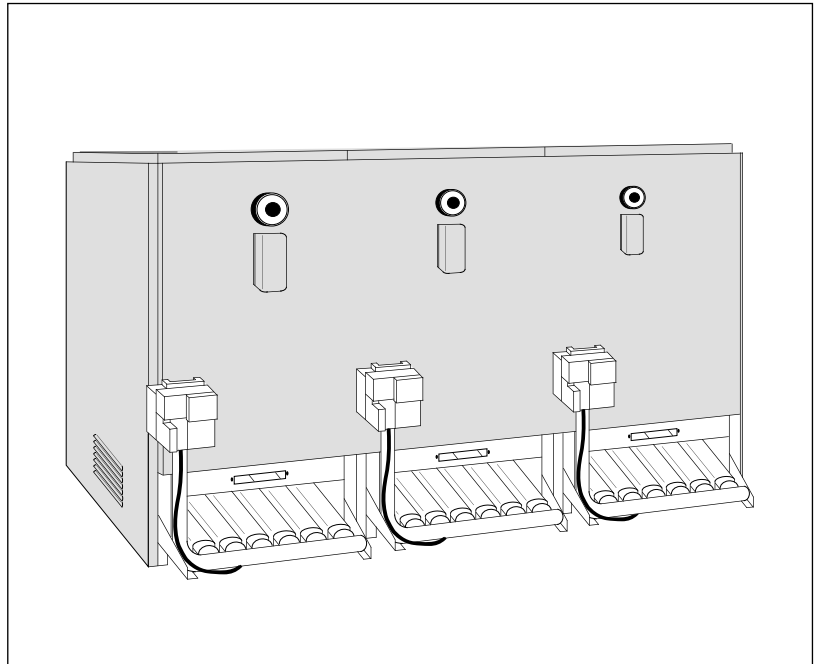


MULTITEMP[®] HydroTherm[®]

MR SERIES INSTALLATION MANUAL AND REPLACEMENT PARTS LIST

Modular Gas-Fired Cast
Iron Water Heating Plants
360,000 to 2,400,000
Btuh Input

Applicable For Larger Heating
Plants Using Boiler Banks Of
8-Modules Or Less



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NOTE: If shop drawings have not been provided, refer to the Appendices at the rear of this manual for sizing (breeching, chimney & gas piping) and control system data.

HydroTherm[®]

SECTION 1: INTRODUCTION

HEATING PLANT DESIGN

Multi-Temp heating plants are comprised of individual cast iron modules that are piped to common headers to provide large hot water heating capacities. They are designed and intended for use for a central space heating system, for volume water heating, or for combination space heating/volume water heating. Each module is self-contained with its own set of controls and can operate independent of the other modules. Multi-Temp modules can be arranged to fit just about any available area. Products of combustion are vented through each module's draft hood, connected to a manifold (breeching) for joining individual draft hoods. The breeching is connected to a chimney which provides the necessary draft.

The objective of a Multi-Temp heating plant control system is to relate plant output to the actual heating load by automatic step-firing. This means that more or fewer modules are operated in response to an increase or decrease in actual heating load. Hydrotherm has developed three basic methods (levels) of control which meet most operating requirements encountered. Typical wiring diagrams for these basic methods are provided in the appendices at the rear of this manual. Special control system designs can be developed through the Hydrotherm applications engineering group.

CODE COMPLIANCE

Installations must conform to requirements of the authority having jurisdiction or, in the absence of such requirements, to the National Fuel Gas Code ANSI Z223.1- latest edition. Where required by the authority having jurisdiction, the installation must also conform to Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1.

All electrical wiring must be in accordance with the requirements of authority having jurisdiction or, in absence of such requirements, with National Electrical Code NFPA-70- latest edition. If an external electrical source is utilized, each installed module must be electrically grounded in accordance with the requirements of the authority having jurisdiction or, in the absence of such

requirements, with the National Electrical Code NFPA-70- latest edition. UL listed power limited circuit cable is almost universally approved for safety controls on heating equipment, either internally or externally, without protection of conduits or raceway.

For Canada, installations must be in accordance with Standards CAN/CGA-B149 .1 or .2, Installation Codes for Gas Burning Appliances and Equipment and with Standard C.S.A. C22.1, Canadian Electrical Code, Part 1 and Part 2, and/or local codes.

WARNING: Installers must follow local regulations with respect to the installation of CO detectors and follow the manufacturer's stated maintenance schedule for this boiler!

ATTENTION: Observer les réglementations régionales à l'égard des détecteurs de monoxyde de carbone et observer l'entretien de fabricant pour cette chaudière!

HEATING PLANT SHIPMENT

Heating plant packing list (attached to one of the packages) clearly lists the number of packages and their contents. Check this list against all material on the job site for completeness.

Heating Modules: Each module is shipped unjacketed in its own carton and weighs 525 lbs. (maximum for R-300B module).

Drafthoods: One drafthood for each module is shipped in a separate carton.

Optional Vent Dampers: When ordered, one vent damper for each module is shipped in a carton enclosed with the module carton.

Jackets: There are two jacket sizes- "A" jacket to enclose two heating modules and "B" jacket to enclose three heating modules. The correct combination of "A"

The following terms are used throughout this manual to bring attention to the presence of potential hazards or to important information concerning the product:

DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death, serious injury or substantial property damage.

WARNING: Indicates a imminently hazardous situation which, if not avoided could result in death, serious injury or substantial property damage.

CAUTION: Indicates an imminently hazardous situation which, if not avoided, may result in minor injury or property damage.

NOTE: Used to notify of special instructions on installation, operation or maintenance which are important to equipment but not related to personal injury hazards.

and "B" jackets are furnished to form a complete enclosure for the entire heating plant.

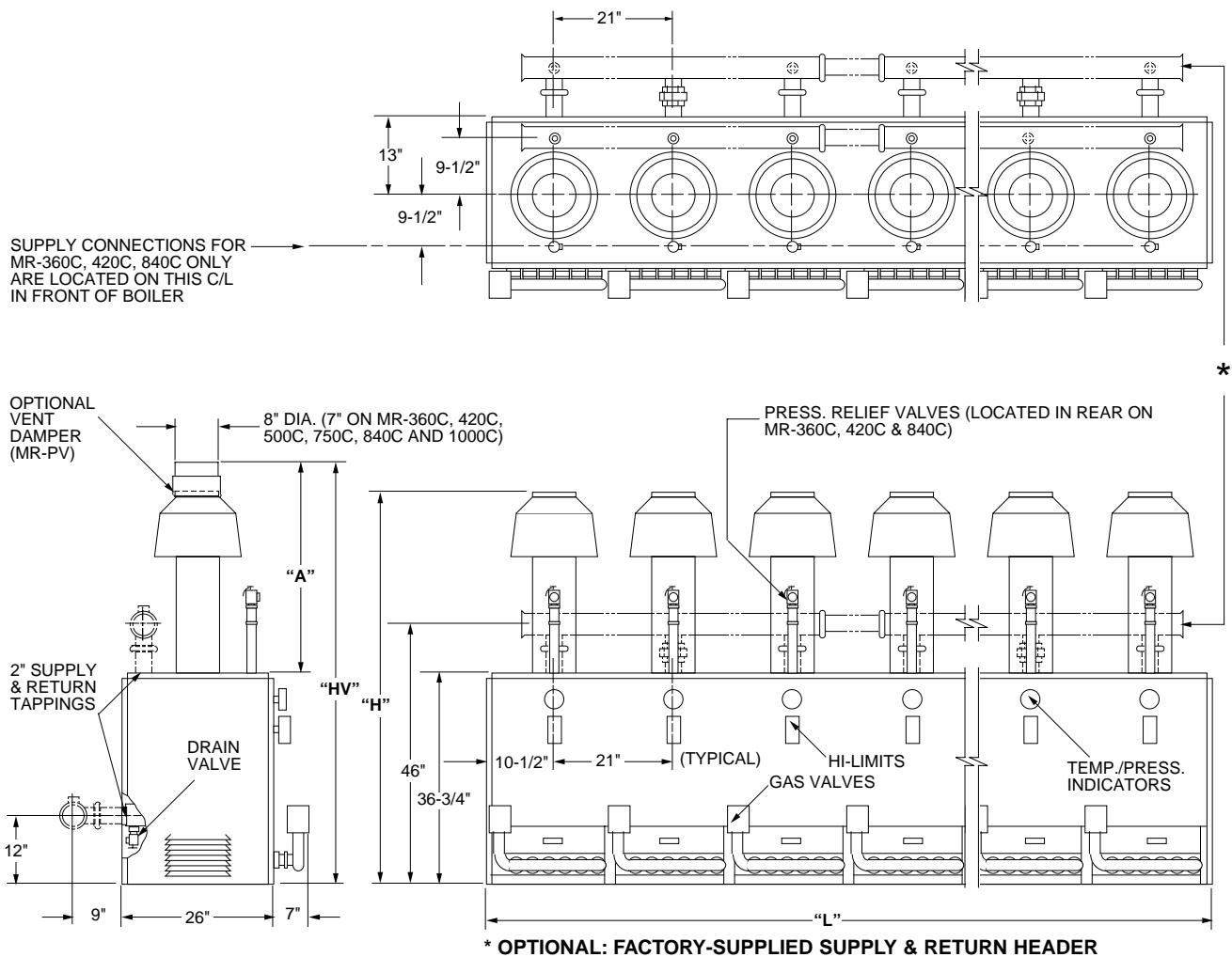
Optional Header Sets: When ordered, each header set includes supply and return headers, pipe nipples, unions and self-aligning couplings. There are two header set sizes - "A" headers for joining two heating modules and "B" headers for joining three heating modules. The correct combination of "A" and "B" headers is furnished to manifold the complete heating plant.

