating thermostat, if applicable, to its highest setting. After a short delay for damper operation, the blower should operate, followed by burner ignition 17 seconds after that.

Note:

The Entering Air Thermostat (EAT) in the heater, if applicable, may need to be adjusted to a higher setting or jumpered to permit burner operation during warm outside conditions.

d. If the temperature control system is EDSM or EDR, adjust the Space Temperature Selector (**STS**) or Remote Heat Adjust (**RHA**) and verify the heater output changes correspondingly.

e. Reset the operating thermostat, if applicable, and the Space Temperature Selector (**STS**), if applicable, to desired temperature. If the **EAT** was adjusted or jumpered, set the control to its previous setting or remove jumper.

f. Turn the mode selector switch to the "Summer Ventilation" position. Verify the blower operates. In **TSS** applications, the override timer may need to be activated to initiate operation.

NOTE

If you need technical assistance, call the Cambridge Customer Service Group at 1-800-473-4569 during the hours of 8:00 A.M. to 5:00 P.M. Central Time Monday through Friday.

CALIBRATION PROCEDURES FOR THE HIGH LIMIT AND DISCHARGE TEMPERATURE CONTROL SYSTEMS:

The discharge temperature control system and high limit have been calibrated at the factory to the **specified** airflow, static pressure, and temperature rise. The actual operating conditions may require minor adjustments to the control or duct deflector settings to ensure the heater functions within the operating parameters of its listing. The high limit temperature may be affected by setting the duct deflector for discharge temperature control, therefore, repeated checks of both readings may be required to ensure both systems are calibrated properly.

HIGH LIMIT CALIBRATION PREPARATIONS:

A. Turn the disconnect switch to the OFF position and open the control enclosure door.

B.1 For MD (Mechanical Discharge) Control Systems only, open the access door on the control enclosure side to expose the gas train components. Remove the two Phillips-head screws on the MD valve. See Step 6.b.1 of Start Up Procedure. (P. 26)

B.2 For ED, EDR and EDSM (Electronic Discharge) Control Systems only, disconnect wire #3 from the amplifier to drive the modulating valve (MV) to full open.

C. Units with an Entering Air Thermostat (EAT) option, adjust to 90°F to prevent the burner from locking out during calibration. If ambient temperature exceeds 90°F, a jumper wire will be required to jump out this thermostat.

D. Remove the access cover from the side of the downturn and verify the temperature sensor is securely mounted in the sampling tube bracket. Refer to the Individual Component Description Section for details of sensor mounting. Replace access cover. Heaters furnished without a downturn are not supplied with a sampling tube. In this event, the service technician will need to provide a means for precisely measuring the discharge temperature.

Note:
The heater access doors must be closed for the remaining portion of this test.

HIGH LIMIT CALIBRATION:

E. Turn the blower and burner service switches to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

F. Using the manual shut-off valve mounted external to the unit, throttle the gas flow **until** the discharge temperature has **stabilized** to 160 °F as shown on the Temperature Display Module (**TDM**) or measured separately by the service technician. Refer to the Electrical Control Enclosure Isometric Drawing, page 38, for the location of the **TDM** and the Individual Component Description Section for information on its operation. (Note: You may need to shine a flashlight at the photocell to activate the display.)

G. When the discharge temperature has **stabilized**, change the **TDM** switch from the **Discharge** to the **Hi Limit** position. The high limit reading should be within the range of 140 to 160 °F with the discharge temperature set to 160 °F. If adjustment is required, perform the following steps:

1. Open the unit access door on the control enclosure side.

2. Locate the adjusting screw for the high limit which is in line with the high limit and back towards the burner. Refer to the Individual Component Description Section for location of high limit adjusting screw. Using a ⅜" wrench and a standard straight blade screwdriver to hold the adjustment screw in position, loosen the jam nut then turn the adjusting screw in small increments counter-clockwise to cool the high limit temperature or clockwise to increase the high limit temperature. **Re-tighten the jam nut each time an adjustment is made.**

3. Close the unit access door and **wait** for the **TDM** temperature for the high limit to **stabilize**.

4. Repeat steps 2 and 3 above until the high limit temperature complies with the high limit temperature guidelines presented in step G above.

5. If any adjustment is made, proceed with the discharge temperature control system calibration procedures in the next section.

DISCHARGE TEMPERATURE CONTROL SYSTEM CALIBRATION PREPARATION:

H. Turn the blower and burner service switches to the "OFF" position.

I. Open the manual shut-off valve to the full open position.

J.1. On MD (Mechanical Discharge) Control Systems, re-install the two Phillips-head screws removed in step B.1 being very careful not to pinch the capillary tube with the valve housing. Then, set the MD knob to the #9 setting.

J.2 On ED, EDR, EDSM (Electronic Discharge) Control Systems, reconnect wire #3 removed in step B.2 to the amplifier.

Note:
The heater access doors must be closed for the remaining portion of this test.

K. Turn the blower and burner service switches to the "LOCAL" position. After a 17 second delay for igniter warm-up, the burner will light.

L. Change the **TDM** switch from the "HI LIMIT" position to the "DISCHARGE" position and monitor the discharge temperature on the **TDM** until it **stabilizes**.

M.1. On MD (Mechanical Discharge) Control System, heaters with the suffix "**LTR**" (see nameplate) and with the #9 setting on the MD valve should produce a discharge temperature of 120 °F. On all other heater models, the # 9 setting on the MD valve should produce a temperature of 160 °F.

M.2. On ED, EDR, EDSM (Electronic Discharge) Control Systems, the series of the control system and configuration of the accessory components and wiring will determine the discharge temperature. The ED and EDSM control systems both utilize the Maxitrol Series 44 control system. EDR control systems utilize the Maxitrol Series 14 control system, however, these systems may have different Remote Heat Adjust (**RHA**) controls. Refer to Individual Component Description Section for additional information. The series of controls (Series 14 or Series 44) can be easily determined from the manufacturer's part number on the amplifier (A1014 for Series 14 and A1044 for Series 44).

On Series 44 control systems, the discharge temperature should match the temperature shown on the **MAX** dial on the amplifier when the Space Temperature Selector (**STS**) is set to its highest setting. If the space temperature is warm, a test potentiometer, 0 to 10,000 Ω, should be connected in the circuit in place of the **STS** and set at 6,750 ±250 Ω. On Cambridge Engineering heaters with the suffix "**LTR**" (see nameplate), the **MAX** dial on the amplifier should be preset to 120 °F. On all other heater models, the **MAX** dial on the amplifier should be preset to 140 °F.

On Series 14 control systems (EDR), jumper terminals 21 and 22 and turn the dial on the Remote Heat Adjust to its highest setting to utilize the full temperature range of the control system. On heaters with a single temperature selection dial on the face of the control, (Maxitrol part number TD114), set the dial to 90°F. In addition, verify the override temperature selector dial which is visible from the top of the control is set at 30 °F. The combination of these two settings should control the discharge temperature to 120 °F. On heaters with dual temperature selection dials on the face of the control, set the discharge temperature to 160°F.

N. The **TDM** should display a discharge temperature of 120 ± 3 °F for units that are setup for 120 °F; 140 ± 3 °F for heaters that are setup for 140 °F; and 160 + 0/- 5 °F for heaters setup for 160 °F. If the discharge temperature does not equal the expected value, re-calibration of the modulating control should be performed as shown below:

1. CALIBRATION PROCEDURES for MD (Mechanical Discharge) UNITS ONLY:

   a. Open the unit access door on the control enclosure side.

   b. Carefully remove the red knob from the modulating (MD) valve by removing the Phillips-head screw centered in the knob and lifting.

   c. To raise the discharge temperature, use a screwdriver to turn the brass slot counter-clockwise. To lower the discharge temperature, turn the brass slot clockwise.

d. Close the unit access door and **wait** for the **TDM** temperature for the discharge temperature to **stabilize**.

e. Repeat steps N.1.c and N.1.d until the discharge temperature complies with the discharge temperature guidelines of step M.1 and N above.

f. Carefully re-install the red knob on the MD valve with the notch at position #9 aligned with the spring steel clip. Tighten the Phillips-head screw and recheck the discharge temperature.

2. CALIBRATION PROCEDURES for ED (Electric Discharge) UNITS ONLY:

a. Open the unit access door on the control enclosure side.

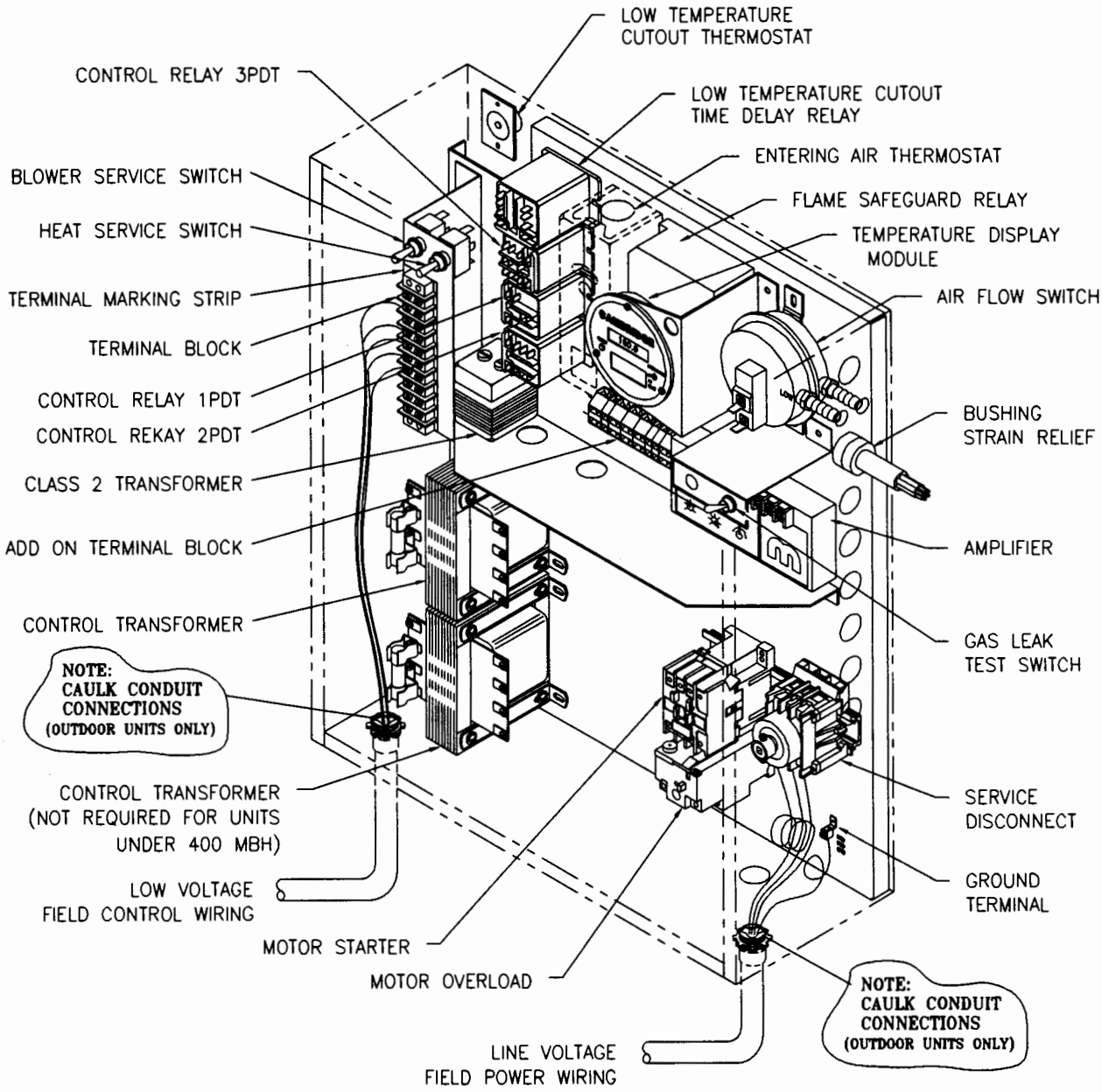
b. Locate the adjusting screw for the discharge temperature sensor which is in line with the discharge temperature sensor and back towards the burner. Refer to the Individual Component Description Section for the location of the discharge temperature adjusting screw. Using a ⅜" wrench and a standard straight blade screwdriver to hold the adjustment screw in position, loosen the jam nut then turn the adjusting screw in small increments counter-clockwise to raise the discharge temperature and clockwise to lower the discharge temperature. **Re-tighten the jam nut each time an adjustment is made.**

c. Close the unit access door and **wait** for the **TDM** temperature for the discharge temperature to **stabilize**.

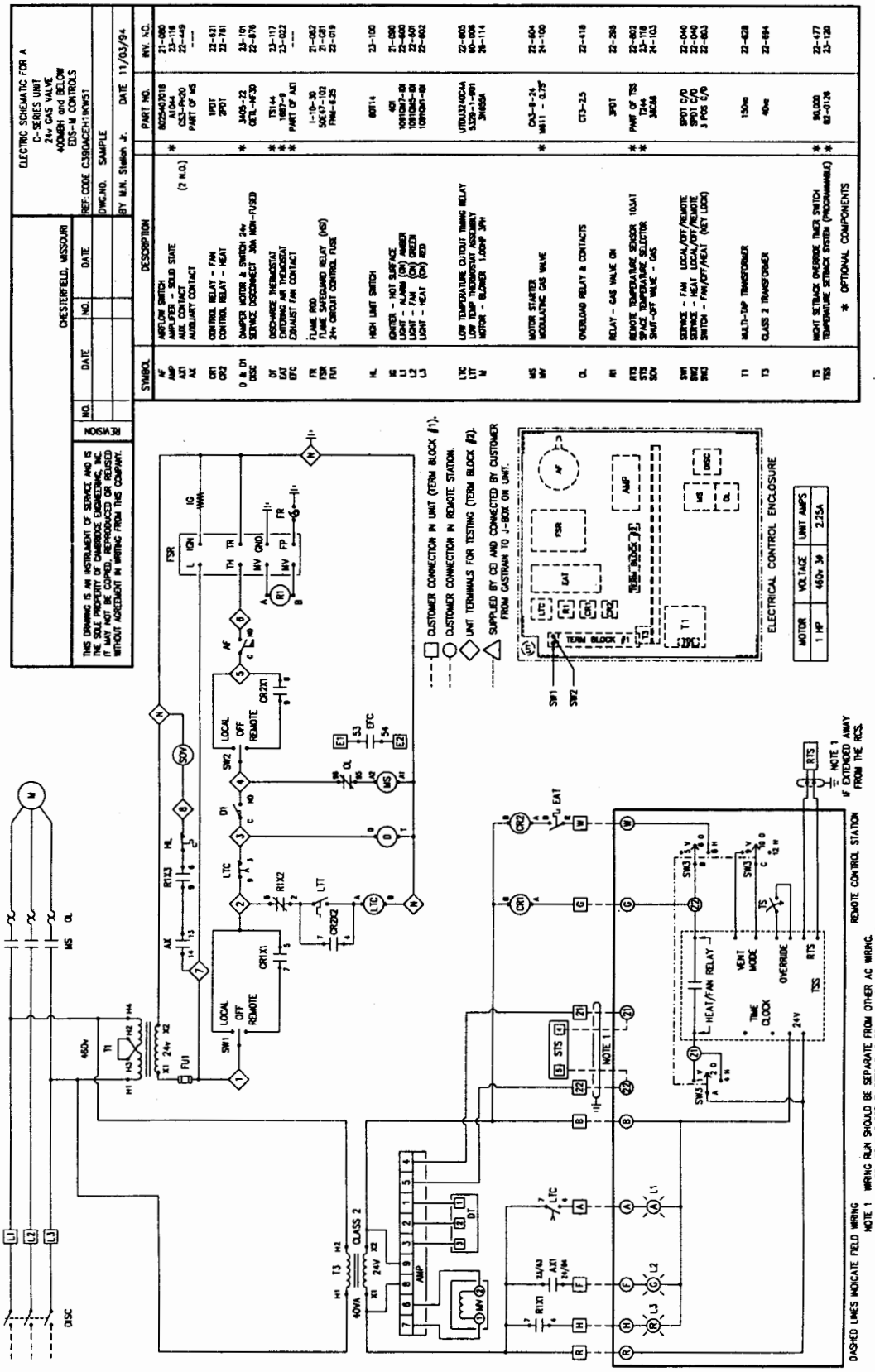
d. Repeat steps N.2.b and N.2.c until the discharge temperature complies with the temperature guidelines of step M.2 and N above.

e. Disconnect wire # 3 from the amplifier to drive the modulating valve (MV) to full open then repeat steps F and G, steps 1 to 4 to ensure the high limit temperature setting has not changed. If no additional adjustment is necessary, return to the Start-Up Procedure, page 31, step 8. If an adjustment is required, repeat steps H through N.2.e.