Optional Heat Exchanger: When ordered, each heat exchanger is shipped with the pipe and fittings required for installation. There are three types of heat exchangers for volume water heating - "MC2" for two heating modules; "MC3" for three heating modules; and "MC4" for four heating modules.

Control Equipment: When ordered, controls such as motorized valves, modulating aquastats, step controllers, thermostats, etc., are furnished in separate cartons.

| Boiler Model | Length "L" | Height | | Vent Damper Height "A" |
|--------------|------------|-------------|------------|------------------------|
| | | "H" MR/MR-P | "HV" MR-PV | |
| MR-360C | 3'6" | 4' 10"-1/2" | 5' 1/2" | 25-1/2" |
| MR-420C | 3'6" | 5'2" | 5' 5-1/2" | 28-3/4" |
| MR-500C | 3'6" | 5' 5-1/2" | 5' 9-1/4" | 32-1/2" |
| MR-600B | 3'6" | 5'6" | 5' 9-3/4" | 33" |
| MR-750C | 5'4" | 5' 5-1/2" | 5' 9-1/4" | 32-1/2" |
| MR-840C | 7'1" | 5'2" | 5' 5-1/2" | 28-3/4" |
| MR-900B | 5'4" | 5'6" | 5' 9-3/4" | 33" |

| Boiler Model | Length "L" | Height | | Vent Damper Height "A" |
|--------------|------------|-------------|------------|------------------------|
| | | "H" MR/MR-P | "HV" MR-PV | |
| MR-1000C | 7'1" | 5' 5"-1/2" | 5' 9-1/4" | 32-1/2" |
| MR-1200B | 7'1" | 5'6" | 5' 9-3/4" | 33" |
| MR-1500B | 8'10" | 5'6" | 5' 9-3/4" | 33" |
| MR-1800B | 10'7" | 5'6" | 5' 9-3/4" | 33" |
| MR-2100B | 12'4" | 5'6" | 5' 9-3/4" | 33" |
| MR-2400B | 14'1" | 5'6" | 5' 9-3/4" | 33" |



MODEL MR HEATING PLANT DIMENSIONS

SECTION 2: INSTALLING MODULES

STEP 1: PLANNING AHEAD

IMPORTANT TO NOTE

1. Observe minimum clearances to combustibles.
2. Observe proper combustion air requirements.
3. Provide a firm, level and fireproof foundation (modules must be installed on non-combustible floor).

MINIMUM CLEARANCES TO COMBUSTIBLES: The following clearances must be maintained: 24" from jackets to front, rear and side walls; and 38" from jacket tops to ceilings. Local requirements may specify greater clearances and must be adhered to.

COMBUSTION AIR REQUIREMENTS:

WARNING: This heating plant must be supplied with combustion air in accordance with Section 5.3, Air for Combustion and ventilation, of the latest of the National Fuel Gas Code, ANSI Z223.1, and all applicable local building codes. Canadian installations must comply with CAN/CGA B149.1 or .2 Installation Code. Failure to provide adequate combustion air to the heating plant can result in excessive levels of carbon monoxide which can result in severe personal injury or death!

If the heating plant is installed in an unconfined space, adequate air will be available via normal infiltration.

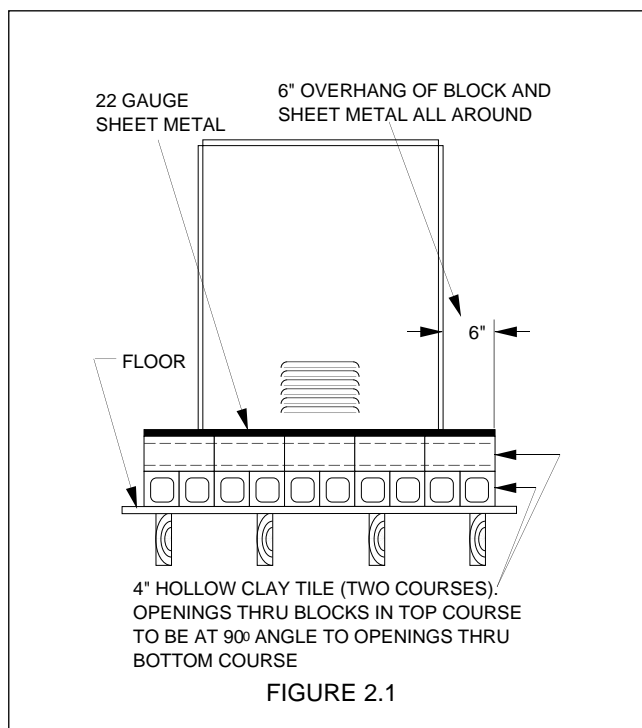
If the heating plant is installed in a confined space having a volume of less than 50 cubic feet per 1000 Btu/hr of gas input for all fuel burning equipment within the space, or building construction is unusually tight, adequate air for combustion must be provided by two openings: one located about 6" below the ceiling, the other about 6" above the floor. **Each opening must have a minimum free area as follows:**

1. One square inch per 4000 Btu/hr of gas input when communicating directly with the outside or through a vertical duct.
2. One square inch per 2000 Btu/hr of gas input when communicating through horizontal ducts to the outside.
3. One square inch per 1000 Btu/hr of gas input when ventilation air is provided by openings in doors, etc. to adjoining spaces having adequate infiltration.

NOTE: Modules employ atmospheric combustion. Combustion air must not be contaminated with halogenated hydrocarbon vapors, cleaning fluid vapors, aerosol propellants, freon or other corrosive chemicals. Otherwise, module heat exchangers will be subject to corrosion, reducing module life.

HEATING PLANT FOUNDATION: Concrete base pad is preferred. Loading is 170 lbs. per square foot; special material and where permitted by local codes, fabricate a fireproof base as shown in Figure 2.1. Local codes may require different construction.

WARNING: Never install this heating plant on carpeting! Never install this heating plant on combustible flooring without fireproof base depicted in Figure 2.1 properly installed under boiler. Failure to with this warning will result in a fire which will cause extensive property damage, severe personal injury or death!



STEP 2: ARRANGING HEATING PLANT

1. Locate heating plant as close to the chimney as possible so breeching length to chimney is kept to a minimum. Only 24" is required between the first module and the chimney.

2. Modules employing MC heat exchangers (if any) must be located closest to the chimney to assure adequate draft for summertime operation.

3. Arrange heating plant in multiple banks of eight modules or less (unless otherwise specified on factory-approved specially-designed venting systems). **NO MORE THAN EIGHT MODULES MAY BE CONNECTED DIRECTLY WITH FACTORY-SUPPLIED HEADERS.** Several examples of typical arrangements are shown here. Recommended clearances (which are more than clearances to combustibles) allow for servicing, system installation & connections.

4. Make sure that any connecting breeching runs will not oppose or face each other, but rather mix together in the same general direction, specifically "Y" together rather than "tee" together.

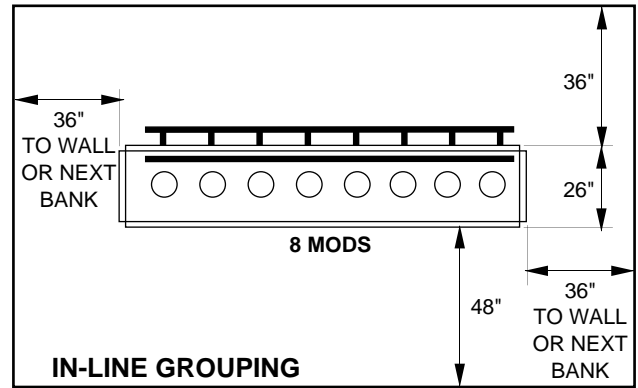


FIG 2.2A

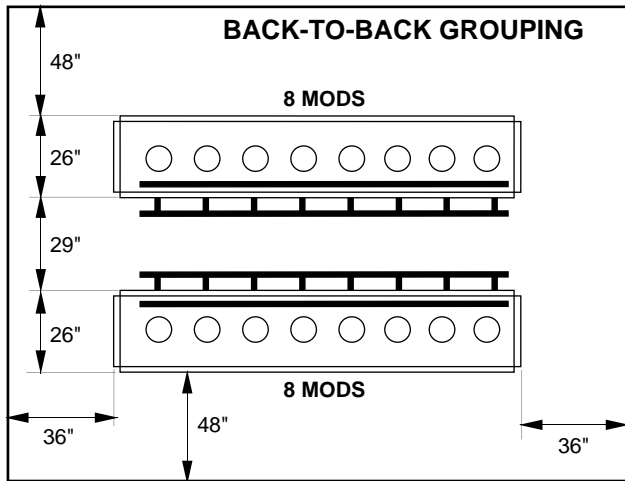
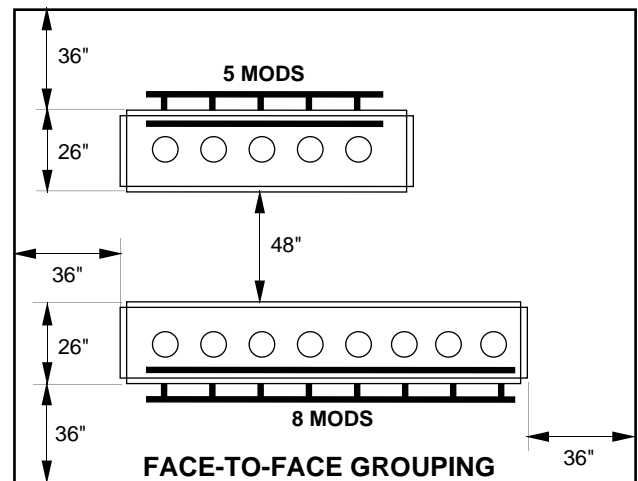


FIG 2.2B



STEP 3: SETTING & ALIGNING MODULES

1. Snap a chalk line on foundation where rear of modules will be located. Modules must be spaced 21" center to center.

2. Remove cartons from modules; move with skids to a position alongside final module location. Rock module off skid into proper location on foundation -rear of burner base should rest on the chalk line and left of burner base at the interval mark.

3. Ensure that supply and return tapplings on rear of each module are spaced at 21" intervals. If more than 1/8" of vertical discrepancy exists, shim under module base to bring the supply tapplings in line.

4. Level each module front-to-rear and side-to-side by shimming under base as necessary.

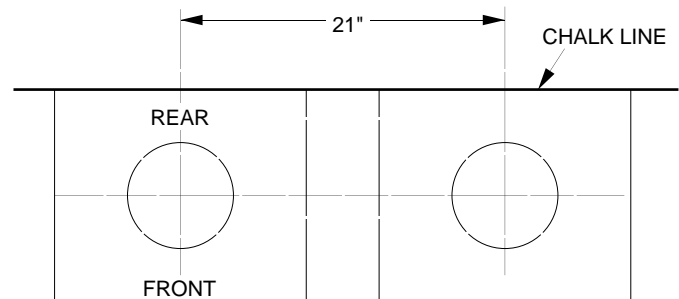


FIG 2.3

CAUTION: Do not loosen tie rods on module absorption unit. They accommodate thermal expansion. Loss of module's structural integrity & water leaks/damage may result.

SECTION 3: INSTALLING WATER PIPING

STEP 1: PLANNING AHEAD

IMPORTANT TO NOTE

1. Field-fabricated headers must have correct number of tappings to accept all water piping accessories; locations of tappings must be in accordance with guidelines provided in Step 4 in this section.

2. If system anti-freeze will be used, the system must be designed to accommodate the necessary changes in heat transfer, pump head, flow rate and expansion.

3. Water treatment is recommended in areas where water quality is a problem; it must be used in hard water areas and on very large volume heating systems.

FIELD-SUPPLIED COMPONENTS: Some of the following components may not have been supplied by Hydrotherm, depending on how the heating plant was ordered, but are required for installation: air separator, air eliminator, expansion tank, low water cut-off, manual reset hi-limit, pressure reducing fill valve, pump(s), shut-off valves, and motorized valve (for combination space/volume water heating). Optional: flow check valve, make-up water meter, strainer & backflow preventer.

FREEZE PROTECTION: Where it's absolutely necessary, system anti-freeze can be utilized, but it must be compatible with hydronic heating systems. For more information, consult The hydronics Institute Technical Topics Number 2A publication.

NOTE: Never use an RV type anti-freeze protection solution no an automotive type anti-freeze as damage to modules and other system components may result.

WATER TREATMENT: A local water treatment company should be consulted to determine the requirements for your particular system and locality through a thorough chemical analysis of your system water.

CAUTION: Modules are not for use in systems where water is replenished. Minerals in the water can build up on heat transfer surfaces and cause overheating and subsequent failure of the cast iron sections. If piping exists where water leakage would not be visible, a water meter should be installed to record introduction of boiler feed water.

STEP 2: MC HEAT EXCHANGERS

For installation of factory-supplied MC/MCI heat exchangers, refer to Hydrotherm MC & MCI Installation Guide MC2 packaged with the heat exchanger. All exter-

nal piping must be supported by hangers, not by the boilers or their accessories.

STEP 3: SUPPLY & RETURN HEADERS

1. Whether installing factory-supplied headers or field-fabricated headers, **WATER PIPING MUST BE INSTALLED TO PROVIDE REVERSE RETURN FLOW** (see Figure 3.1). This piping arrangement ensures adequate flow to every heating plant module.

2. For installation of factory-supplied supply and return headers, refer to Hydrotherm Supply & Return Header Installation Guide H2 package with the header sets. All external piping must be supported by hangers, not by the boilers or their accessories. **NO MORE THAN EIGHT MODULES MAY BE DIRECTLY CONNECTED WITH FACTORY-SUPPLIED HEADERS.**

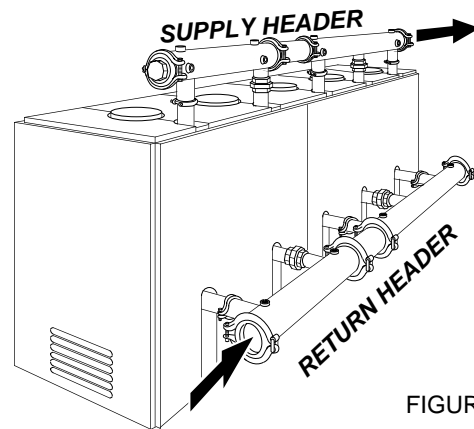


FIGURE 3.1

STEP 3: SUPPLY & RETURN HEADERS (CONTINUED)

Examples of typical supply & return water piping for headers. No more than eight modules may be directly connected!

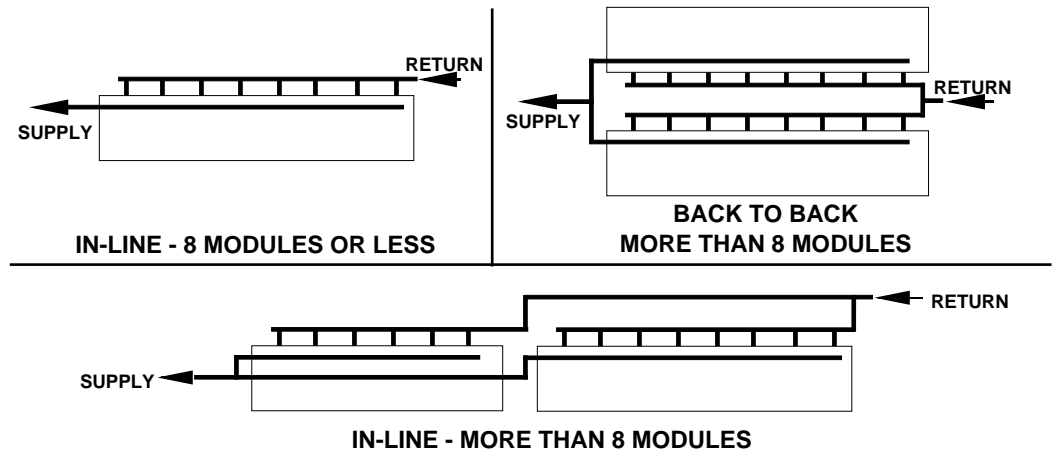


FIG 3.2

STEP 4: HYDRONIC COMPONENTS

The diagrams in Figures 3.4 through 3.7 show typical locations of various hydronic components required for Multi-Temp heating plants. In all cases, installation should be in accordance with component manufacturer's recommendations (literature, if applicable, is packaged with component). In addition, the following guidelines should be followed.