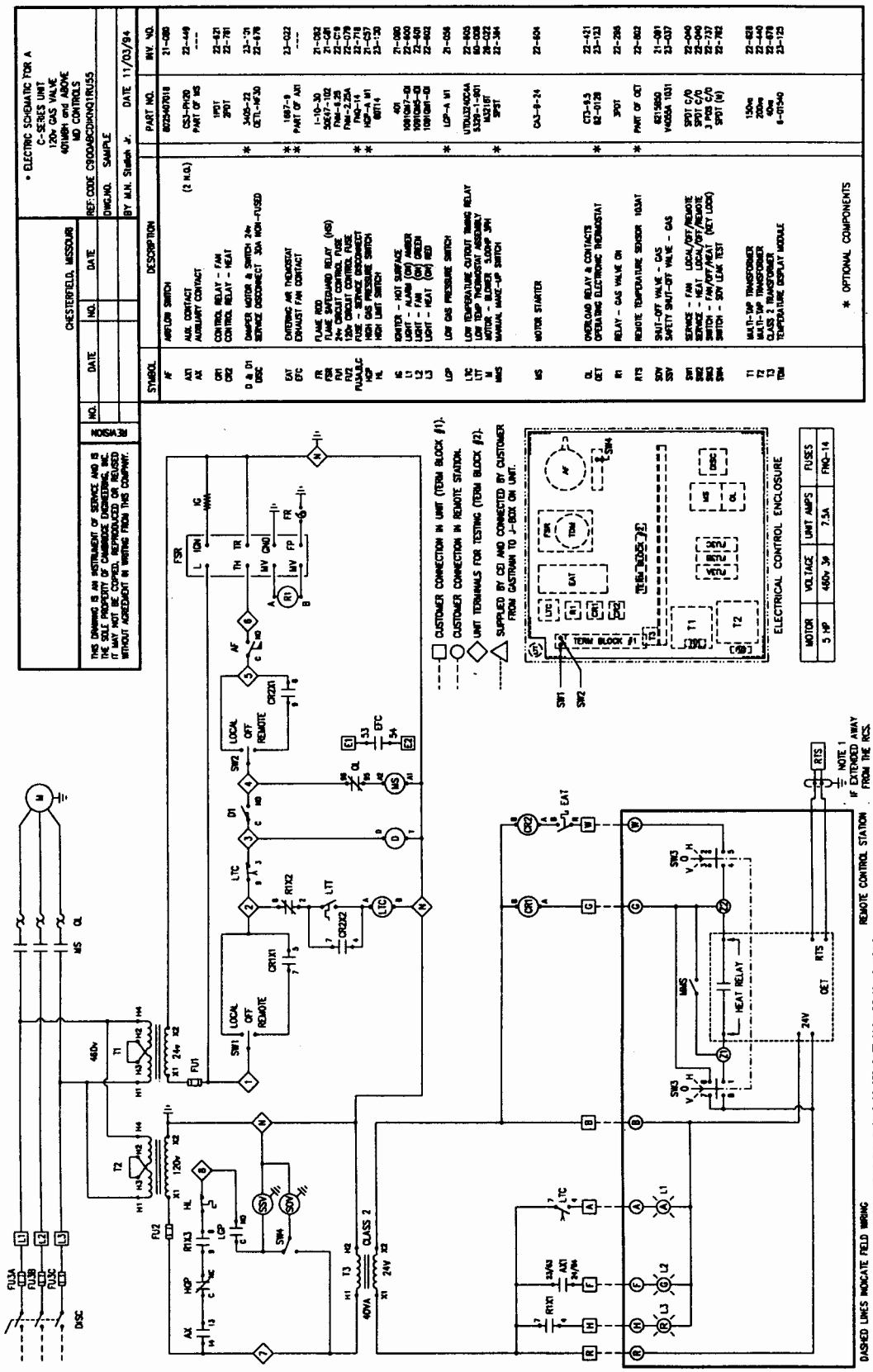
ELECTRICAL CONTROL ENCLOSURE ISOMETRIC DRAWING



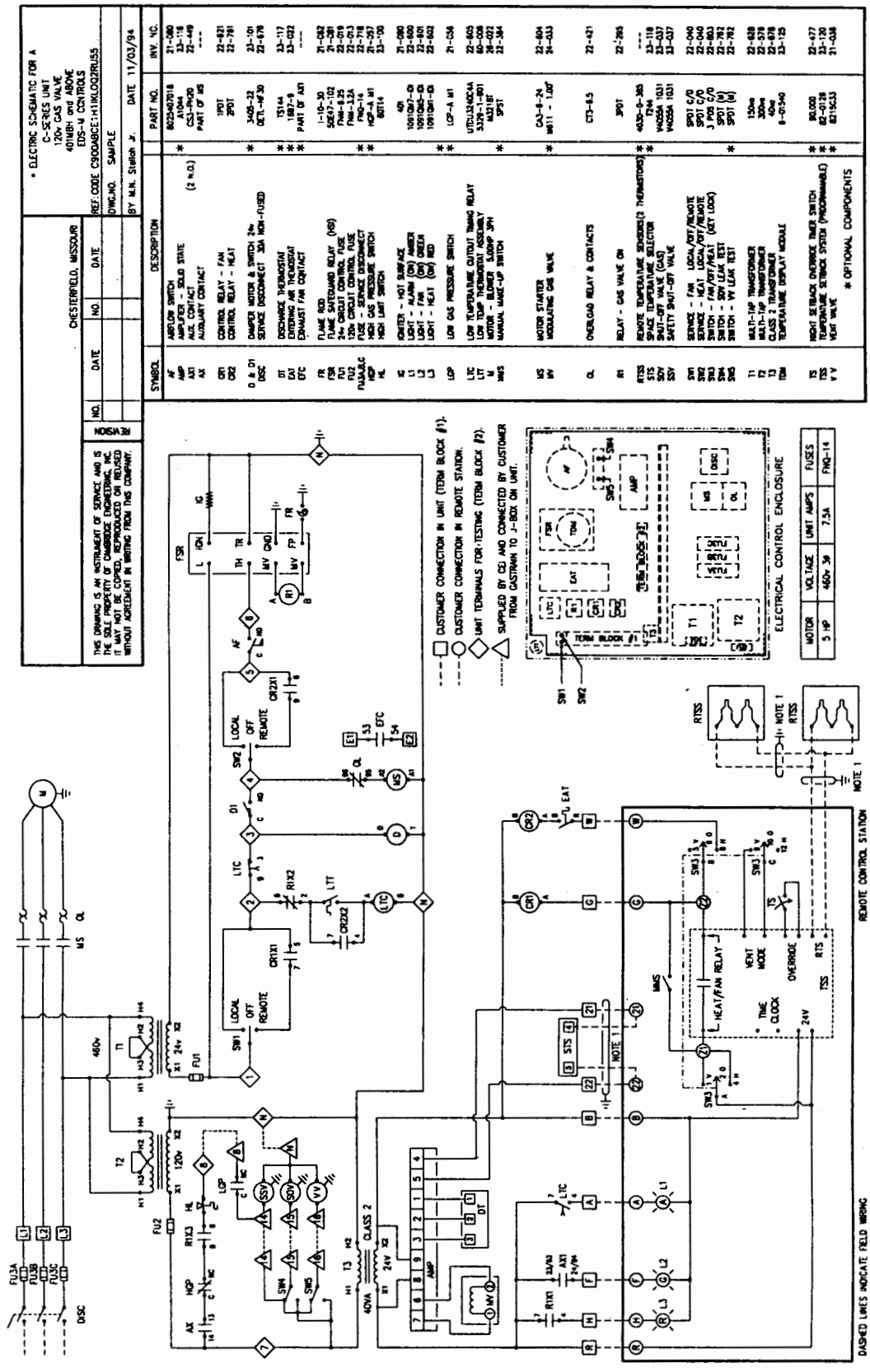
WIRING DIAGRAM 400,000 BTU/HR & BELOW (EDSM CONTROLS)



WIRING DIAGRAM OVER 400,000 BTU/HR (MD CONTROLS)

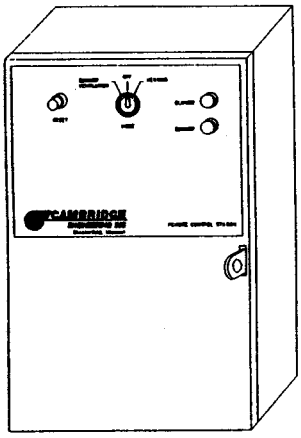


WIRING DIAGRAM OVER 400,000 BTU/HR (EDSM CONTROLS)



INDIVIDUAL COMPONENT DESCRIPTIONS

REMOTE CONTROL STATION - SECURITY (RCS-S)

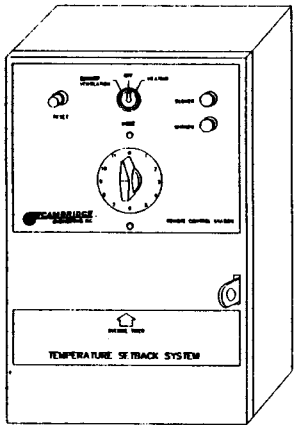


The **RCS-S** is a lockable NEMA 1 enclosure equipped with: a three position keylock selector switch (Summer Ventilation - Off - Heating); an operating electronic thermostat (**OET**); and indicating lights for blower operation (green), burner operation (red), and reset (amber).

The operator can control the heater from this panel provided the heater mounted disconnect is in the ON position and the Service Switches (optional on **LTR** models) are in the REMOTE position. The **OET** utilizes an encapsulated thermistor to sense space temperature. The adjustable differential is addressed by the selection of the ON and OFF temperatures. See instructions for the Operating Electronic Thermostat. (P. 64)

The thermistor enclosure (SH-1) is packed in the **RCS-S** for shipment. It can be mounted on the exterior sides or bottom of the **RCS-S** or a remote location within 500 feet of the **RCS-S** using 18 gauge stranded, twisted-pair, shielded cable. The thermistor is hard wired to the temperature sensor terminal block. If a remote location of the sensor is desired, the connecting cable must be wired between the thermistor and this point.

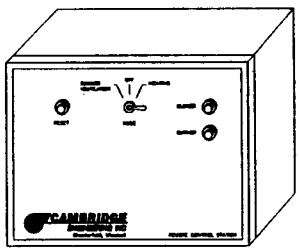
TEMPERATURE SETBACK SYSTEM (TSS)



The **TSS** is a lockable NEMA 1 enclosure equipped with: a three position key lock selector switch (Summer Ventilation - Off - Heating); a combination seven day programmable timer and thermostat; a zero to twelve hour override timer; and indicating lights for blower operation (green), burner operation (red), and reset (amber).

The operator can control the heater from this panel provided the heater mounted disconnect is in the ON position and the Service Switches (optional on **LTR** models) are in the REMOTE position. The **TSS** utilizes an encapsulated thermistor to sense space temperature. The adjustable differential is addressed by the selection of the ON and OFF temperatures. This control can accommodate separately programmed timing for both the ventilation and heating modes. See the operating and programming instructions for the **TSS** Controller. (P. 66)

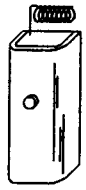
The thermistor enclosure (SH-1) is packed in the **TSS** for shipment. It can be mounted on the exterior sides or bottom of the **TSS** or a remote location within 500 feet using 18 gauge stranded, twisted-pair, shielded cable. The thermistor is hard wired to the temperature sensor terminal block. If a remote location of the sensor is desired, the connecting cable must be wired between the thermistor and this point.



REMOTE CONTROL STATION (RCS)

The **RCS** is a NEMA 1 enclosure equipped with a three position selector switch (Summer Ventilation - Off - Heating) and indicating lights for blower operation (green), burner operation (red), and reset (amber).

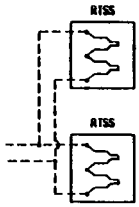
The operator can control the heater from this panel provided the heater mounted disconnect is in the ON position and the Service Switches (optional on **LTR** models) are in the REMOTE position. The optional operating thermostat (**OT**) or other electrical interlock contacts (i.e. exhaust fan interlocks, manual make-up air switch,etc.) are normally wired between terminals Z1 and Z2 for controlling operation in the heating mode.



OPERATING THERMOSTAT (OT)

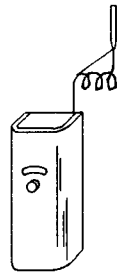
The **OT** option is a capillary type electrical/mechanical temperature sensing device for cycling the heater (ON-OFF) to maintain space temperature. This option is normally used with the **RCS**. The **OT** is normally wired across Terminals Z1 and Z2 of the **RCS**.

An adjustable differential is factory set at 3°F. Contact factory if the heater is subjected to short cycling.



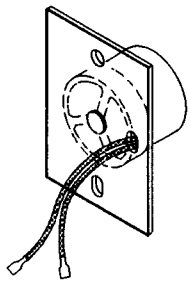
TEMPERATURE AVERAGING SYSTEM (TAS-2)

The **TAS-2** option is used in conjunction with the **RCS-S** or **TSS** to average the space temperature between two distant points within a facility. It consists of four thermistors which are wired in a series/ parallel combination in order to simulate a single thermistor response.



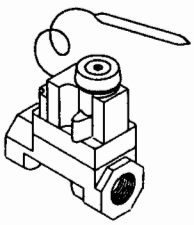
ENTERING AIR THERMOSTAT (EAT)

The optional **EAT** senses the incoming air temperature. It is recommended on make-up applications where the heater is required to operate on a continuous basis. It acts as an economizer thermostat by automatically turning off the burner during unseasonably warm days and thereby continuing to provide the required ventilation without overheating the space. It is normally set at or slightly below the desired space temperature.



LOW TEMPERATURE CUTOUT (LTC)

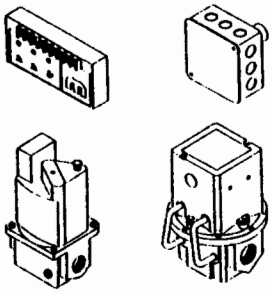
The optional **LTC** thermostat senses the incoming air temperature. The contact on this thermostat will close when it senses a temperature of 45°F or below. This device is intended to prevent building freeze-up by shutting off the blower in the event the temperature falls with the heater in the ventilation mode.



MD TEMPERATURE CONTROL VALVE

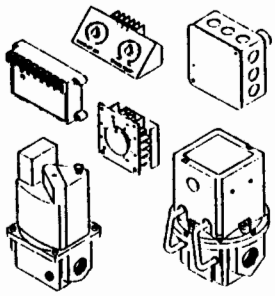
The MD temperature control valve is a mechanical proportioning valve used for maintaining the selected discharge temperature. The sensing bulb is mounted in the discharge airstream and directly acts to maintain a constant discharge temperature. The table below indicate the control setting and approximate discharge temperature. Also see the low fire adjusting procedure (P78).

SETTING	#1	#2	#3	#4	#5	#6	#7	#8	#9
DISCHARGE TEMPERATURE (°F) (**LTR**)	40	50	60	70	80	90	100	110	120
DISCHARGE TEMPERATURE (°F)	61	73	85	97	109	121	134	147	160



ELECTRONIC DISCHARGE (ED)

The **ED** temperature control system utilizes Maxitrol's Series 44 modulation controls. The discharge temperature sensor which is mounted in the discharge duct transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The amplifier creates a voltage output to drive an electronic proportioning gas valve to maintain the selected discharge temperature. The discharge temperature is set at the amplifier. The **MIN** dial controls the discharge temperature at its setpoint between 40 and 80 °F when the resistance between terminals 4 and 5 on the amplifier is below 4000Ω. The **MAX** dial controls the discharge temperature at its setpoint between 80 and 140 °F when the resistance between terminals 4 and 5 is above 6000Ω.

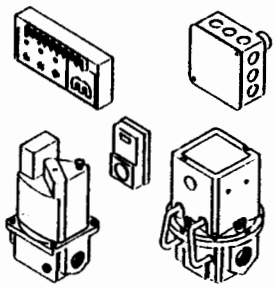


ELECTRONIC DISCHARGE-REMOTE (EDR)

The optional **EDR** temperature control system utilizes Maxitrol's Series 14 modulation controls. The discharge temperature sensor, which is mounted in the discharge duct, transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The amplifier creates a voltage output to drive an electronic proportioning gas valve to maintain the pre-selected temperature that is set on the Remote Heat Adjust (**RHA**).

Heaters which are specified with a temperature rise of less than 100 °F (**LTR**) are normally supplied with a single adjusting knob on the dial face of the **RHA**. This control permits manual adjustment of the discharge air temperature from 55 to 130 °F. The override temperature selector dial, which is visible from the top of the **RHA** control, increases the discharge temperature above the setting on the dial face by the increment selected when a jumper or switch contact is provided across terminals 21 and 22.

Heaters which are specified with a temperature rise above 100 °F are normally supplied with dual adjusting knobs on the dial face of the **RHA**. This control permits manual adjustment of the discharge temperature from 55 to 105 °F or 120 to 160 °F. A jumper or switch contact is required across terminals 21 and 22 to activate the higher temperature selection.

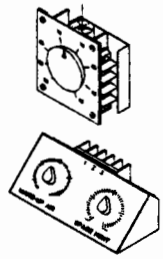


ELECTRONIC DISCHARGE-SPACE MODULATION (EDSM)

The optional **EDSM** temperature control system utilizes Maxitrol's Series 44 modulation controls. The Space Temperature Selector (**STS**) is set to maintain the space temperature and it transmits a resistance output to the amplifier to control the discharge temperature. The discharge temperature sensor which is mounted in the discharge duct transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The amplifier creates a voltage output to drive an electronic proportioning gas valve to maintain the selected space temperature by controlling the heater output between the **MIN** and **MAX** setting on the amplifier. The **MIN** dial setting determines the minimum discharge temperature the heater will deliver (40 to 80 °F). The **MAX** dial setting determines the maximum discharge temperature the heater will deliver (80 to 140 °F).

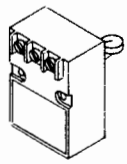
REMOTE HEAT ADJUSTMENT (RHA)

OVERRIDE TEMPERATURE SELECTOR DIAL



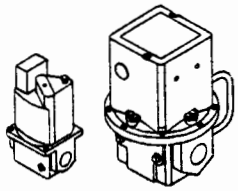
As discussed under the component description for the **EDR** control system, the **RHA** may have a single or dual adjusting knob(s) on the dial face. The single adjusting knob control permits manual adjustment of the discharge air temperature from 55 to 130 °F. The override temperature selector dial which is visible from the top of the **RHA** control, increases the discharge temperature above the setting on the dial face by the increment selected when a jumper or switch contact is provided across terminals 21 and 22.

Heaters which are specified with a temperature rise above 100 °F are normally supplied with dual adjusting knobs on the dial face of the **RHA**. This control permits manual adjustment of the discharge temperature from 55 to 105 °F or 120 to 160 °F. A jumper or switch contact is required across terminals 21 and 22 to activate the higher temperature selection.



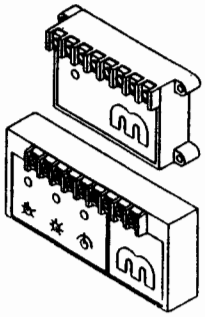
DISCHARGE TEMPERATURE SENSOR (DTS)

The **DTS** is mounted in the discharge duct and is a component of the ED, EDR, and EDSM temperature control system. It senses the average discharge temperature and transmits a resistance signal back to the amplifier that corresponds to the discharge temperature. The **ED** and **EDSM** control systems use the Series 44 sensor (p/n TS144). The **EDR** control system uses the Series 14 sensor (p/n TS114).



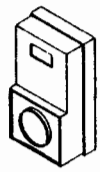
MODULATING VALVE (MV)

The **MV** responds to a 4 to 24 volt DC signal from the amplifier to modulate the flow of gas to the burner. On the M611 valve, the low fire adjusting screw is located on the far side of the valve under the dust cover. An Allen wrench is required for adjustment. On the MR212 valve, the low fire adjusting screw is located under the large dust cover. This modulating valve also serves as the pressure regulator.



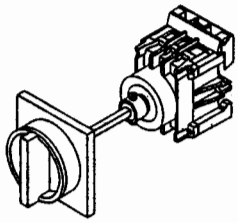
AMPLIFIER

The amplifier creates a voltage output to drive an electronic proportioning gas valve to maintain the selected discharge temperature. On **ED** control systems, the discharge temperature is set at the amplifier. On **EDR** control systems, the discharge temperature is set on the Remote Heat Adjust (**RHA**). On **EDSM** control systems, the range of the discharge temperature is set at the amplifier, however, the **STS** controls when more or less heat is required. The **ED** and **EDSM** control systems use the Series 44 amplifier (p/n A1044). The **EDR control** system uses the Series 14 amplifier (p/n A1014).



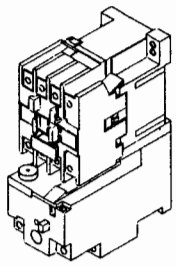
SPACE TEMPERATURE SELECTOR (STS)

The **STS** is part of the **EDSM** control system. It senses the space temperature and provides a resistance signal back to the amplifier that corresponds to the temperature variation from setpoint. A 3 °F drift from the set temperature will cause the heater to modulate to the extreme end of the pre-set range on the amplifier.



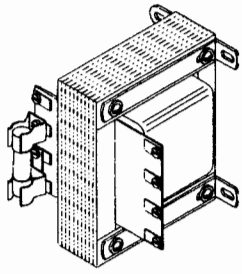
DISCONNECT SWITCH

The disconnect is provided on all heaters and includes the disconnect rod and lockable operating knob. The disconnect must be in the **OFF** position to gain access to the control enclosure. Once the control enclosure is open, experienced service technicians may activate the electrical circuit by twisting the disconnect rod clockwise to assist in trouble-shooting. The disconnect rod must be turned back to the **OFF** position before attempting to secure the enclosure door.



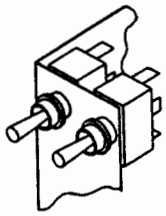
MOTOR STARTER, OVERLOAD, & AUXILIARY CONTACT

The motor starter assembly consists of a motor starter, overload relay and auxiliary contact. The overload relay protects the motor from excessive current or single phasing. If the overload relay trips, it must be reset manually. The auxiliary contacts are used in the gas valve safety circuit as an indication the blower is operating, and as an optional exhaust fan contact for interlocking other equipment with the operation of the heater.



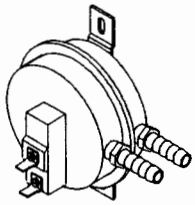
TRANSFORMER

Heaters which are supplied with an output of greater than 400,000 Btu/hr are furnished with two control voltage transformers unless the primary voltage is 115 volts. The specific transformer furnished depends on the primary voltage (208, 230, or 460 volts). These transformers provide the secondary control voltage of 24 or 115 volts. Heaters rated below 400,000 Btu/hr or supplied for 115 volts are furnished with the 24 volt secondary transformer only. Secondary fusing is provided in all Class I transformer circuits to protect the downstream components from short circuit. Fuse sizing is as follows: FNM-6.25 for 150 va 24 volt; FNM-1.8 for 150 va 115 volt; and FNM-2.25 for 200 va 115 volt. Consult the heater wiring diagram to identify the proper fusing for the heater in question. **Do not increase the fuse rating over that which is specified.**



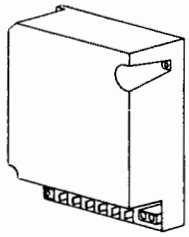
SERVICE SWITCH (SS)

The service switches are mounted in the electrical control enclosure. In the **LOCAL** or **OFF** position, the service technician has local control of the heater. These switches must be placed in the **REMOTE** position for normal control from the remote control station.



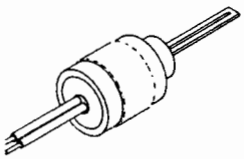
AIR FLOW SWITCH

The air flow switch senses the pressure drop across the burner. It is factory set and not adjustable. It is designed to prevent burner operation if the airflow significantly drops below the minimum design airflow of the heater. The minimum airflow for the C390/C600 is 1500 cfm; for the C900/C1200 is 3000 cfm; and for the C1900/C2500 is 6000 cfm.



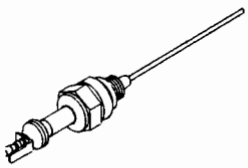
FLAME SAFEGUARD RELAY

The flame safeguard relay supplies 24 volts AC to the igniter for 17 seconds after which time the gas valve is energized. The onboard light emitting diode (LED) will flash each time the control is powered for the first time. If the burner does not light (flame is not established within 7 seconds), this control will lock out. Lockout is indicated by blinking of the onboard LED. If flame signal is lost during burner operation, the control will allow one retry for ignition. A steady light indicates that the control needs to be replaced.



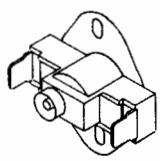
IGNITER

The hot surface igniter is the ignition source for lighting the gas in the burner. It is made of silicon carbide which is very fragile. Care should be used in handling. It operates on 24 volts and the current ranges from 1.3 to 1.7 amps. It will reach temperatures in excess of 2400 °F during the ignition trial. It is furnished with a vinyl sleeve for shock mounting and sealing the igniter in the mounting tube.



FLAME ROD

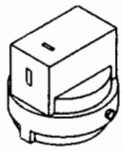
The flame rod senses the presence of flame, and signals the flame safeguard relay. The presence of flame is detected by the flame rectification of the AC signal that is supplied to the flame rod thus creating the DC response. The resulting current flow produced can be measured with a DC micro amp meter. The reading should be steady and between 0.5 and 1.2 micro amps.



HIGH TEMPERATURE LIMIT

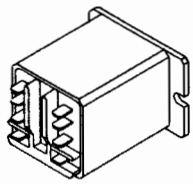
The high limit opens when discharge air temperature exceeds 180°F. This limit must be manually reset.

HIGH/LOW GAS PRESSURE SWITCH



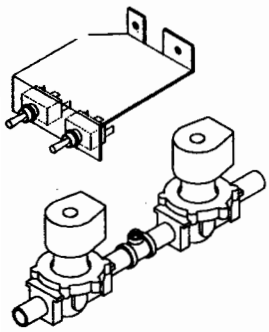
This gas pressure switch is a manual reset safety device to lock out the burner operation should large gas pressure fluctuations occur. The high gas pressure switch should be set at 4" W.C. above manifold gas pressure and the low pressure switch should be set at 2" W.C.. The adjustment screw is located under the top plate. **The low gas pressure switch will have to be reset whenever gas supply has been interrupted.**

LOW TEMPERATURE CUTOUT TIME DELAY RELAY



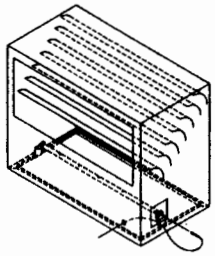
The low temperature cutout time delay relay is activated by the **LTC** thermostat in the ventilation mode or the CR2 relay (call for heat) in conjunction with the failure of the R1 relay to remain energized in the heating mode. The blower will shut off and the reset light at the remote control station will be illuminated after approximately four (4) minutes. The heater can be reset at the control station by turning the heater OFF and then ON.

LEAK TEST FACILITY



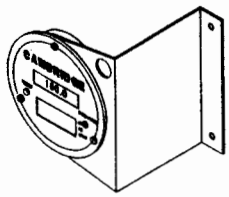
The leak test facility is provided on all heaters over 400,000 Btu/hr and consists of the following: a momentary switch for the first safety shut-off valve in the gas train; a gauge port between the first and second safety shut-off valve; and, if applicable, a momentary switch for the vent valve. By holding the gas valve momentary switch closed, the first gas valve is energized which allows gas pressure to build on the seat of the second gas valve. If the heater is supplied with a vent valve, both momentary switches would need to be held closed for the pressure to build on the seat of the second gas valve. The gauge port between valves is used to determine if the first gas valve seat is properly sealed. If the heater is supplied with a vent valve, the momentary switch for the vent valve would have to be held for pressure to build between the valves.

SENSOR/SAMPLING TUBE MOUNTING

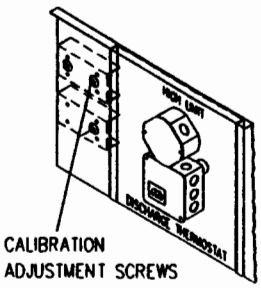


The sensor for measuring the discharge temperature is mounted in the downturn behind the access cover on the control enclosure side of the heater. The sensor is inserted into a hole in the sampling tube mounting bracket with the shrink tube forming a tight fit. Silicon RTV is then applied to hold the sensor in place.

TEMPERATURE DISPLAY MODULE (TDM)

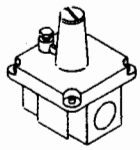


The **TDM** is provided to indicate the discharge temperature and the high limit temperature. It also aids in setting up the equipment and trouble-shooting. The **TDM** is powered by a photo-cell only and can be activated by shining a flashlight directly at the photo-cell. The **TDM** is supplied with a toggle switch on the face of the device to switch from the DISCHARGE to the HI LIMIT reading. The discharge sensor is installed in a sampling tube in the downturn when a downturn is provided. The high limit sensor is mounted immediatelv behind the high limit in the discharge duct.



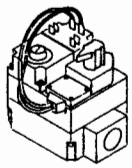
HIGH LIMIT AND DISCHARGE TEMPERATURE CONTROL SYSTEM ADJUSTMENT

The adjusting screws for the high limit and discharge temperature calibration procedures are shown on the adjacent figure. These should not be tampered with unless it is associated with the calibration procedures found on pages 34 thru 37 of this manual.



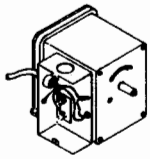
PRESSURE REGULATOR

The gas pressure regulator controls the burner manifold pressure. When the MR212 valve is used, this modulating valve also serves as the pressure regulator. The maximum gas supply pressure rating is normally determined by the exposed pressure rating of the regulating device. The RV-53 is rated at 14 " W.C.; the RV61 and RV81 are rated at 1 psig; and the MR212 is rated at 5 psig.



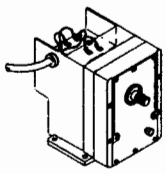
COMBINATION VALVE

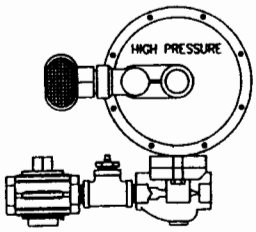
The combination valve serves as a pressure regulator and redundant gas shut-off valve. This control is typically used for gas capacities below 400,000 Btu/hr. The valve operates on 24 volts AC power. The combination valve is rated for a maximum gas supply pressure of 14 " W.C. .



DAMPER MOTOR

The damper motor operates on 24 volts AC and transmits power to the motor starter when the damper blades are fully open by the closure of the damper end switch. On the C390/C600 and C900/C1200 damper motor, the damper end switch is an adjustable internal SPDT auxiliary switch which has been factory set to operate when the damper is fully open. The end switch for the C1900/C2500 damper motor is not field adjustable.





HIGH PRESSURE REGULATOR (HPR)

The **HPR** option is required when the gas supply pressure exceeds the nameplate rating for the heater. Unless otherwise specified, the **HPR** assembly is also furnished with a high gas pressure manual shut-off valve and a tap for measuring the upstream gas pressure. The **HPR** must be a positive lock-up type regulator which must be vented to outdoors. It is sized according to the gas supply pressure and the capacity requirements of the heater.