PRESSURE RELIEF VALVES: One supplied for each module. Install relief valves with spindle in the vertical position (i.e., valve discharge in horizontal) with coupling and nipple in 3/4" tapping at top of modules. Install field-supplied valve discharge piping (Figure 3.3).

WARNING: Never install any type of valve between the pressure relief valve and the heating plant modules! Failure to comply with this warning can result in a heating plant explosion causing extensive property damage, severe personal injury, or death!

CAUTION: Piping must be installed from the relief valve discharge so there will be no danger of scalding personnel.

TEMPERATURE/PRESSURE INDICATORS: One temperature/pressure indicator supplied for each module. INSTALL AFTER ASSEMBLING JACKET.

DRAIN VALVES: One supplied for each module. Install below return connection.

PRESSURE REDUCING (FILL) VALVE: Follow manufacturer's installation instructions.

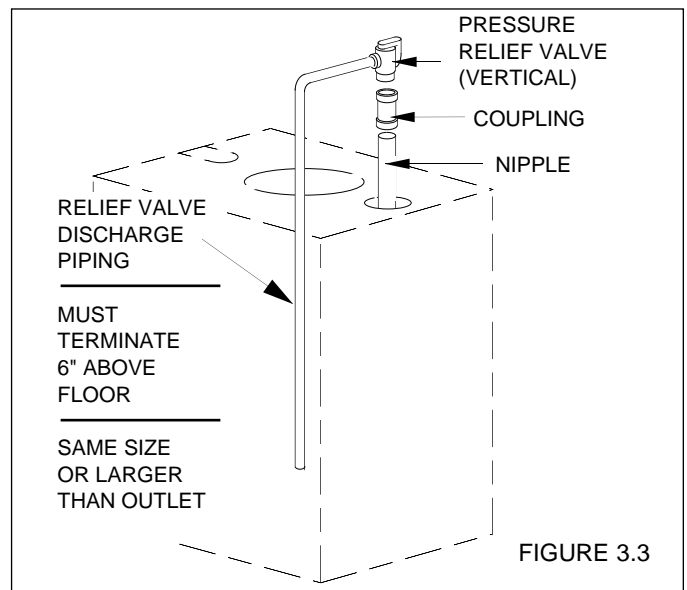


FIGURE 3.3

AIR SEPARATOR⁽¹⁾: Locate in the supply line between boiler and system pump (where it will protect all modules under all operating conditions). Follow manufacturer's installation instructions.

AIR ELIMINATOR⁽¹⁾: Install on air separator (where it will protect all modules under all operating conditions). Follow manufacturer's installation instructions.

EXPANSION TANK⁽¹⁾: Locate on suction side of pump (where it will protect all modules under all operating conditions). Follow manufacturer's instructions.

(1) For heating plants providing **volume water heating only** (instantaneous recovery or with storage tank), see Figures 3.6 and 3.7 on page 10 for installation guidelines

STEP 4: HYDRONIC COMPONENTS (CONTINUED)

MANUAL RESET HI-LIMIT⁽¹⁾: Locate in supply piping downstream of connection of the last module.

LOW WATER CUTOFF⁽¹⁾: (Electronic type or float type) Locate in supply header. Follow manufacturer's installation instructions. If heating plant is to be installed above level of radiation, a low water cut-off must be installed to protect plant from dry fire.

CAUTION: To prevent accidental dry fire, do not install isolation valves between low water cutoff and the module.

CAUTION: Do not install any low water cut-off in a location where water will not freely drain away from the float or probe (i.e., in a pipe tree or loop) should a low water condition develop in the module.

For electronic probes, vertical installation (where all water can freely drain away from probe) is preferred over horizontal. Do not install in small diameter pipe nipples or bushings, as insufficient clearance to probe may result in corrosion and/or erroneous readings.

SYSTEM PUMP⁽¹⁾ Locate in the heating plant supply piping, downstream of the modules. Follow manufacturer's installation instructions.

CAUTION: HEATING PLANTS MUST NOT BE USED WITHOUT FORCED SYSTEM CIRCULATION, AS OVERHEATING/FAILURE OF CAST IRON SECTIONS MAY RESULT.

MOTORIZED VALVE: Commonly used on combination space/volume water heating systems to ensure a priority for domestic hot water over space heating. Use a 2" globe valve with motor for MC2 heat exchanger and a 2-2/2" butterfly valve with motor and linkage for MC-3 & 4 heat exchangers. See Figure 3.5 for location and follow manufacturer's instructions.

FLOW CHECK VALVE (Optional): Important to control direction of flow and prevent gravity circulation. Locate

where it cannot cause isolation of any particular loop or zone from the main system. Follow manufacturer's installation instructions.

MAKE-UP WATER METER (Optional): Will help determine total system water volume for purposes of water treatment, and aid in the identification of a system leak. Follow manufacturer's installation instructions.

STRAINER (Optional): For retrofit or steam conversion systems, basket-type strainer will trap loose system scale. Locate in return water line. Follow manufacturer's installation instructions.

BACKFLOW PREVENTER (Optional): Used as a means of isolation (space heating system from main water supply) to safeguard against potential hazard of fill valve connection allowing migration of water treatment chemicals into potable water supply. Follow manufacturer's installation instructions.

OTHER COMPONENTS: Install all other waterside components such as shut-off valves, mixing valves, thermometers and supply water temperature sensors; install sensors or probes in a location that will sense supply water temperature from all modules. Follow manufacturer's installation instructions.

STEP 5: HYDROTESTING THE SYSTEM

It is recommended that hydrotesting of the entire heating system be performed before installing jackets and controls or wiring the system. Fill the entire system with water. The assembled boiler shall be subjected to a hydrostatic test pressure not less than 1-1/2 times the maximum allowable working pressure. The required test shall not exceed the test pressure by more than PSI.

All fittings and components should then be inspected for visible signs of leakage. If no pressure drop is detected for a two-hour period while the system is under pressure, the heating system may be considered water tight.

(1) For heating plants providing **volume water heating only** (instantaneous recovery or with storage tank), see Figures 3.6 and 3.7 on page 10 for installation guidelines