OPERATING SEQUENCE

POWER ON

A. Control transformer energized.
B. Operator must select "SUMMER VENTILATION" or "HEATING" mode.

SUMMER VENTILATION MODE

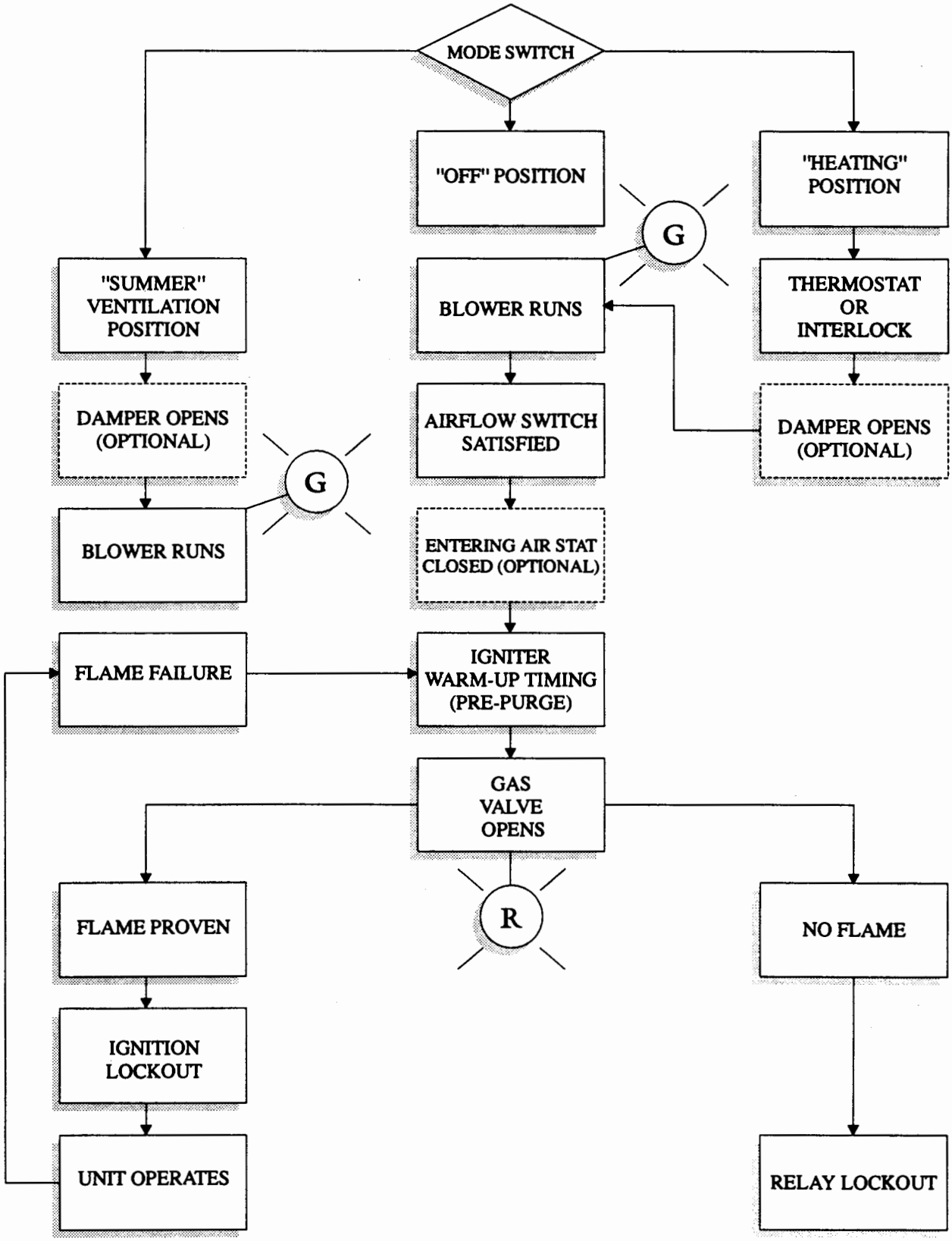
A. Mode switch in "SUMMER VENTILATION" position.
B. Optional motorized discharge damper opens.
C. Blower motor starts.
D. Unit continues to run until manually turned off.

NOTE:
On units supplied with TSS option, the TSS timer may be programmed to automatically operate this control option.

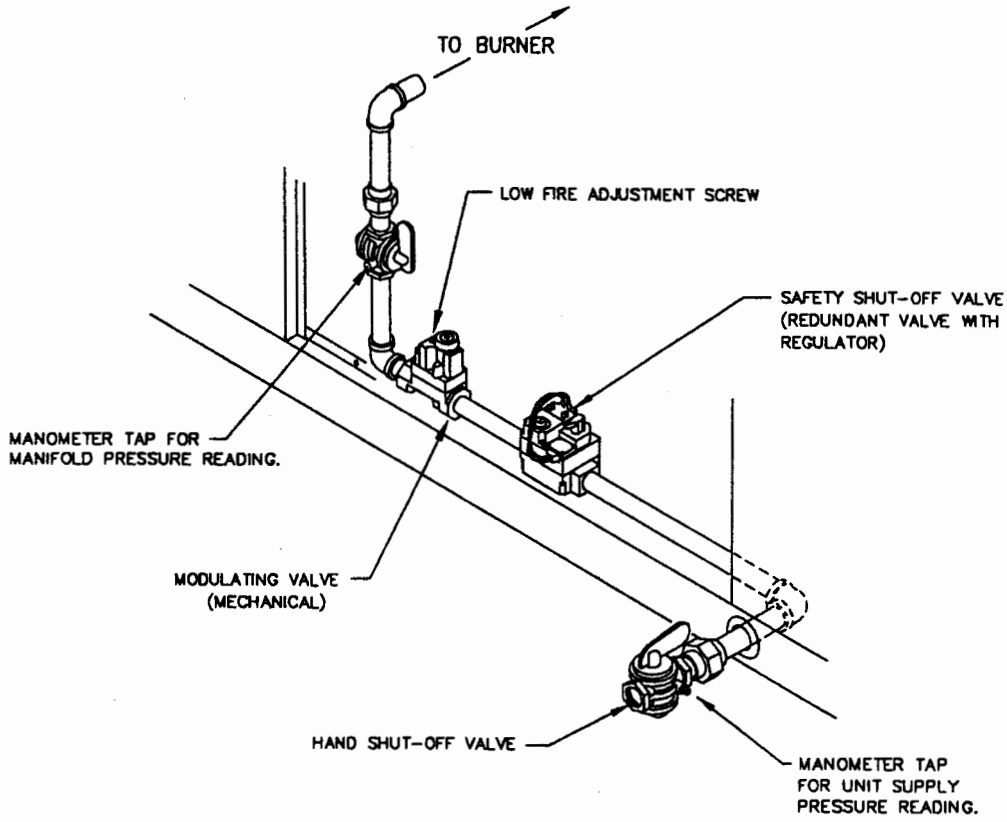
HEATING MODE

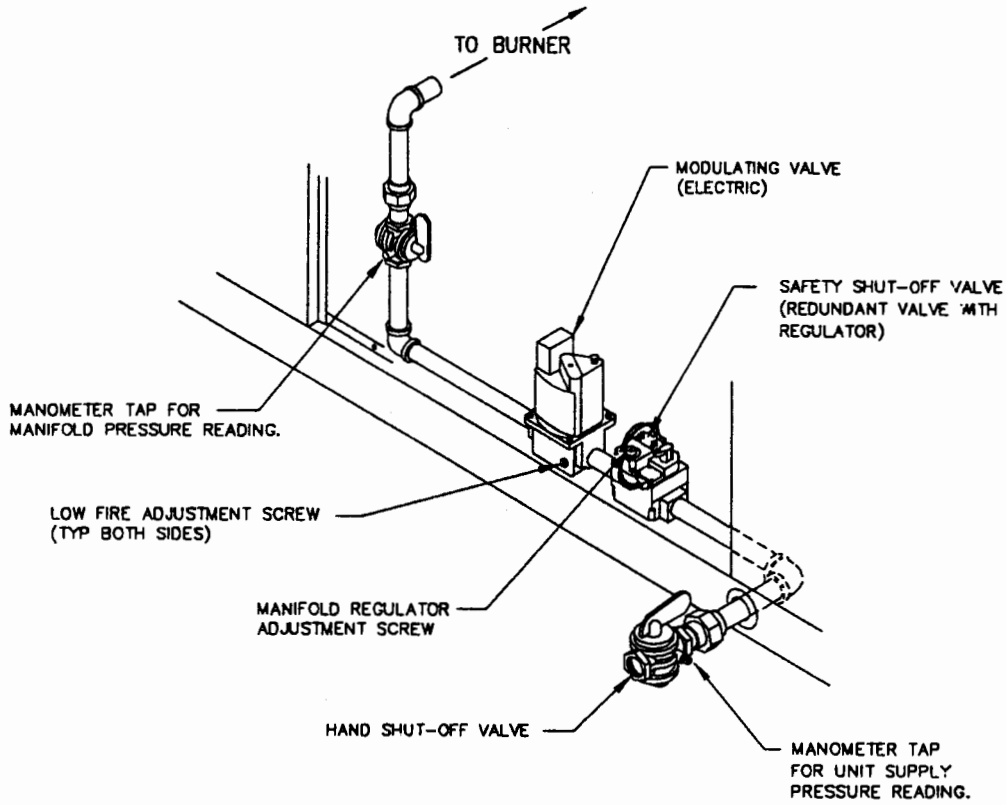
A. Mode switch in "HEATING" position.
B. Power is supplied to operating thermostat or interlock (nothing occurs until either control calls for heat).
C. Optional motorized discharge damper opens.
D. Blower motor starts.
E. Air flow switch closes.
F. Entering air thermostat (optional) closes when inlet temperature is below set point.
G. Ignitor warm up timing (pre-purge).
H. Gas valve opens.
I. Burner lights.
J. Ignition stops.
K. Unit runs until operating thermostat and/or interlock opens (unit shuts off).
L. Steps (B) through (K) repeat themselves automatically as necessary.

CONTROL SEQUENCE

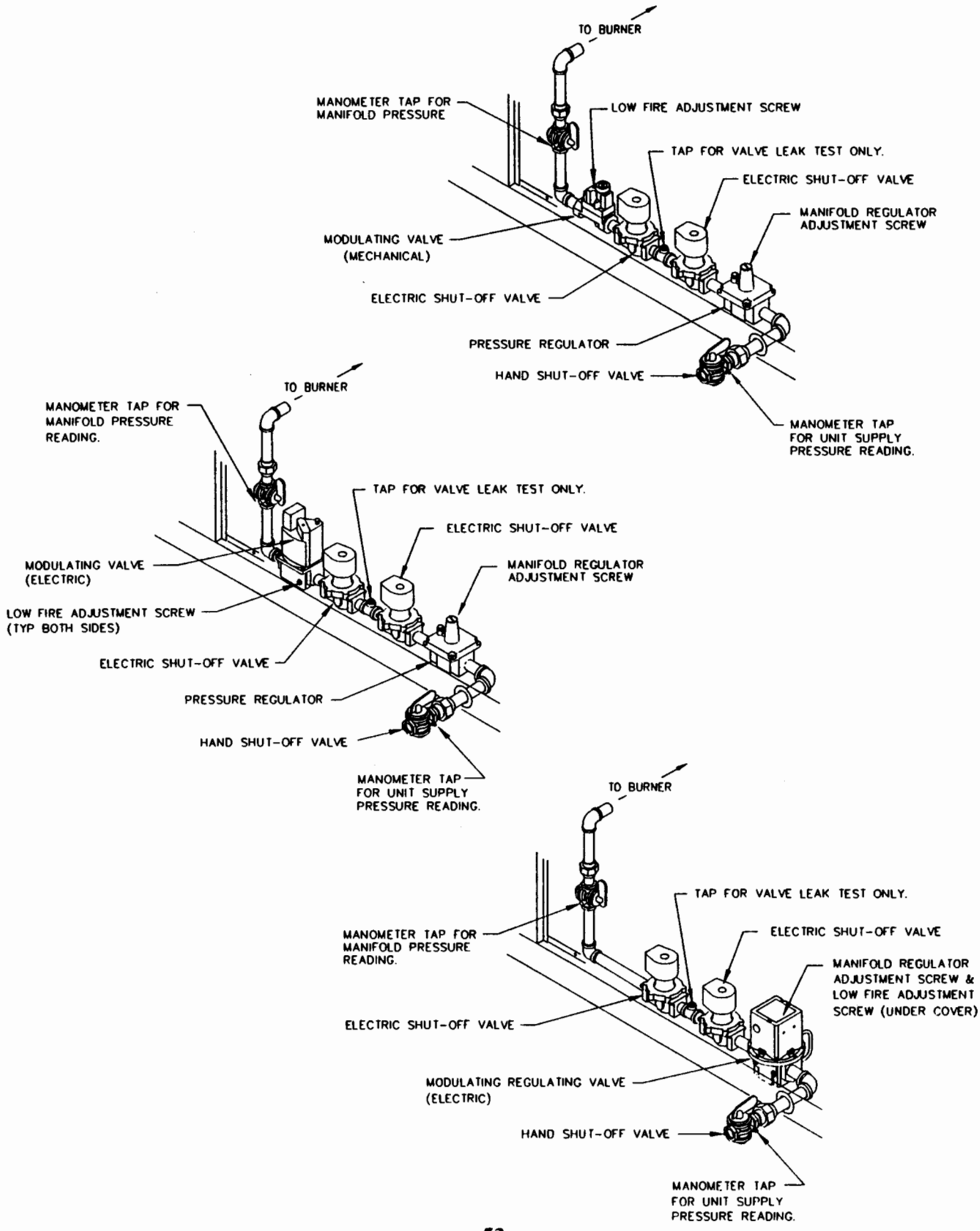


GAS TRAIN 400,000 BTU/HR AND BELOW (MD AND ED CONTROLS)