TYPICAL PIPING FOR SPACE HEATING SYSTEM

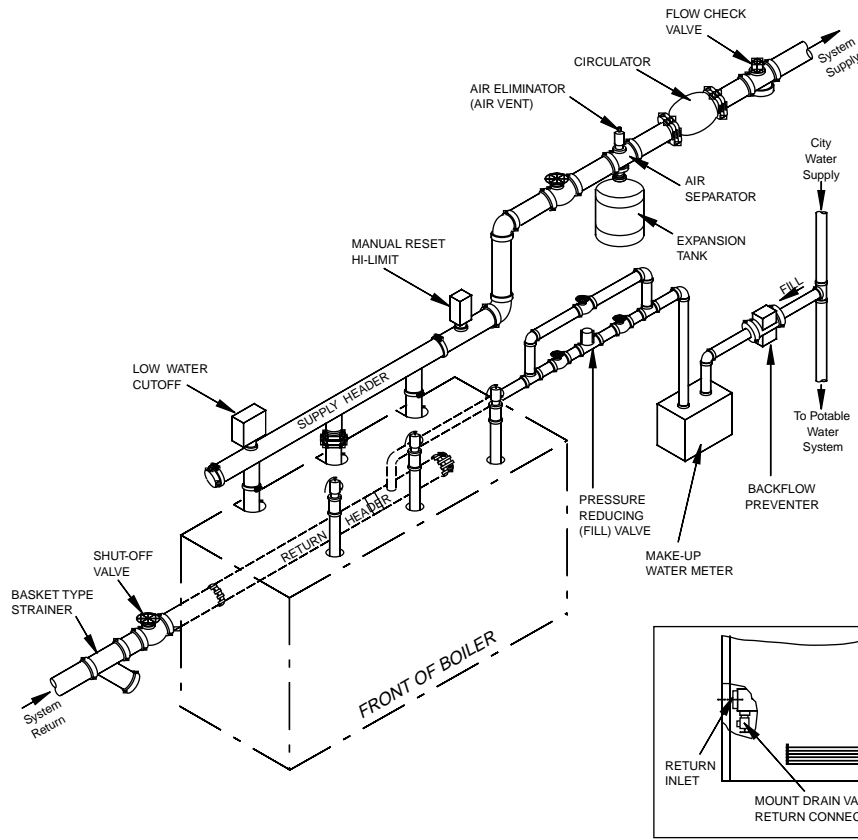


FIG. 3.4

TYPICAL PIPING FOR COMBINATION SPACE/VOLUME WATER HEATING SYSTEM

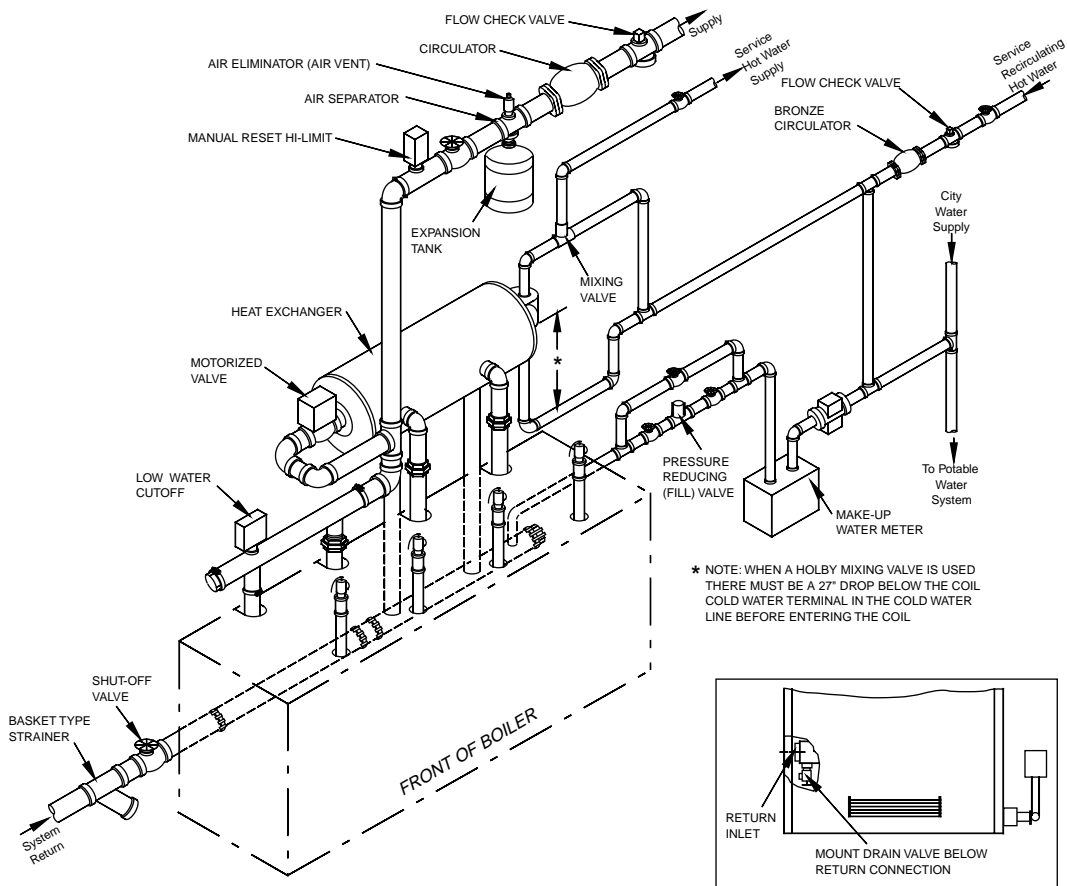
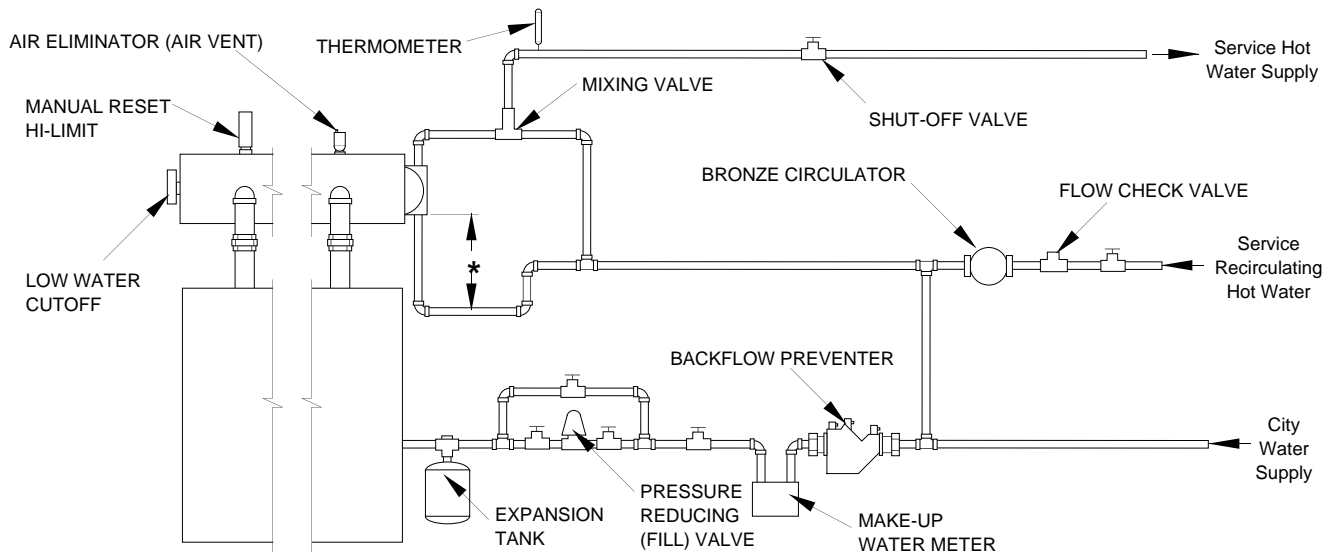


FIG. 3.5

TYPICAL PIPING FOR VOLUME WATER HEATING ONLY (INSTANTANEOUS RECOVERY)



* NOTE: WHEN A HOLBY MIXING VALVE IS USED THERE MUST BE A 27" DROP BELOW THE COIL COLD WATER TERMINAL IN THE COLD WATER LINE BEFORE ENTERING THE COIL FIG. 3.6

TYPICAL PIPING FOR VOLUME WATER HEATING ONLY (WITH STORAGE TANK)

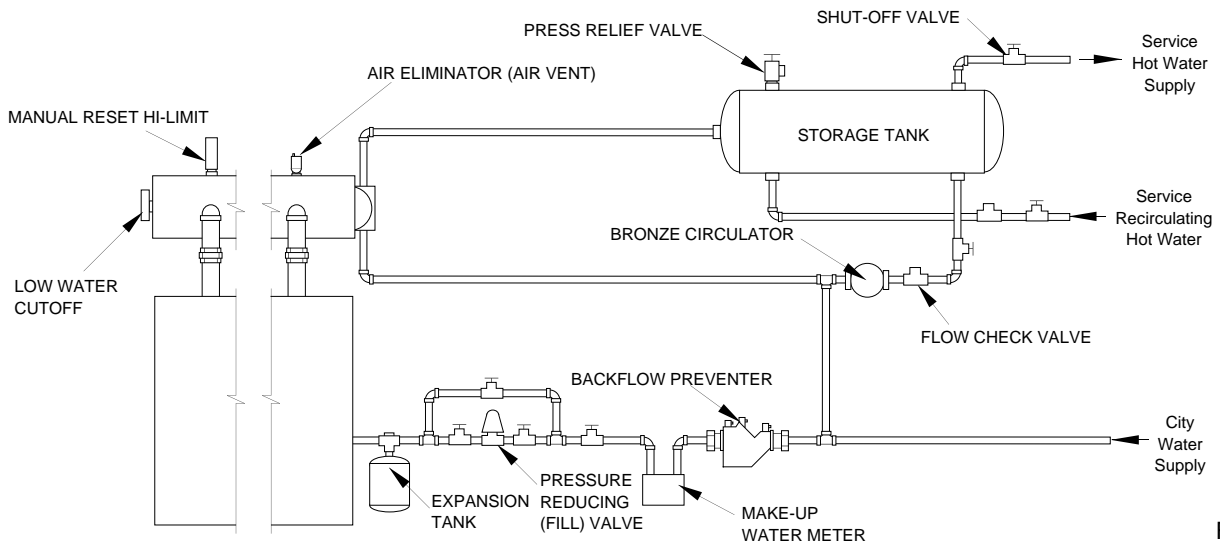


FIG. 3.7

COMBINATION HEATING & COOLING INSTALLATIONS

If hot water module is installed in connection with water chiller, chilled water must be piped in parallel with module using appropriate valves to prevent chilled medium from entering module. When modules are connected to heating coils in air handling units, where they may be exposed to refrigerated air circulation, module piping system shall be equipped with flow-control valves or other automatic means to prevent gravity circulation of module water during cooling cycle.