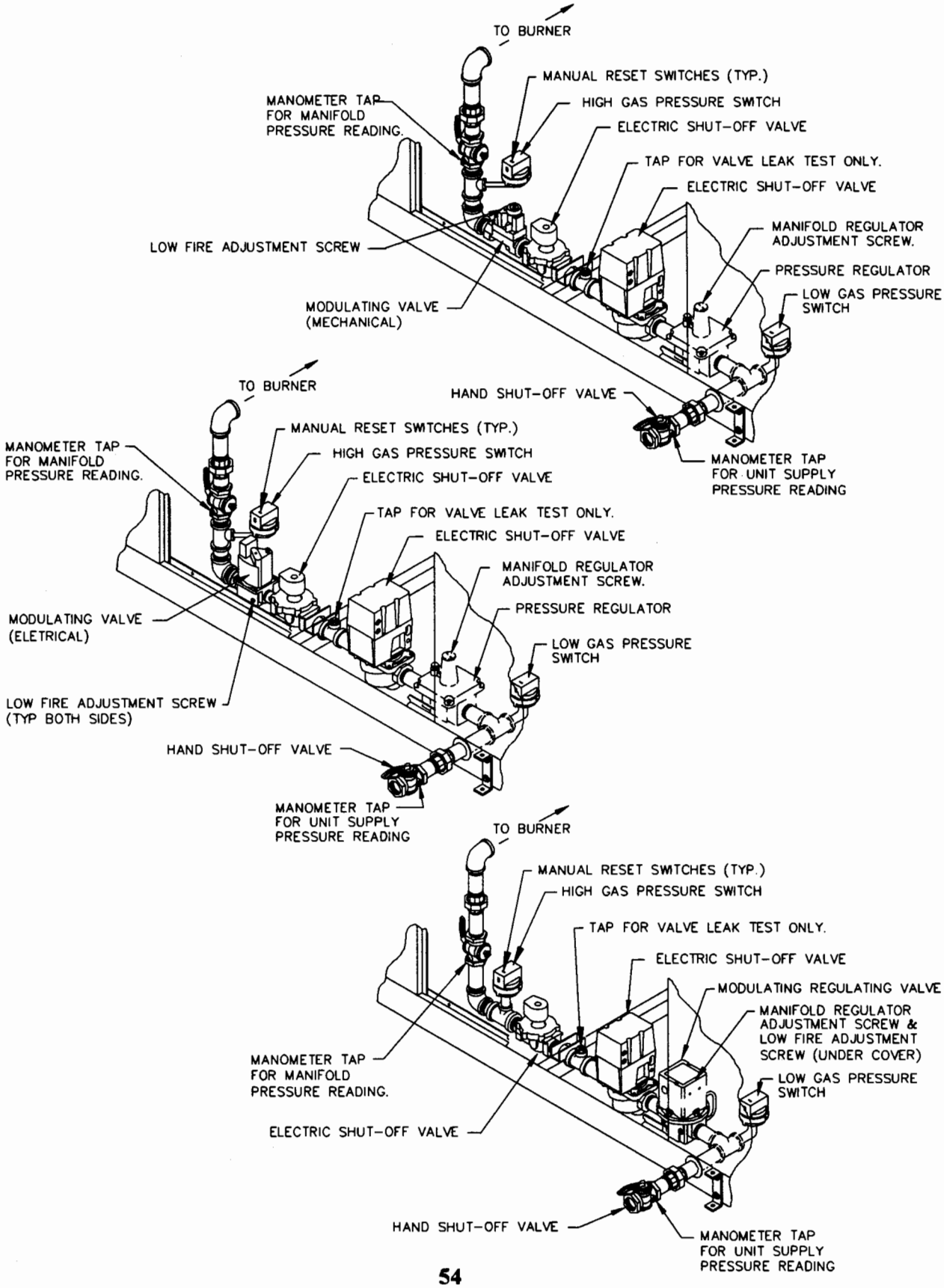




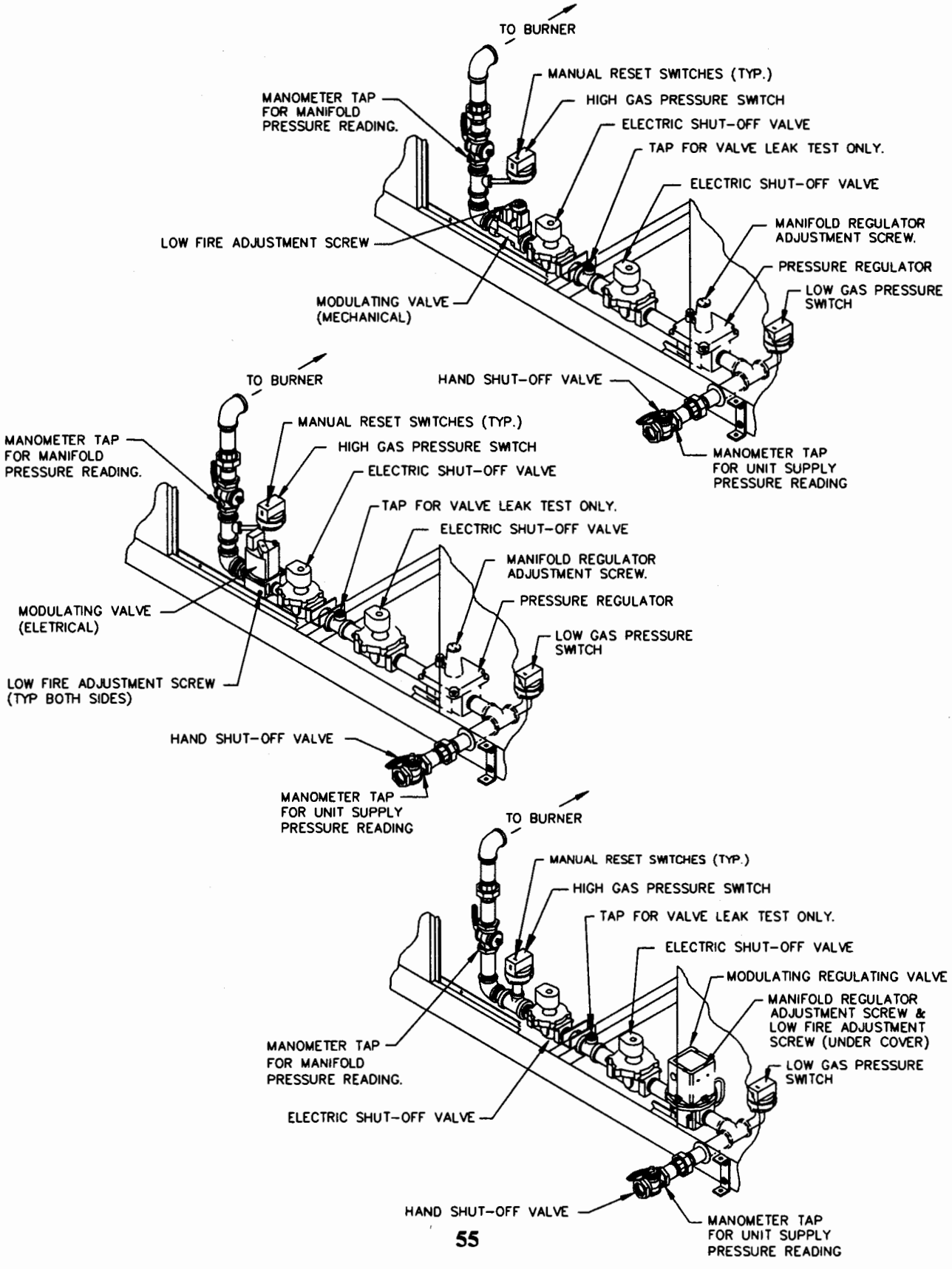
GAS TRAIN OVER 400,000 BTU/HR (MD AND ED CONTROLS)



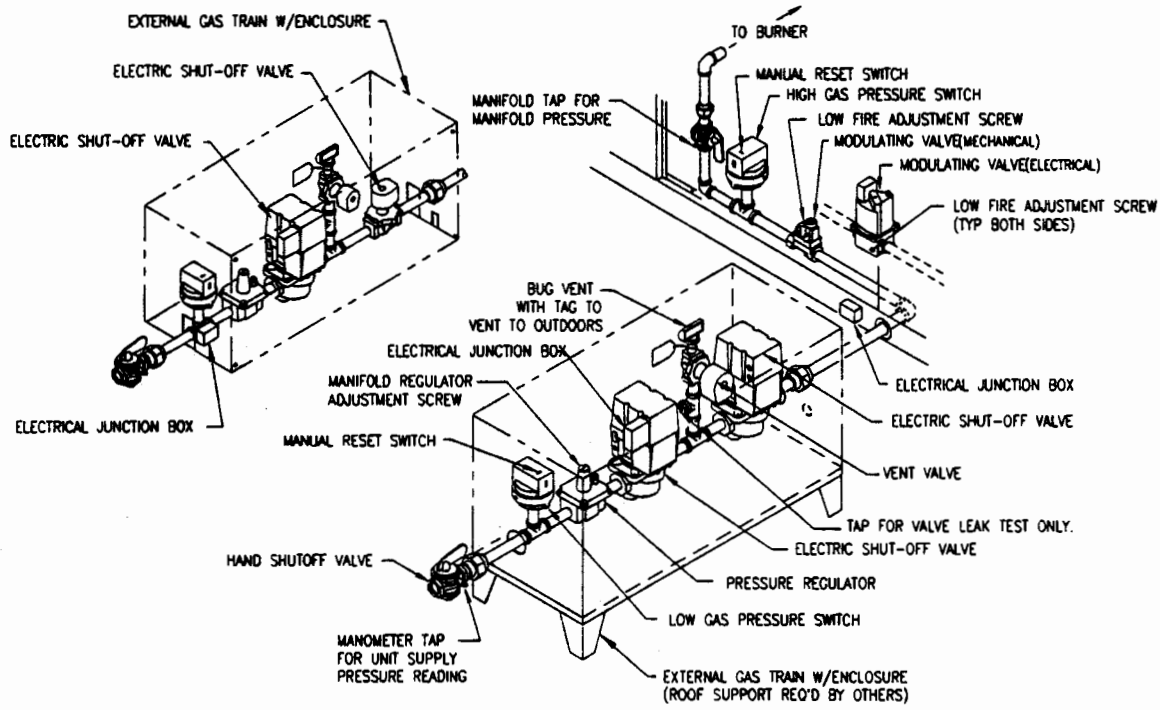
GAS TRAIN OVER 400,000 BTU/HR (MD AND ED CONTROLS)
FM (w/ Discharge Damper & w/o Filter Section)

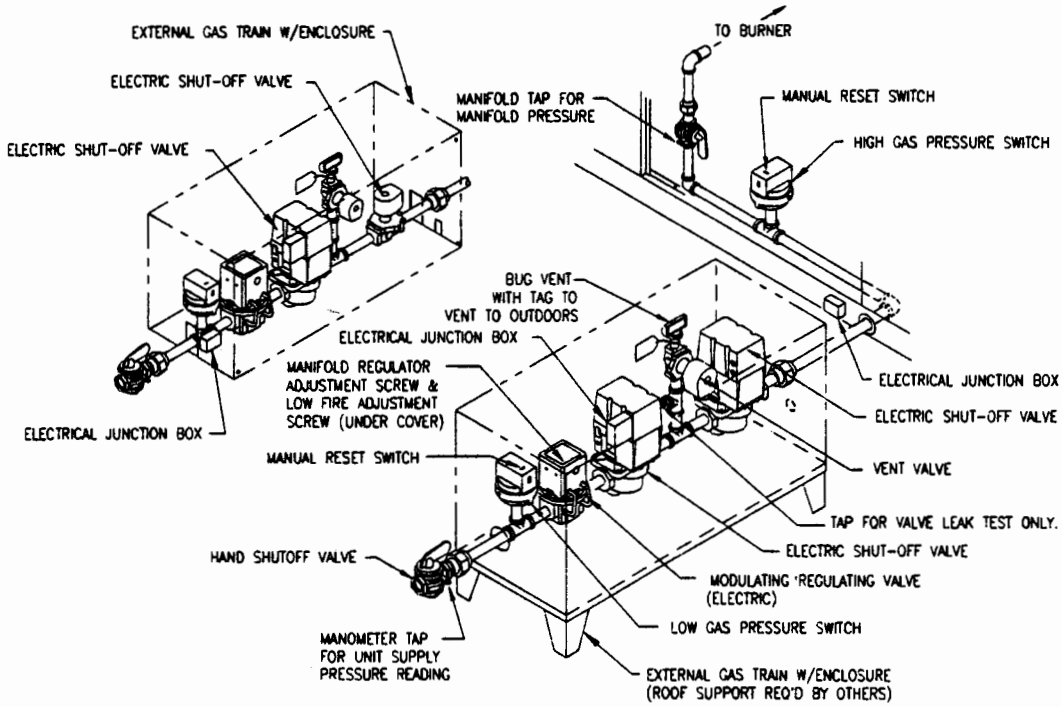


GAS TRAIN OVER 400,000 BTU/HR (MD AND ED CONTROLS)
IRI (Under 1,000,000 Btu/hr)



GAS TRAIN OVER 400,000 BTU/HR (MD AND ED CONTROLS)
FM (w/o Discharge Damper or w/ Filter Section) or
IRI (Over 1,000,000 Btu/hr)





MAINTENANCE INSTRUCTIONS

WARNING
Place the heater disconnect switch in the OFF position when performing service or maintenance functions.

BLOWER BEARING LUBRICATION

The C390, C600, C900, and C1200 model heaters have permanently lubricated, double shielded, and double sealed ball bearings which do not require additional lubrication. The C1900 and C2500 model heaters require lubrication on intervals of 3 to 6 months. Use Shell "Alvania #2", Exxon "Unirox N2", Mobile "532", Mobil "Mobilux #2", Texaco "Multifak #2", Texaco "Premium RB" lubricants.

MOTOR BEARING LUBRICATION

Motors are pre-greased normally with Shell "Dolium R". Equivalent greases which are compatible with the motor furnished grease are Chevron "SRI No. 2" and Texaco "Premium RB".

HOURS OF SERVICE PER YEAR	SUGGESTED RELUBE INTERVAL	
	NEMA FRAME SIZE	
	42 TO 215T	254 TO 326T
5000 HOURS	5 YEARS	3 YEARS
CONTINUOUS NORMAL APPLICATION	2 YEARS	1 YEAR
SEASONAL SERVICE MOTOR IS IDLE FOR 6 MONTHS OR MORE	1 YEAR (BEGINNING OF SEASON)	1 YEAR (BEGINNING OF SEASON)
CONTINUOUS HIGH AMBIENTS, DIRTY OR MOIST LOCATIONS, OR HIGH VIBRATION.	6 MONTHS	6 MONTHS

BELT TENSIONING

Proper belt tension is attained when a force of 6-9 pounds applied at the center span between the pulleys results in a 1/4"deflection for the C390, C600, C900, C1200 and 7/16" deflection for the C1900 and C2500. Periodic belt adjustments may be required. Indications of loose belts include barking or squealing when the blower starts.

BLOWER CLEANING

Blower wheel should be examined for accumulation of dust on the concave side of the blades. These surfaces must be kept clean. Dirt accumulation will result in significant air flow reduction and/or possible imbalance of blower wheel. Prolonged imbalance CAN result in catastrophic failure of the blower wheel and other related components.

BURNER CLEANING

The Cambridge Engineering burner is for the most part self-cleaning. However, if the application is extremely dirty or dusty, it may become necessary to periodically clean the burner. Remove and clean the burner in accordance with the following recommended procedures.

A. Turn the heater disconnect switch to the OFF position. Turn the manual shut-off valve that supplies gas to the OFF position.

B. Loosen union in the gas train.

CAUTION
Igniter is made of silicon carbide material and should be handled with care to avoid breakage.

C. Disconnect ignition cable from burner and then remove flame rod and igniter.

D. Examine flame rod ceramic for cracks and replace if necessary. Clean flame rod element with emery cloth to remove oxidation.

E. Remove fasteners that secure burner to the housing. Burner will then be free to slide out.

CAUTION
Be sure to take necessary safety precautions (such as wearing eye protection, etc) before attempting this step.

F. Clean burner by back-flushing using high pressure air (40-80#). Continue back-flushing until dust particles are completely expelled from burner.

G. Reassemble burner using above steps in reverse order. Ensure proper burner alignment by verifying that the burner lip on the discharge side is nested in its mating track(s).

GAS VALVE CLEANING

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise, or leakage will indicate that cleaning is required. Refer to step 8, Gas Valve Leak Check, of the Start-up Procedures, Page 31.

WARNING:

In the extreme case, faulty valve operation will occur and the valve may fail to open or fully close.

NOTE:

It is not necessary to remove the valve from the pipeline for repairs.

WARNING:

To prevent the possibility of severe personal injury or property damage, turn off electrical power, close the upstream manual gas valve, depressurize valve, extinguish all open flames and avoid any type of sparking or ignition. Vent hazardous or combustible fumes to a safe area before servicing the valve.

ASCO Gas Valves: Series 8214 (See page 60)

Disassemble valve and clean all parts as follows:

Note:

If parts are worn or damaged, install a complete ASCO Rebuild Kit.

A. Remove solenoid enclosure.

B. Remove bonnet screws, valve bonnet, bonnet gasket, core/diaphragm sub-assembly and body gasket.

C. All parts are now accessible to clean or replace.

D. Lubricate bonnet gasket and body gasket with a light coat of DOW CORNING ® 200 Fluid lubricant or an equivalent high-grade silicone fluid.

E. Apply a light coat of RemGrit TFL 50 ® Dry Lubricant to: Valve seat; Valve body surface where diaphragm assembly contacts the valve body and body gasket; and internal surface of valve bonnet where diaphragm assembly contacts bonnet when valve is in the energized (open position).