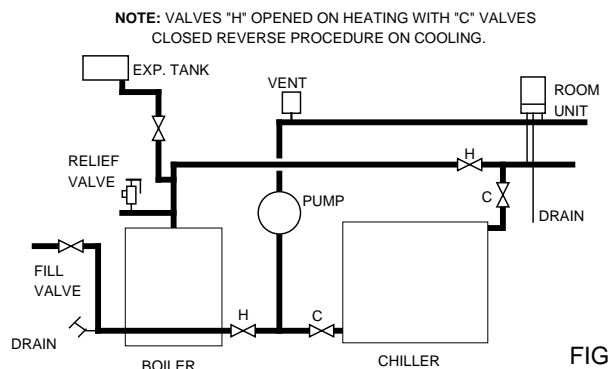


FIG. 3.8

SECTION 4: VENTING THE HEATING PLANT

STEP 1: PLANNING AHEAD

IMPORTANT TO NOTE:

1. Breeching runs must be as short as possible.
2. No more than eight modules may be served by one breeching run to assure adequate draft (unless otherwise specified on factory-approved specially-designed venting systems).
3. Observe breeching construction requirements.
4. Observe proper chimney requirements.
5. Flues from other fuel-burning appliances must not be connected into heating plant breeching; otherwise, inadequate draft may result.
6. Natural draft equipment (heating plants without mechanical draft components) must not be connected into any portion of a mechanical draft or power vent system operating under positive pressure, including the chimney.
7. If shop drawings with approved breeching and chimney sizes are not available, you can use sizing guidelines recommended in Appendix A at the rear of this manual.

MULTI-TEMP HEATING PLANT VENTING SYSTEM: Consists of drafthoods, vent dampers (when ordered) vent connectors, breeching and chimney or vent pipe (see Figure 4.1). Drafthoods are installed between each module's flue outlet and vent connector. Breeching is the horizontal manifold for connecting each module's vent connector to the chimney. When specified, vent dampers are installed between the top of each module's drafthood and vent connector.

Venting system components must be installed in accordance with requirements of the local authority having jurisdiction or, in the absence of such requirements, to the National Fuel Gas Code ANSI Z223.1-latest edition and chimney manufacturer's guidelines.

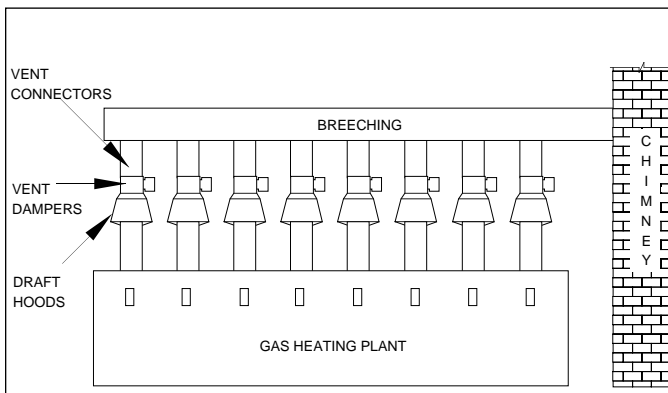


FIGURE 4.1

BREECHING CONSTRUCTION REQUIREMENTS:

Round breeching is preferred to maximize flue gas flow. Rectangular breeching is the only acceptable alternative; **the larger dimension of the rectangle must be in the vertical.** Breeching should be constructed of sheet metal with smooth interior surfaces. Figure 4.2 provides minimum sheet metal gauges (adhere to local requirements for sheet metal thickness). All joints must be rolled or welded with sufficient overlap to provide a gas tight joint.

| MINIMUM SHEET METAL GAUGE FOR ROUND AND RECTANGULAR BREECHING | | |
|---|-----------------------------|-------------------|
| ROUND | RECTANGULAR | SHEET METAL GAUGE |
| DIAMETER IN INCHES | GREATER DIMENSION IN INCHES | |
| 6 TO 10 | 10 TO 13 | 24 |
| 10 TO 12 | 14 TO 18 | 22 |
| 14 TO 16 | 19 TO 20 | 20 |
| OVER 16 | OVER 20 | 16 |

FIGURE 4.2

CHIMNEY REQUIREMENTS: Lined masonry chimneys or Type B metal vent systems, constructed in accordance with the National Fuel Gas Code, are suitable. Chimney construction materials must be compatible with the fuel being used.

Chimney condition is of paramount importance for a safe/efficient installation. For existing chimneys, all installations must include a chimney inspection by qualified individual or agency. Particular attention should be paid on oil-to-gas conversions. Soot may have accumulated in the chimney and/or degraded the chimney liner. Most utilities require installation of a new liner, safety spill switches or other chimney upgrades. Check local utility for the required safety precautions.

DANGER: A chimney which does not meet modern safety standards will result in a fire or deadly carbon monoxide poisoning of the building residents.

MECHANICAL DRAFT REQUIREMENTS: When proper venting of the Multi-Temp heating plant cannot be accomplished by natural means, mechanical draft inducers or power venters may be used. All mechanical draft equipment must be properly sized and properly installed by following the recommendations of their manufacturers. A fan prove switch must be used in the control system and wired such that the heating plant will not fire (prevent flow of fuel) until inducer or power venter fan operation is proved.

STEP 2: DRAFTHOODS & VENT DAMPERS

1. Install draft hood on each module's flue outlet.

DANGER: Draft hood, flue outlet and vent damper as supplied must not be altered in any way as proper module operation would be jeopardized. Flame roll-out, fire or carbon monoxide poisoning will result.

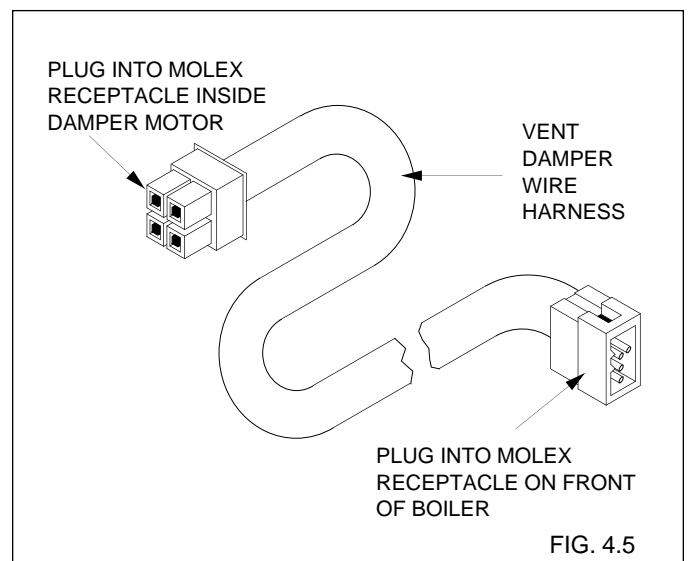
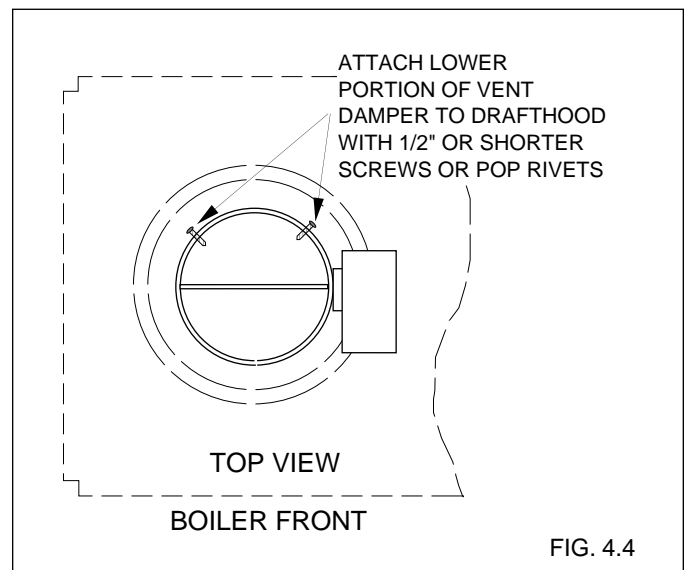
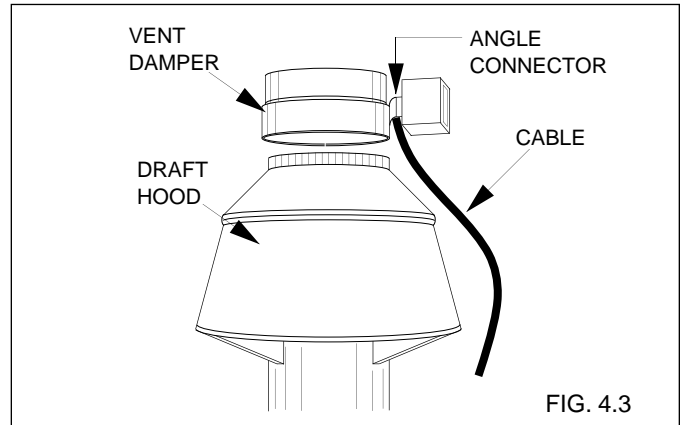
2. If ordered with heating plant, mount each module's vent damper directly on top of the draft hoods with the vent damper motor on the right side (see Figure 4.3). The flow arrow imprinted on the vent damper must point upward.

DANGER: Only one module may be served by one vent damper. Do not vent more than one module through a vent damper. In addition, a minimum clearance distance of 6" must be maintained between vent system components and all combustible construction. Failure to comply with this warning can result in carbon monoxide poisoning or a fire which will cause extensive property damage, severe personal injury or death!

NOTE: The vent damper must be accessible for servicing and checking the position indicator.

3. Position the vent damper motor cable (see Figure 4.3) so it does not touch the metal surface of the draft hood. Where necessary, turn the angle connector on the vent damper upward until the cable clears; tighten the locknut to secure.

Secure vent damper housing to draft hood outlet as shown in Figure 4.4



STEP 3: VENT CONNECTORS & SLIP JOINTS

1. Install a vent connector between each module's draft hood (or vent damper) outlet and the breeching. Vent connector diameter should be the same as draft hood (or vent damper) outlet; **IT MUST NEVER BE SMALLER.**

2. Where possible, vent connector height should use all available head room. Minimum vertical height of vent connector is 1-foot; a 3-foot rise is preferred.

3. Vent connector should connect to the breeching with a straight 90° connection. For improved flue gas flow, vent connectors may be installed with a 45° rounded type elbow; angled toward the chimney (as shown on the far right).

4. For ease of servicing, install a slip joint or a draw band between the draft hood (or the vent damper) outlet and the vent connector.

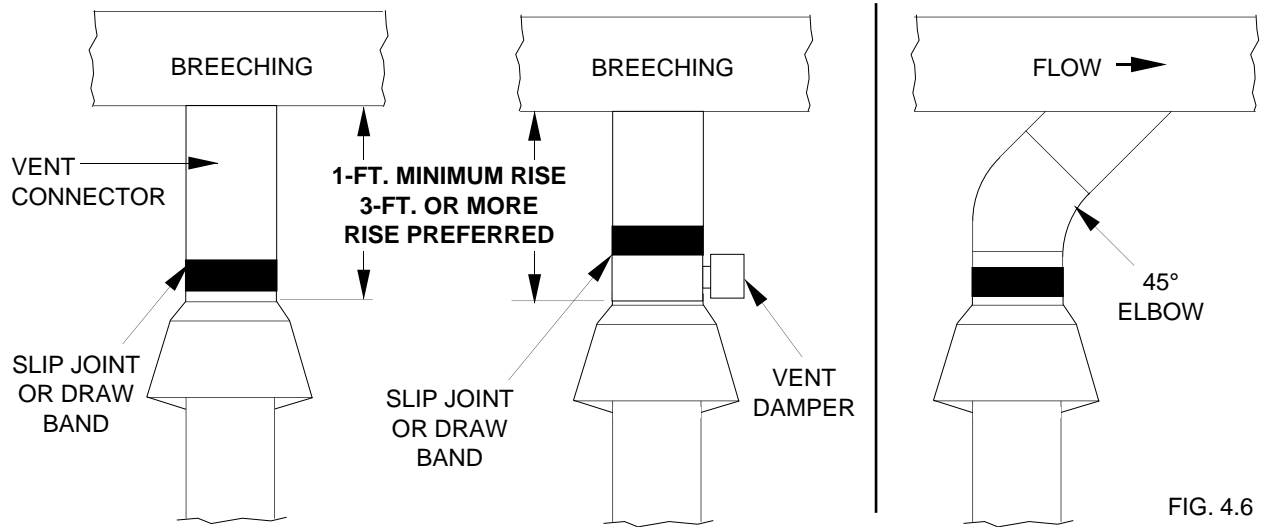


FIG. 4.6

5. Where it may be necessary to vent two banks of boilers into a common breeching, the vent connectors must be angled at 45°s and they must enter the breeching at the lowest point possible to minimize the ineffective area of the breeching. The 45° elbows must be the rounded type, and the 1-foot minimum height; 3-foot or more preferred height must be maintained.

This arrangement applies for a maximum of four boilers per bank, unless otherwise specified on factory-approved specially-designed venting systems. For larger banks of boilers, use individual breeching for each bank.

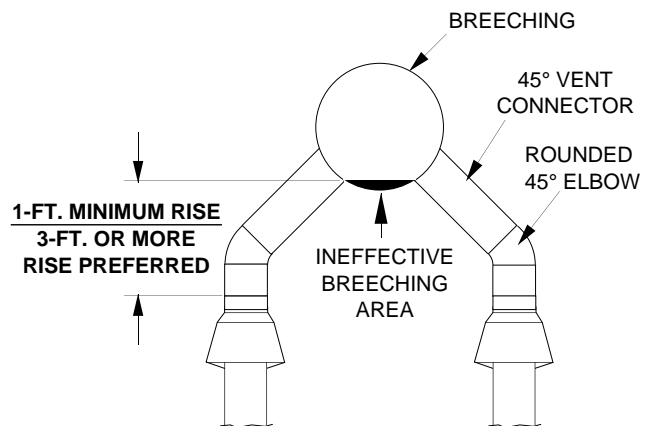


FIG. 4.7

STEP 4: BREECHING RUNS

FIG. 4.8

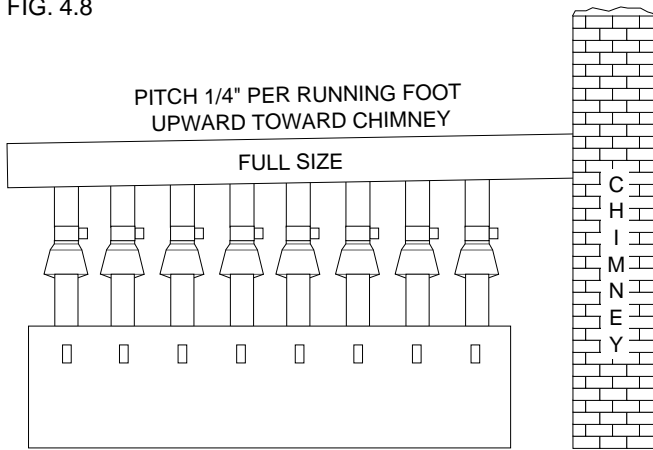
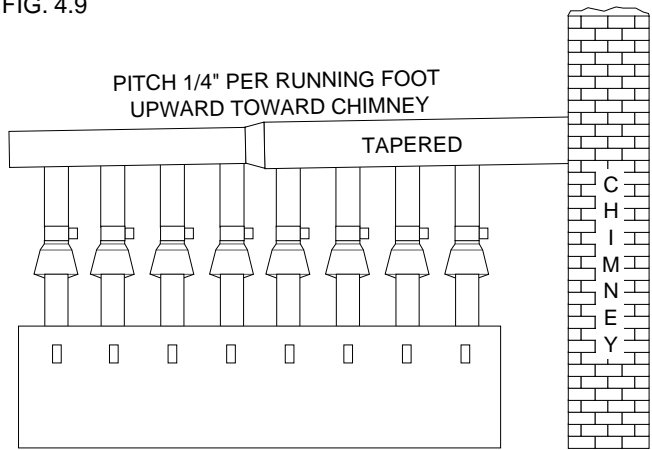


FIG. 4.9



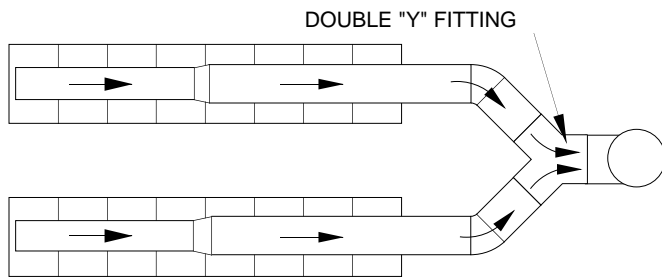
1. Breeching can be full size for an entire bank of boilers (Figure 4.8 left) or may be tapered (Figure 4.9 right), using one tapered division within a bank of eight modules.