IMPORTANT:

If valve has been disassembled for inspection and cleaning only and a Rebuild Kit is not being installed, lubricate the following with RemGrit TFL 50® Dry Lubricant:

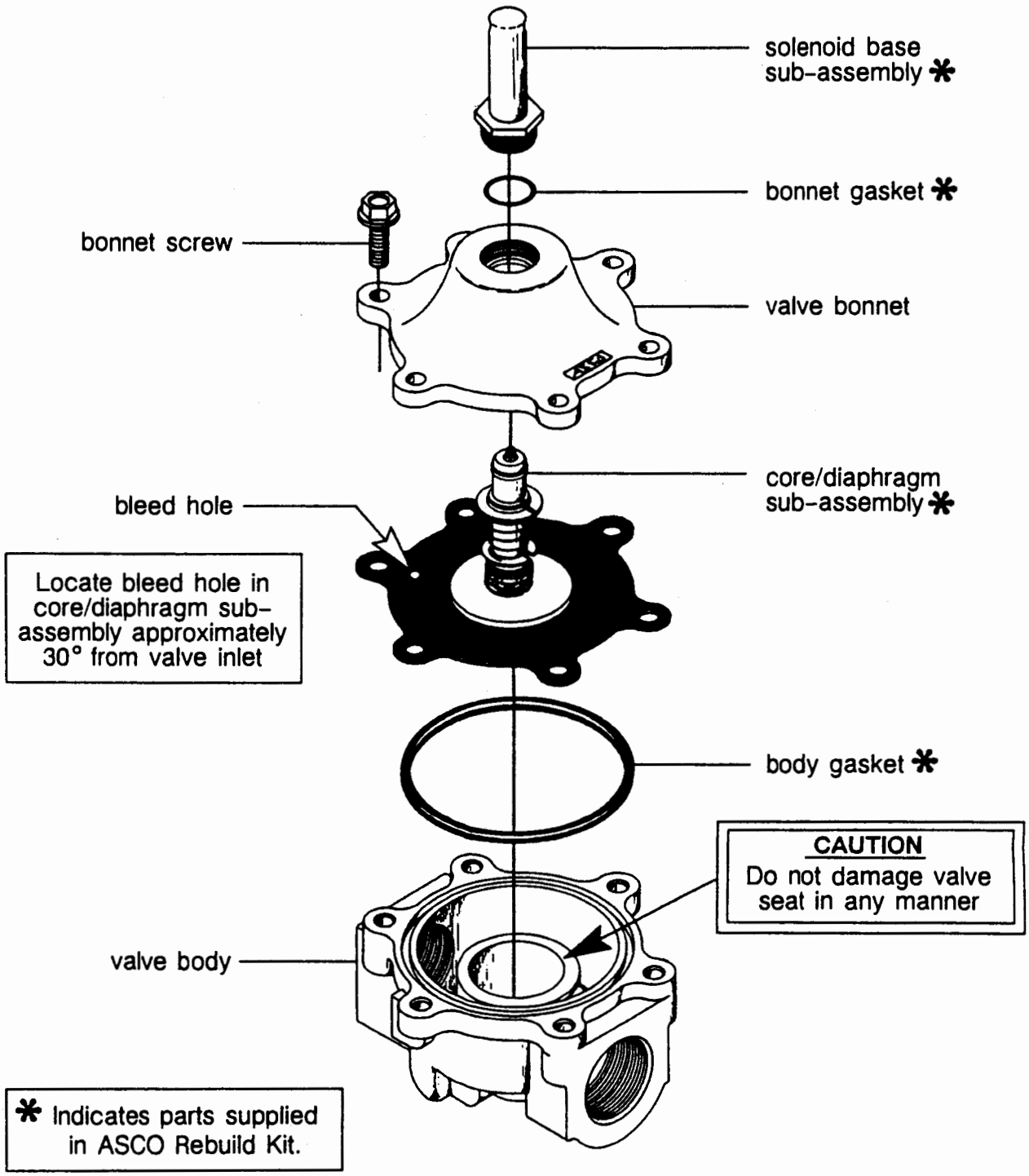
- Diaphragm assembly on both sides
- Main disc at base of core/diaphragm sub-assembly.
- Pilot disc at base of core assembly.

CAUTION:

Do not distort hanger spring between core assembly and diaphragm assembly when lubricating pilot disc.

F. Replace body gasket and core/diaphragm sub-assembly with closing spring attached. Locate bleed hole in core/diaphragm sub-assembly approximately 30° CCW from the valve inlet.

Disassembled View of ASCO Valve



G. Replace valve bonnet and bonnet screws (6). Torque screws in a crisscross manner to 100 ± 10 in-lbs. Replace solenoid and make electrical hookup.

WARNING:

To prevent the possibility of severe personal injury or property damage, check valve for proper operation before returning to service. Also perform a gas valve leak check and gas train leak check in accordance with Steps 8 and 9 of the Start-up Procedures, Pages 31 and 32.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded views are supplied in Rebuild Kits.

When ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

Honeywell Gas Valves: Series V5055A (See page 62)

Disassemble valve and clean all parts as follows:

Note:

If parts are worn or damaged, install a complete Honeywell Rebuild Kit.

A. Remove the valve actuator from the valve assembly by loosening the two Allen head screws and lifting actuator off.

B. Remove bonnet screws and valve bonnet assembly.

C. All parts are now accessible to clean or replace.

CAUTION:

Do not disassemble the valve bonnet assembly; the valve seat is not replaceable.

D. Depress the plunger and wipe or blow any contaminants or foreign material off valve seal.

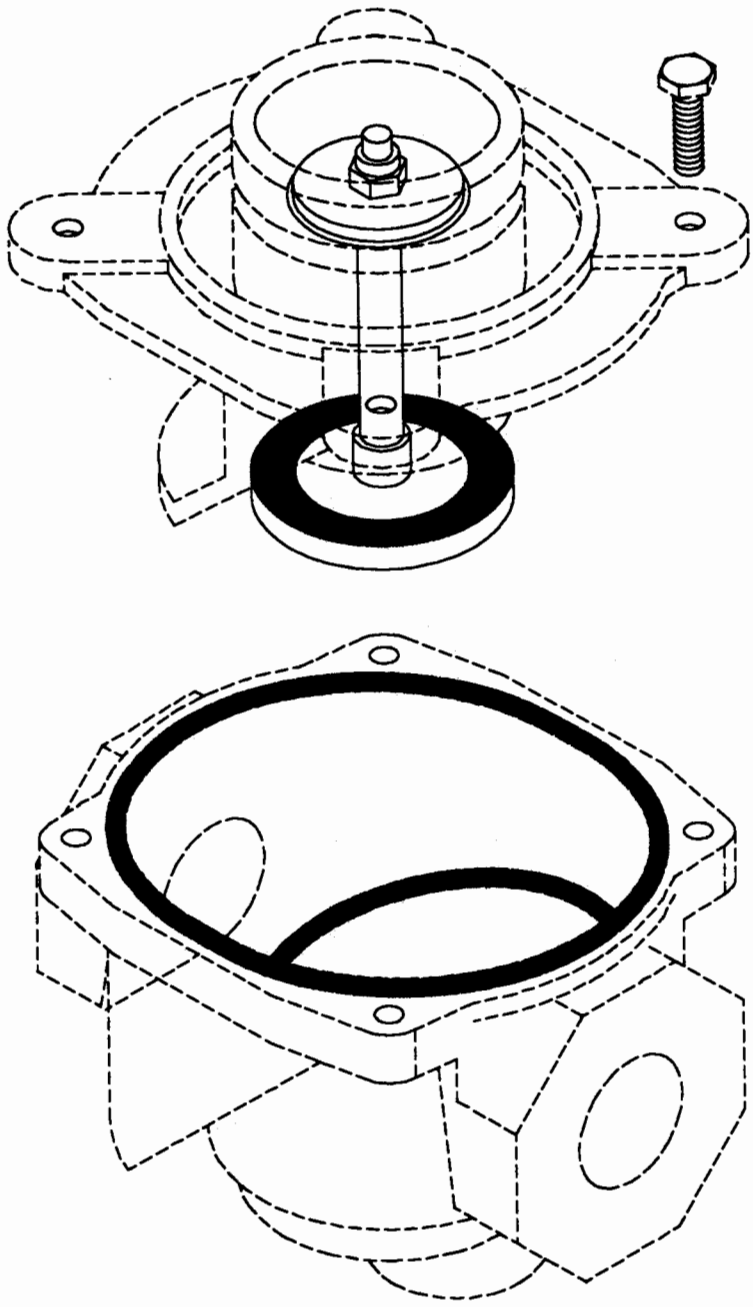
CAUTION:

Failure to properly position and seat the seals in valve body may result in a hazardous gas leak.

E. Carefully replace valve bonnet assembly and bonnet screws (4). Torque screws in a crisscross manner to 100 ± 10 in-lbs.

F. Re-install the actuator and tighten the Allen head screws into the groove in the valve assembly collar.

Disassembled View of Honeywell Valve



WARNING:

To prevent the possibility of severe personal injury or property damage, check valve for proper operation before returning to service. Also perform a gas valve leak check and gas train leak check in accordance with Steps 8 and 9 of the Start-up Procedures, Pages 31 and 32.

ORDERING INFORMATION FOR HONEYWELL REBUILD KITS

REPLACEMENT PARTS:

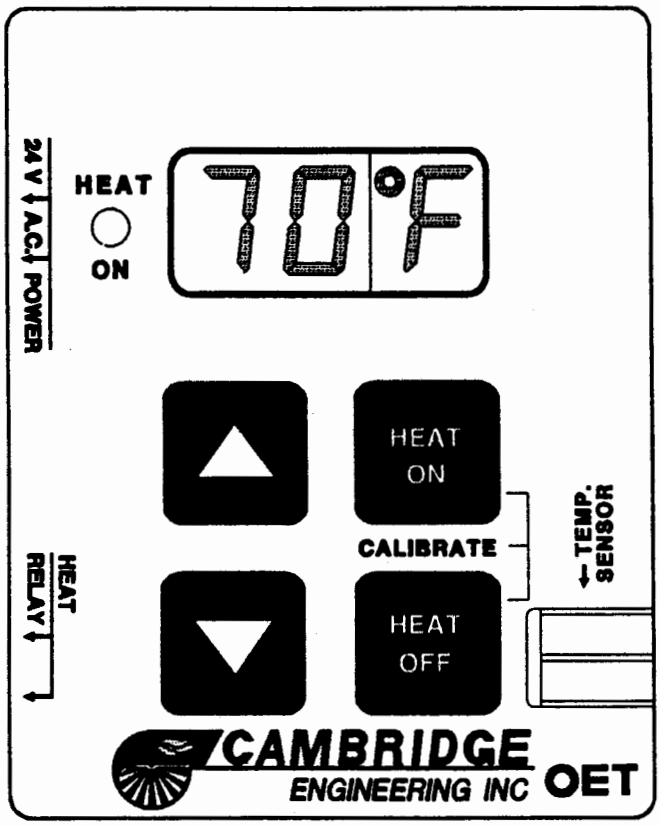
Replacement seal assembly -- includes valve seal, bonnet seal, and tube of lubricant. #133393A for 1, 1¼, and 1½ in. valves; #133392A for 2 in. valves.

Replacement bonnet assembly -- includes complete bonnet assembly, plus the required replacement seal assembly. #133398AA for 1, 1¼, and 1½ in. valves; #133417AA for 2 in. valves.

GAS TRAIN LEAK CHECK

Periodically check the gas control assembly, internal and external piping for leaks. Refer to Step #9, Gas Train Leak Check, of the Start-up Procedures, page 32. All relief vents on the gas controls should be checked for blockage (gas pressure regulators and pressure switches.)

OPERATING INSTRUCTIONS
FOR THE OPERATING ELECTRONIC THERMOSTAT



The Cambridge Engineering Electronic Thermostat includes the following features:

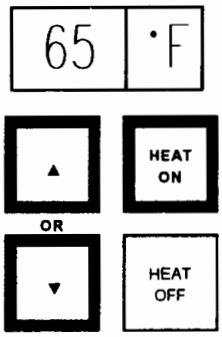
- Digital LED display of current temperature and temperature settings.
- LED indication of status of output relay.
- Separate settings for HEAT ON and HEAT OFF temperatures.
- Temperature Calibration for accurate temperature control.
- EEPROM storage maintains temperature settings indefinitely in case of power loss.

SETTING TEMPERATURES

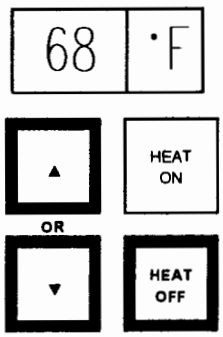
The Electronic Thermostat requires two temperature settings. When the temperature drops below the HEAT ON setting, the heater will turn on. When the heater raises the space temperature above the HEAT OFF setting, the heater will turn off. This difference provides an adjustable range of operation for the heater which minimizes short cycling.

The minimum run time and off time for the heater regardless of temperature are both set at 2 minutes. The allowable temperature range is 40°F to 99°F. **The HEAT OFF temperature can not be set lower than the HEAT ON temperature.**

1. Press and hold the **HEAT ON** button while pressing the ▲ or the ▼ button until the desired temperature for the heater to turn ON is displayed.



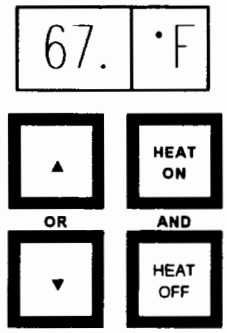
2. Press and hold the **HEAT OFF** button while pressing the ▲ or the ▼ button until the desired temperature for the heater to turn OFF is displayed.



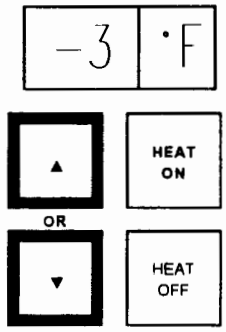
TEMPERATURE CALIBRATION

To compensate for lead wire resistance, it may be necessary to make an adjustment to the displayed temperature to correct it to the temperature measured at the thermistor sensor. The calibration feature allows the displayed temperature to be offset either above or below the actual sensed temperature. Be sure to use an accurate temperature meter for making this correction.

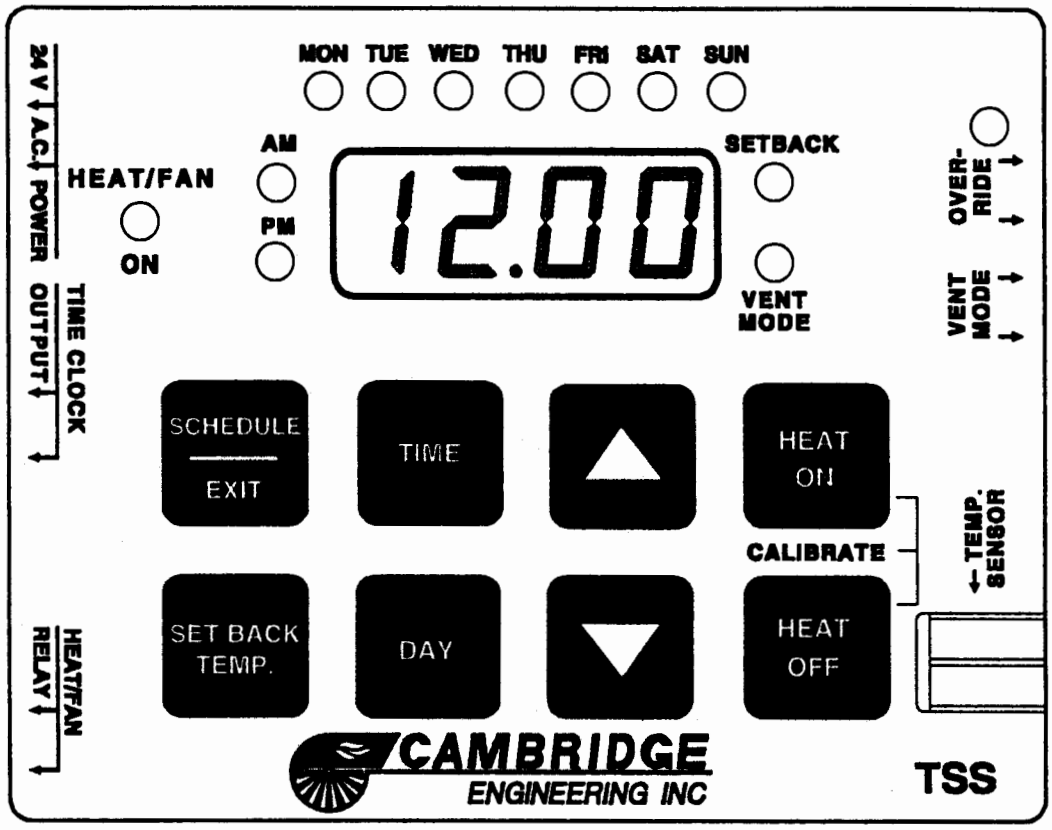
1. Press and hold the **HEAT ON** and **HEAT OFF** buttons while pressing the ▲ or the ▼ button until the correct temperature is displayed. (A period [.] after the temperature will indicate the Calibration Mode).



2. Pressing the ▲ or the ▼ button will display the current calibration difference above or below (-) the measured temperature.



OPERATING AND PROGRAMMING INSTRUCTIONS FOR THE TSS CONTROLLER



The Cambridge Engineering TSS Controller provides several features to tailor the operation of the Cambridge heating system to particular applications.

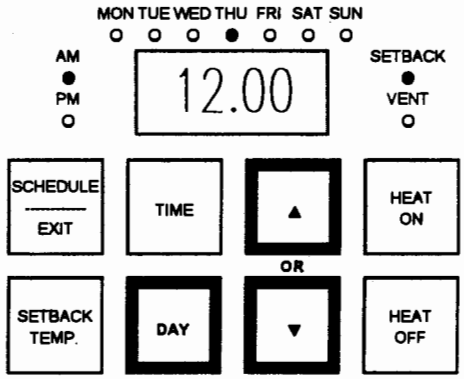
- Seven day programmable clock.
- Separate temperature settings for Heating and Setback operation.
- Separate schedules for Summer Ventilation and Heating modes.
- Setback Override for temporary heating operation.
- Holiday Setback Timer for temporary setback operation of up to 10 days.
- Temperature Calibration for accurate temperature control.
- Capacitor backup maintains current time and day of week for power loss of up to 48 hours.
- EEPROM storage maintains schedules and temperature settings indefinitely.

SETTING CURRENT DAY AND TIME

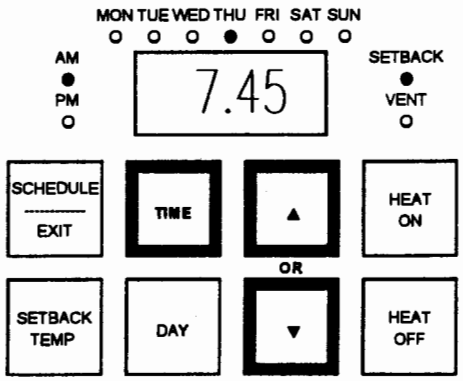
For proper operation of the scheduler, the TSS Controller clock must be set to the correct time and day of the week. In the event of power loss of more than 48 hours, these settings must be updated.

During normal operation, the TSS Controller display will alternate between the current space temperature and the current time and day of the week.

1. Press and hold the **DAY** button while pressing the ▲ or the ▼ button until the light for the current day is illuminated .



2. Press and hold the **TIME** button while pressing the ▲ or the ▼ button until the current time is displayed.



SETTING TEMPERATURES

The TSS Controller has two temperature control modes with the key switch on the front of the **TSS** enclosure in the HEATING position. The HEAT mode controls the heater when the ON time schedule is in effect. The SETBACK mode controls the heater when the OFF time schedule is in effect. (See **SETTING SCHEDULES** for instructions on setting the ON and OFF schedules).

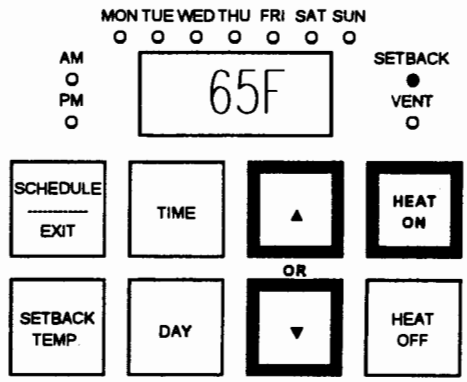
With the key switch in the SUMMER VENTILATION position the heater fan will run based on the time schedule with no temperature control.

HEAT MODE (ON Time Schedule)

The HEAT mode requires two temperature settings. When the temperature drops below the HEAT ON setting the heater will turn on. When the heater raises the space temperature above the HEAT OFF setting, the heater will turn off. This difference provides an adjustable range of operation for the heater which minimizes short cycling.

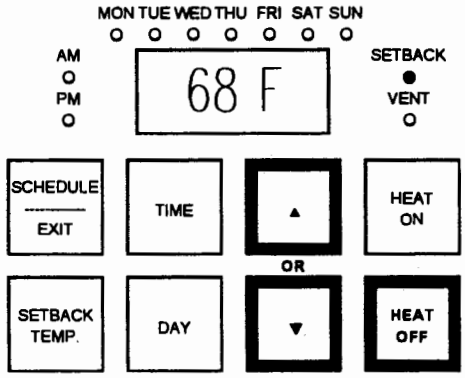
The minimum on time and off time for the heater regardless of temperature is 2 minutes. The allowable temperature range is 40°F to 99°F. **The HEAT OFF temperature can not be set lower than the HEAT ON temperature.**

1. Press and hold the **HEAT ON** button while pressing the ▲ or the ▼ button until the desired temperature for the heater to turn ON is displayed.



SETTING TEMPERATURES (cont.)

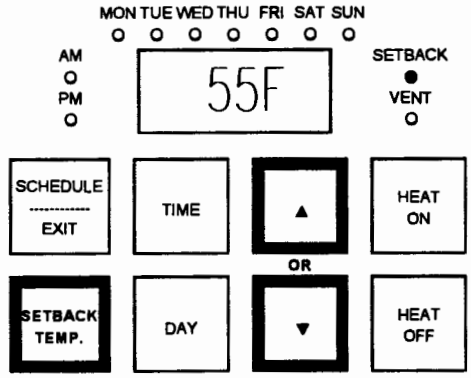
2. Press and hold the **HEAT OFF** button while pressing the ▲ or the ▼ button until the desired temperature for the heater to turn OFF is displayed.



SETBACK MODE (OFF Time Schedule)

The SETBACK mode requires setting only the ON temperature. The OFF temperature will be automatically set based on the temperature difference between HEAT ON and HEAT OFF programmed above for the HEAT mode.

1. Press and hold the **SETBACK TEMP.** button while pressing the ▲ or the ▼ button until the desired temperature for the heater to turn ON is displayed.



SETBACK OVERRIDE

In instances where temporary heat is desired when the scheduler is in the SETBACK mode, the OVERRIDE timer can be used. Setting this timer, located on the front of the TSS panel, will override the SETBACK temperature setting and increase the space temperature to the HEAT temperature setting for the amount of time set on the OVERRIDE timer.

SETTING SCHEDULES

The TSS Controller has separate programmable daily schedules for the HEATING and the SUMMER VENTILATION modes. The schedule currently in effect is determined by the position of the key switch in the door of the enclosure.

With the key switch in the HEATING or OFF position, the schedule for the HEAT (ON) and SETBACK (OFF) time periods is accessible. (See **SETTING TEMPERATURES** for instructions on setting the HEAT and SETBACK temperatures).

With the key switch in the SUMMER VENTILATION position, the schedule for the Ventilation ON and OFF time periods is accessible. (This will be indicated by the **VENT MODE** light on the TSS Controller being illuminated).

Before attempting to program the schedule, determine the planned time periods for HEAT (ON) and SETBACK (OFF) for the HEATING mode and the planned ON and OFF time periods for the Ventilation mode. The time that it takes to recover from the SETBACK temperature to the HEAT temperature must also be taken into consideration for the ON time in the HEATING mode. The following charts can be filled in for a reference during the programming of the schedule.

There are eight available ON and OFF program cycles for both HEATING and SUMMER VENTILATION. The first ON and OFF cycles are fixed for Monday through Friday and should only be used when the schedules for those days are identical. The seven additional numbered cycles can be programmed for any one day.

A Holiday Setback Timer is available for temporary operation in the Setback Mode of up to 250 hours without affecting the current schedules.

All unused program cycles should not contain any settings. Check all cycles after programming to assure that the display for unused cycles shows " --:-- ". If undesired settings have been entered, scroll the time display until " --:-- " is displayed (between 11.59PM and 12.00AM).

HEATING SCHEDULE

CYCLE	TIME	AM/PM	DAY
ON			M - F
OFF			M - F
HLdY			
ON1			
OFF1			
ON2			
OFF2			
ON3			
OFF3			
ON4			
OFF4			
ON5			
OFF5			
ON6			
OFF6			
ON7			
OFF7			

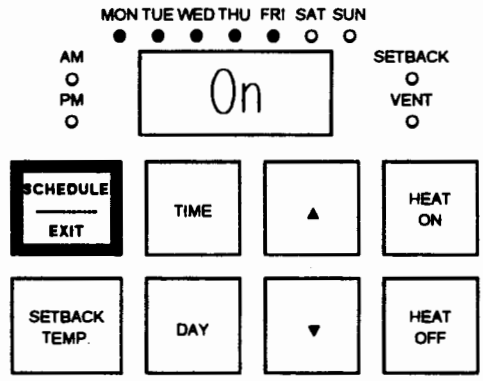
SUMMER VENTILATION SCHEDULE

CYCLE	TIME	AM/PM	DAY
ON			M - F
OFF			M - F
HLdY			
ON1			
OFF1			
ON2			
OFF2			
ON3			
OFF3			
ON4			
OFF4			
ON5			
OFF5			
ON6			
OFF6			
ON7			
OFF7			

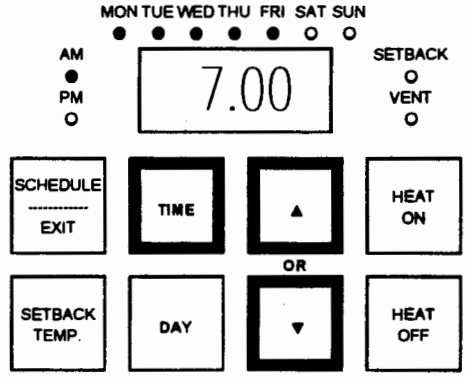
SETTING SCHEDULES (cont.)

1. **Switch the key switch on the front of the enclosure to the desired operating mode.** Allow ten seconds before proceeding.

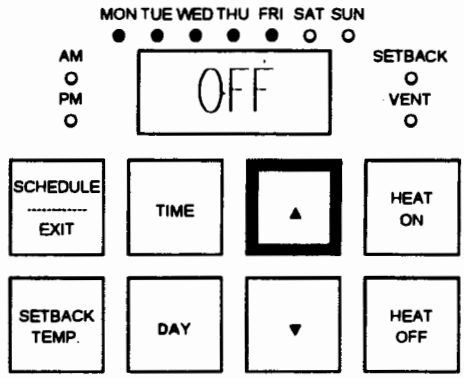
2. Press the **SCHEDULE/EXIT** button to enter the scheduling program at the first ON cycle.



3. Press and hold the **TIME** button while pressing the ▲ or the ▼ button to scroll to the desired ON time for Monday through Friday.

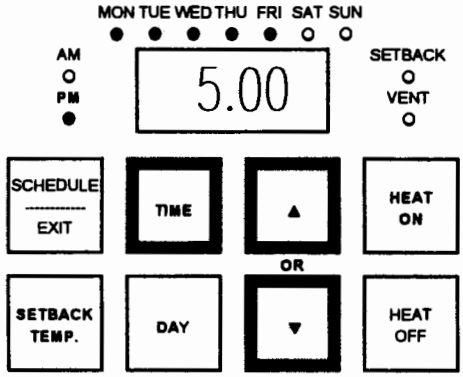


4. Press the ▲ button once to step to the first OFF cycle.



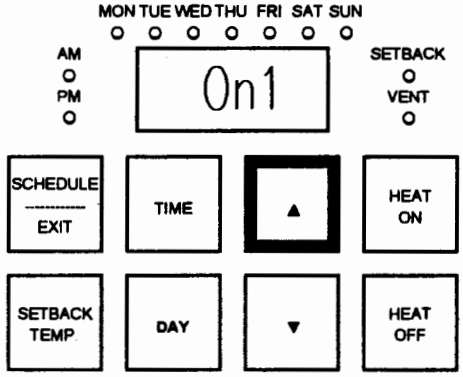
SETTING SCHEDULES (cont.)

5. Press and hold the **TIME** button while pressing the ▲ or the ▼ button to scroll to the desired OFF time for Monday through Friday.



6. **If Monday through Friday is the only schedule required, proceed to Step 14.** If any additional programming is required, proceed with the following steps.

7. Press the ▲ button once to step to the next ON cycle.

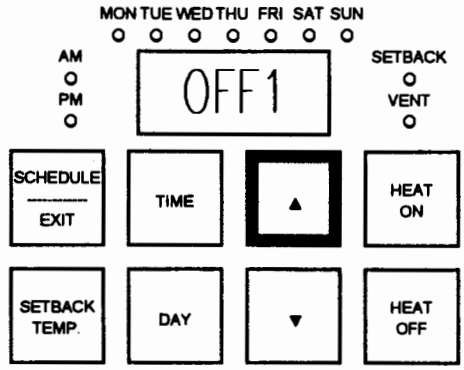


8. Press and hold the **TIME** button while pressing the ▲ or the ▼ button to scroll to the desired ON time.

9. Press and hold the **DAY** button while pressing the ▲ or the ▼ button until the light for the desired day is illuminated.

SETTING SCHEDULES (cont.)

10. Press the ▲ button once to step to the next OFF cycle.

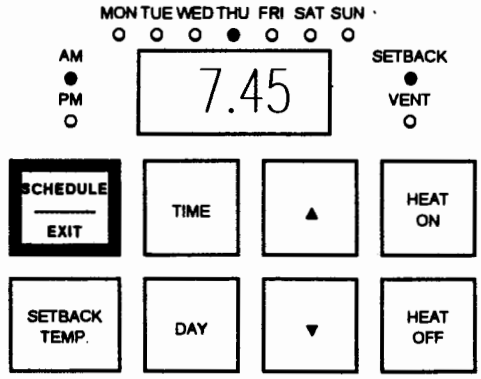


11. Press and hold the **TIME** button while pressing the ▲ or the ▼ button to scroll to the desired OFF time.

12. Press and hold the **DAY** button while pressing the ▲ or the ▼ button until the light for the desired day is illuminated.

13. Repeat steps 7-12 until all required program cycles have been entered.

14. Press the **SCHEDULE/EXIT** button to exit the scheduling program.



15. Verify that the correct current time and light for day of the week are still displayed.

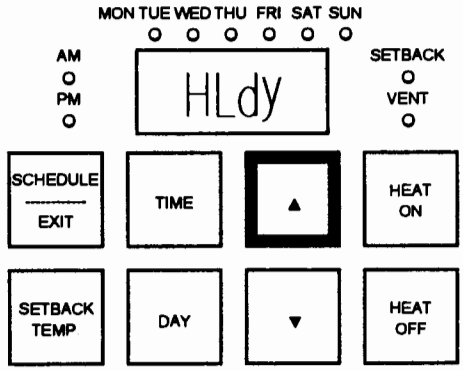
HOLIDAY SETBACK TIMER

The Holiday Setback Timer overrides the normal schedule and holds the space at the SETBACK temperature. Set the timer for the number of hours the facility will be unoccupied (up to 250 hours). **The timer starts immediately after setting.**

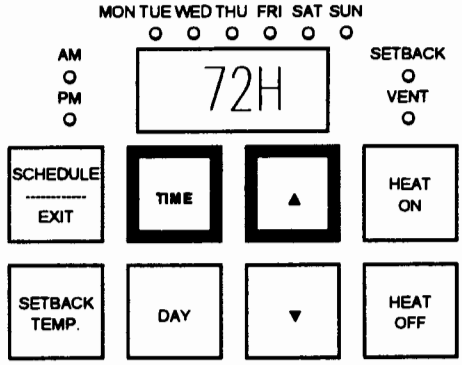
Example: For a Monday holiday with a M-F 8:00AM-5:00PM schedule, start the timer for 72 hours at 5:00PM Friday.

1. Press the **SCHEDULE/EXIT** button to enter the scheduling program.

2. Press the ▲ button twice to step to the Holiday Setback Timer.



3. Press and hold the **TIME** button while pressing the ▲ or the ▼ button until the desired setback time period (in Hours) is displayed.



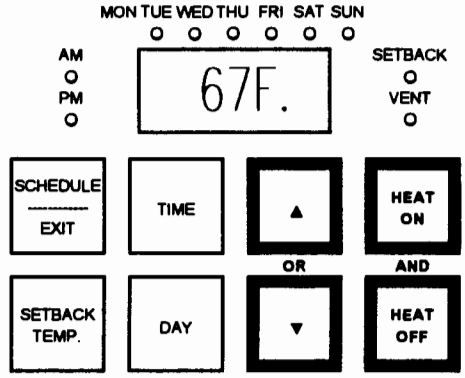
4. Press the **SCHEDULE/EXIT** button to exit the scheduling program. The heater will now operate in the SETBACK mode for the amount of time set in the Holiday Setback Timer.

NOTE: During Holiday Setback, the display will alternate between the current space temperature, the current time, and the hours remaining in the Holiday Setback period.

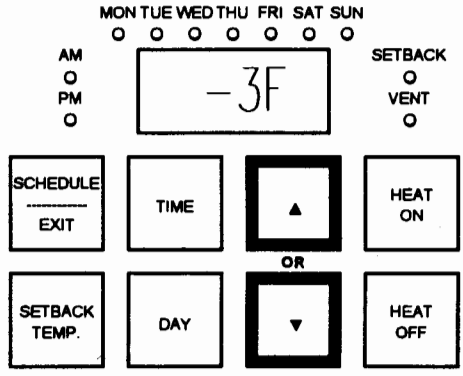
TEMPERATURE CALIBRATION

To compensate for lead wire resistance, it may be necessary to make an adjustment to the displayed temperature to correct it to the temperature measured at the thermistor sensor. The calibration feature allows the displayed temperature to be offset either above or below the actual sensed temperature. Be sure to use an accurate temperature meter for making this correction.

1. Press and hold the **HEAT ON** and **HEAT OFF** buttons while pressing the ▲ or the ▼ button until the correct temperature is displayed. (A period [.] after the **F** will indicate the Calibration Mode).



2. Pressing the ▲ or the ▼ button will display the current calibration difference above or below (-) the measured temperature.



TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
I. NO BLOWER OPERATION	1. Mode Selector Switch	
	a) Switch in OFF position	a) Place switch in proper mode
	2. Blower Service Switch	
	a) Switch in OFF position	a) Place switch in REMOTE position
	b) Defective switch	b) Replace switch
	3. Control Transformer	
	a) No input voltage	a) Check disconnect and supply fusing
	b) Blown control fuse	b) Replace control fuse
	c) Defective transformer	c) Replace transformer
	4. Unit in Reset	
	a) Time Delay relay timed out (Outside temperature below 45°F in Vent Mode or R1 relay not energized on call for heat)	a) Turn unit OFF momentarily and turn unit ON
	5. Damper End Switch	
	a) Switch not made	a) Adjust end switch setting
	b) Damper not operating	b) Check damper operation
	c) Defective Damper Motor	c) Replace damper motor
	6. Motor Protection	
	a) Overload relay tripped	a) Reset overload relay and check motor amps/overload setting
	b) Overload relay defective	b) Replace overload relay
	7. Motor Starter	
	a) Defective starter	a) Replace starter
	8. Motor	
	a) No input voltage	a) Check fusing
	b) Improper wiring	b) Correct wiring
	c) Defective motor	c) Replace Motor
	9. Blower Damage	
	a) Defective or locked bearings.	a) Replace bearings
	b) Check for physical damage	b) Replace or repair blower
	10. Belts	
	a) Belt Slipping	a) Tighten belts
	b) Belt broken or missing	b) Replace belts
	11. Control Relays	
	a) Improper part	a) Check relay voltage (24 volt)
	b) Improper wiring	b) Check wiring
	c) Defective relay (CR-1)	c) Replace relay
	12. Operating Thermostat	
	a) Thermostat satisfied	a) Adjust thermostat, if applicable
	b) Open in thermistor circuit	b) Check wiring or replace thermistor
	c) Defective thermostat	c) Replace thermostat

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
II. BLOWER RUNS; NO HEAT; FLAME SAFETY RELAY DOESN'T LOCK OUT	1. Mode Selector Switch	
	a) Switch in VENT position	a) Place switch in proper mode
	2. Burner Service Switch	
	a) Switch in OFF position	a) Place switch in REMOTE position
	3. Entering Air Thermostat	
	a) Thermostat satisfied	a) Adjust thermostat, if applicable
	4. Airflow Switch	
	a) Blower running backwards	a) Reverse motor direction
	b) Belts slipping	b) Tighten and/or replace belts
	c) Blocked intake or discharge	c) Find and remove obstruction
	d) Clogged airflow tubing or pick-up ports	d) Clean or replace tubing or pick-up ports
	e) Switch defective	e) Replace switch
	5. Flame Safeguard Relay (FSR)	
	a) No input voltage	a) Check wiring
	b) Defective FSR	b) Replace FSR
III. BLOWER RUNS; NO HEAT; FLAME SAFETY RELAY LOCKS OUT	1. Igniter	During trial for ignition:
	a) No current (open igniter)	a) Check igniter current
	b) No voltage	b) Check FSR output to igniter
	2. High Limit	
	a) High limit tripped	a) See Problem Number VI. (P.75)
	3. Gas Valve	
	a) No input voltage	a.1) Check FSR output to R1 relay during ignition trial
		a.2) Check gas valve circuit and wiring
	b) Gas valve does not open	b.1) Compare supply voltage to nameplate voltage
		b.2) Inlet gas pressure too high.
	c) Defective solenoid	b.3) Clean and/or replace gas valve parts
		c) Replace solenoid or valve assembly
	4. Modulating Valve	
	a) Low fire set too low	a) Adjust low fire on modulating valve
	5. Regulator	
	a) Clogged vent orifice	a) Clean or replace orifice
	b) No supply pressure	b) Check all gas cocks and piping
	c) Improper manifold pressure	c) Adjust regulator
	d) Defective regulator	d) Replace regulator
	6. High or Low Gas Pressure Switch	
	a) Gas pressure switch tripped	a.1) Check gas supply for low gas pressure or no gas
		a.2) Check manifold gas pressure for high pressure reading
	b) Pressure switch defective	b) Replace gas pressure switch

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
IV. BLOWER RUNS; UNIT HEATS; FLAME SAFETY RELAY LOCKS OUT	1. Low Flame Current	
	a) Flame rod oxidized	a) Scrape oxide coating off rod or replace flame rod
	b) Dirt build-up on insulator	b) Clean dirt deposit from insulator surface and install protective boot
	c) Low fire set too low	c) Adjust low fire on modulating valve
	2. No flame Current	
	a) Flame rod oxidized or grounded	a) Replace flame rod
	b) Ground connection open	b.1) Reference transformer to ground b.2) Secure FSR grounded b.3) Tighten loose ground screws
	c) Wire termination oxidized	c) Clean terminal and reinsert
	3. Fluctuating Flame Current	
	a) Unit overfiring	a) Check manifold pressure
	b) Defective Burner	b) Replace burner
	c) Intermittent ground connection	c) Tighten all ground points
	4. R1 Relay	
	a) Welded contact in LTC circuit	a) Replace relay
	5. Flame Safeguard Relay	
	a) Defective FSR	a) Replace relay
V. BLOWER RUNS; UNIT HEATS; SHORT CYCLES WITHOUT RESETTING	1. Air Flow Switch	
	a) Blower running backwards	a) Reverse motor direction
	b) Belts slipping	b) Tighten and/or replace belts
	c) Blocked intake or discharge	c) Find and remove obstruction
	d) Air delivery below unit specs	d) Increase fan RPM for air delivery to comply with minimum requirements
	e) Clogged airflow tubing or pick-up ports	e) Clean or replace airflow tubing or pick-up ports
	f) Defective switch	f) Replace switch
	2. Flame Safeguard Relay	
	a) Defective FSR	a) Replace FSR
	3. Operating Thermostat	
	a) Differential temperature setting too tight	a) Increase differential temperature setting
	4. Damper Motor End Switch	
	a) End switch not adjusted properly	a) Adjust end switch
	5) Entering Air Thermostat	
	a) Differential temperature setting too tight	a) Increase differential temperature setting

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
VI. HIGH LIMIT TRIPPED	1. High Limit	
	a) TDM reading for high limit temperature above 160°F	a) Perform high limit calibration (See Page 34)
	b) High limit will not reset	b) Replace high limit
	2. Unit Overfiring	
	a) TDM reading for discharge temperature with and without burner operating exceeds allowable temperature rise for heater	a) Adjust appliance regulator to obtain temperature rise specified on heater nameplate
	3. Discharge Damper	
	a) Damper blades partially closed	a) Adjust damper linkage
	b) Damper motor defective	b) Replace damper motor
	4. Airflow Restricted	
	a) Blower running backwards	a) Reverse motor direction
	b) Belts slipping	b) Tighten and/or Replace belts
	c) Blocked intake or discharge	c) Find and remove obstruction
	5. Temperature Control System	
	a) Temperature control system does not modulate	a) See Problem VIII for MD systems (below) or Problem IX for ED, EDR, or EDSM (P.76)
	b) System modulates but TDM reading for discharge temperature is above 160°F for prolonged time	b) Perform temperature control system calibration (See Page 34)
VII. BLOWER RUNS; UNIT HEATS; WILL NOT CYCLE OFF	1. Operating Thermostat	
	a) Open in thermistor circuit	a) Check thermistor wiring and/or replace thermistor
	b) Thermostat defective	b) Replace thermostat
	c) Thermostat located improperly	c.1) Thermostat in cold draft-relocate c.2) Thermostat not satisfied-turn down
	d) Thermostat differential setting too wide	d) Reduce differential setting
	2. Burner Service Switch	
	a) Switch in LOCAL position	a) Place switch in REMOTE position
	3. Auxiliary Control	
	a) Auxiliary contacts closed	a) Check auxiliary circuit wiring and contacts
VIII. MODULATING VALVE DOES NOT MODULATE (MD VALVE)	1. Modulating Valve	
	a) Sensing bulb not seated in bulb clips	a) Reseat bulb in mounting clips
	b) Top of valve housing not secured to valve	b) Tighten the two Phillips head screws
	c) Capillary kinked or out of charge	c) Replace valve
	d) Valve out of calibration range	d) Perform temperature control system calibration

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
IX. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS HIGH FIRE (ED, EDR,& EDSM)	1. Amplifier (A1014 or A1044)	
	a) Wire not connected to amplifier terminal 3 or 4. Also terminal 5 on A1044 only.	a) Re-install wire
	b) Jumper not installed between terminals 2 and 3 of A1014 amplifier only.	b) Re-install jumper
	c) Amplifier Defective	c) Replace Amplifier
	2. Discharge Temperature Sensor (TS114 or TS144)	
	a) Open in sensor circuit	a) Replace the sensor if the resistance measured at: terminals 1 and 2 on TS114 sensor exceeds 11,000 Ω; terminals 1 and 3 or 2 and 3 on TS144 exceeds 6,000 Ω.
	b) Temperature control system out of calibration range	b) Perform temperature control system calibration
	c) Sensor cross-wired to amplifier	c) Correct wiring terminations
	3. Space Temperature Selector (T244 or TS244/TD244)	
	a) Open in sensor circuit	a) Replace the sensor if the resistance measured is more than: 7,000 Ω for the T244; 5,500 Ω for the TS244; or 2,250 Ω for the TD244.
	b) Induced voltage in field wiring	b) Utilize shielded, twisted pair wiring. (See Page 21 and 22)
	c) Space sensor in cold draft	c) Relocate sensor
	4. Remote Heat Adjust (RHA) (TD114 or CEI 4175-0-960)	
	a) Short in RHA circuit	a) Replace RHA if resistance measured between terminals 1 and 3 of RHA is less than 6,000 Ω.
	b) Induced voltage in field wiring	b) Utilize shielded, twisted pair wiring (See Page 21 and 22)
	5. Modulating Valve (M611 or MR212)	
	a) Foreign material holding valve open	a) Disassemble valve and remove foreign material.
X. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS LOW FIRE (ED, EDR, & EDSM)	1. Transformer Class II	
	a) No voltage output to amplifier	a) Replace transformer (Also check for short in modulating valve coil)
	2. Modulating Valve	
	a) Valve coil is open or shorted	a) Replace valve coil if its resistance is less than 40 Ω or greater than 85 Ω.
	b) Plunger jammed	b) Clean or replace plunger
	c) Ruptured main or balancing diaphragm	c) Determine diaphragm condition and replace if defective.

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
X. MODULATING VALVE DOES NOT MODULATE; CONTINUOUS LOW FIRE (ED, EDR, & EDSM) Continued:	3. Amplifier a) No output voltage to valve	a) With the wire removed from terminal 3 of amplifier, replace amplifier if the valve voltage does not exceed 18 volts DC
	4. Discharge Temperature Sensor (TS114 or TS144) a) Short in sensor circuit	a) Replace the sensor if the resistance measured at: terminals 1 and 2 on TS114 is less than 8000 Ω; terminals 1 and 3 or 2 and 3 on TS144 is less than 2900 Ω.
	b) Temperature control system out of calibration range	b) Perform temperature control system calibration
	5. Space Temperature Selector (T244 or TS244/TD244) a) Short in sensor circuit	a) Replace the sensor if the resistance measured is less than 5,000 Ω for the T244 or 3,500 Ω for the TS244 and 1,950 Ω for the TD244.
	6. Remote Heat Adjust (RHA) (TD114 or CEI 4175-0-960) a) Open in the RHA control circuit	a) Replace the control if the resistance measured at terminals 1 and 3 exceed 12,000 Ω.
XI. ERRATIC or PULSATING FLAME	1. High Pressure Regulator a) Vent undersized	a) Enlarge vent piping size or reduce vent piping length.
	b) Defective regulator	b) Replace regulator
	2. Amplifier a) Hunting	a) Adjust sensitivity control dial counter-clockwise
	b) Temperature control system out of calibration	b) Perform temperature control system calibration
	c) Defective Amplifier	c) Replace amplifier
	3. Space Temperature Selector (T244 or TS244/TD244) a) Induced voltage in field wiring	a) Utilize shielded, twisted pair wiring. (See Page 21 and 22)
	4. Remote Heat Adjust (RHA) (TD114 or CEI 4175-0-960) a) Induced voltage in field wiring	a) Utilize shielded, twisted pair wiring. (See Page 21 and 22)

LOW FIRE ADJUSTMENT PROCEDURE

The low fire setting is preset at the factory at approximately 15°F rise. This low fire setting is not critical in **Space Heating** applications where the heater is cycled in response to the space temperature sensed by an operating thermostat. In this case, the heater tends to operated at the maximum discharge temperature, far from the low fire setpoint. In **Make-Up Air** applications, the discharge temperature may slightly exceed the discharge temperature setpoint during periods of mild weather. An entering air thermostat (**EAT**) is normally recommended for applications which operate continuously to avoid overheating the space by shutting off the burner as the outside temperature approaches the desired space temperature.

Note: If a temperature rise of less than 15 °F is desired, a DC microammeter is required to monitor flame signal during the adjustment procedure to ensure the flame current remains steady and of sufficient strength to maintain burner operation for both consistent ignition at low fire and locking in the flame safeguard relay. Do not allow the flame signal to drop below 0.50 µamp DC.

A. Turn the Blower Service Switch to the ON position and monitor the discharge temperature on the Temperature Display Module (**TDM**).

B.1 On MD applications, set the red knob to its lowest setting. (Dial set to the No.1 position.)

B.2 On ED, EDR, and EDSM applications, remove the wire from terminal NO. 8 on the amplifier.

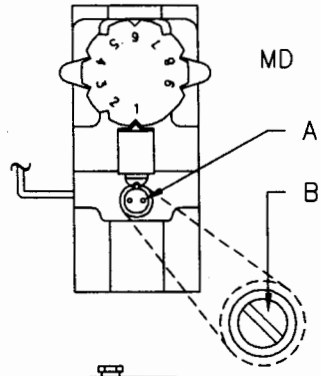
C. Turn the Burner Service Switch to the ON position and monitor the discharge air temperature on the **TDM**. Subtract the temperature from Step A above from this reading to determine the temperature rise.

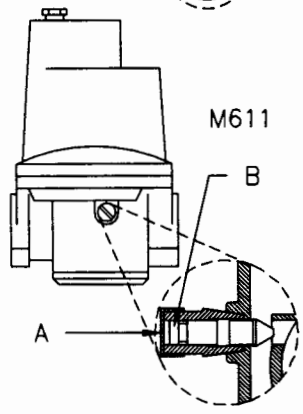
D. Remove cap (A) exposing the low fire adjusting screw. On the MR212 modulating/regulating valve, remove the housing cover, then cap (A), and then loosen lock screw (C). Turn the adjusting screw (B) to obtain the desired low fire setting.

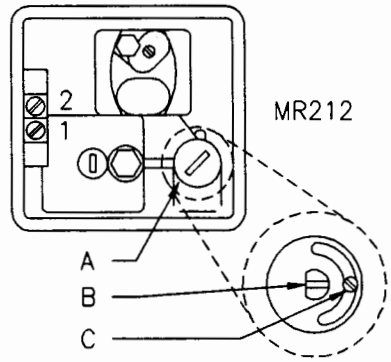
E. Replace cap (A). Tighten lock screw (C) on the MR212 valve prior to re-installing cap and housing cover. Reset Service Switches.

F.1 On MD applications, set the MD to the desired setting. See page 44.

F.2 On ED, EDR, and EDSM applications, reconnect wire to amplifier terminal No. 8.







MAINTENANCE LOG		
MODEL No.		SERIAL No.
Date	**Activity**	**Technician**