2. For tapered breeching, the smallest sized breeching division is always the furthest from the chimney with transition to the larger division leading toward the chimney (see Figure 4.9 right). All increaser fittings must be tapered to assure proper flue gas flow.

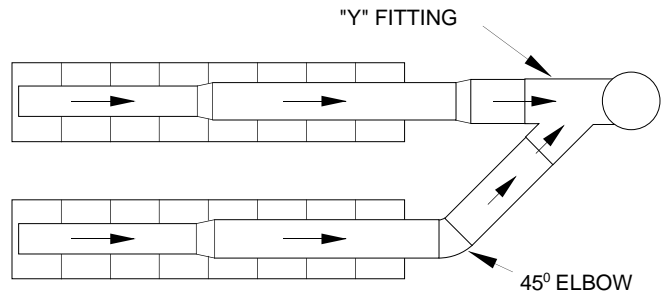
3. Remember, for rectangular breeching, the larger dimension of the rectangle must be in the vertical position,

4. ALL BREECHING RUNS MUST BE PITCHED 1/4" PER FOOT OF LENGTH UPWARDS TOWARD THE CHIMNEY.

5. Where one breeching run connects into another breeching run, they must be connected so the flow-streams from each breeching run do not face or oppose each other. They must flow in the same general direction (see Figure 4.10). Construction involves using "Y"-fittings and rounded 45° elbows angled towards the chimney to assure proper flue gas flow, specifically "Y" together rather than "tee" together.



PREFERRED



ACCEPTABLE

FIGURE 4.10

6. Where two or more breeching runs connect into the same chimney, make sure the openings into the chimney do not directly face or oppose each other.

7. At the breeching-chimney connection, breeching must be flush with the inside of the chimney liner and sealed.

8. Always use "Y" fittings rather than "tee" fittings when connecting breeching together.

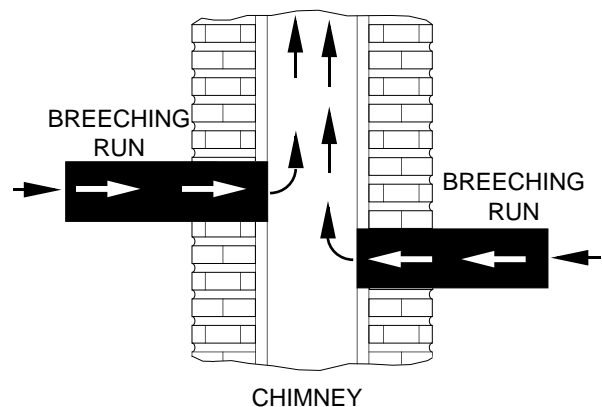


FIGURE 4.11

SECTION 5: INSTALLING JACKETS

NOTE: Remember, "A" jacket sets are for enclosing two modules and "B" jacket sets are for enclosing three modules.

1. Place front and rear panels along heating plant, and attach side panel on the right with screws provided.
2. Any number of "A" or "B" jackets may be joined together to form one continuous jacket by omitting one left side panel in between jacket sets. Fasten front and rear panels to remaining side panel(s) with screws provided. When assembling the jacket, overlap bends as shown.

3. Install top panels starting with left top panel. Lock each panel into the preceding panel and secure with the screws provided.
4. Snap stiffening channels across elongated slot in rear panel beneath each return water piping connection.
5. Attach rating plate, lighting instructions label and literature pack where indicated by stencils.

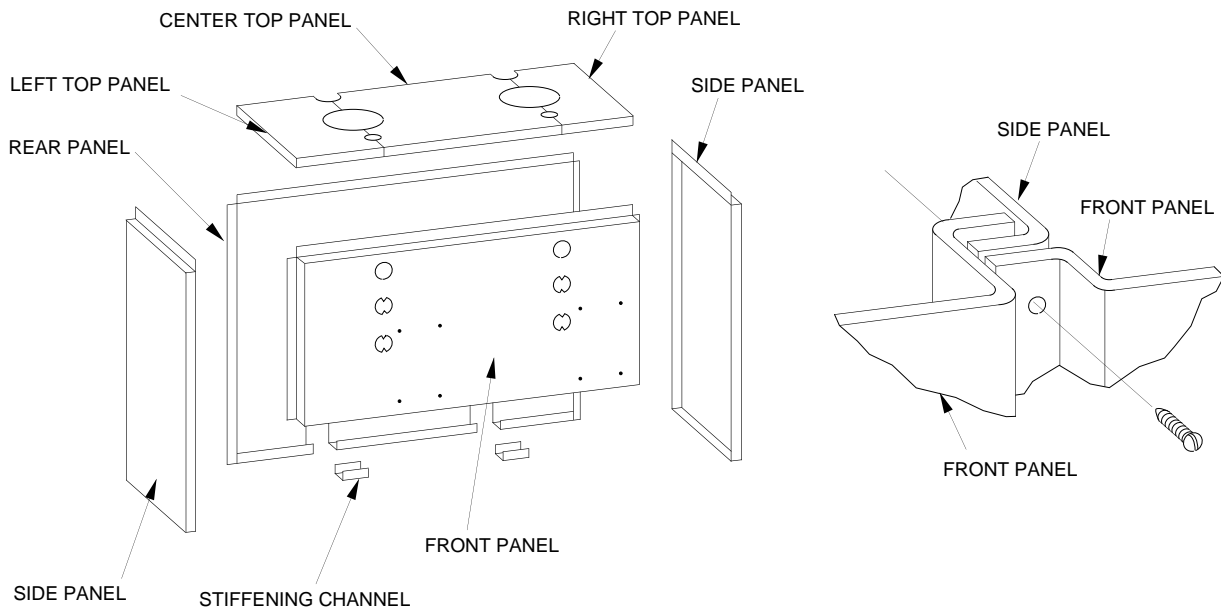


FIGURE 5.1

6. Temperature/Pressure indicators: Install in top holes of front panels; one per module

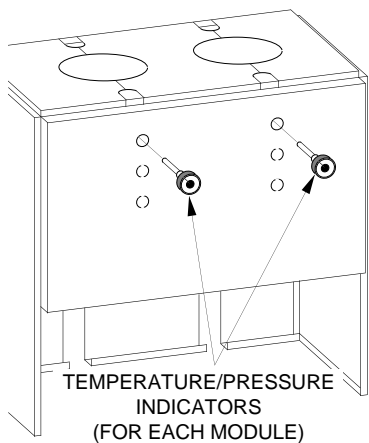


FIGURE 5.2

7. Hi-Limits: Install through appropriate knockouts as shown; one per module. (Well is factory installed.)

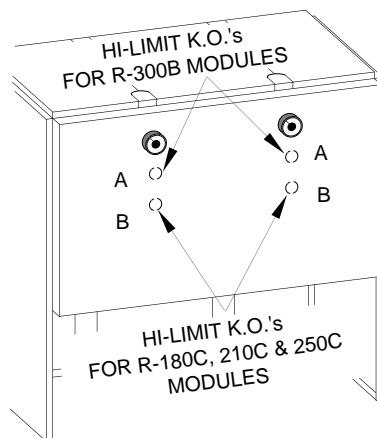


FIGURE 5.3

8. Electrical Subchassis: For all modules equipped with electronic ignition (does not apply for standing pilot mods); mount on front panels.

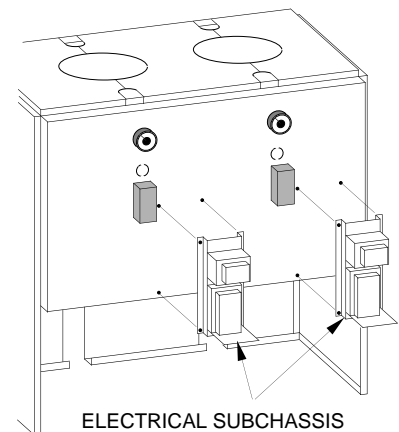


FIGURE 5.4

SECTION 6: INSTALLING GAS PIPING

STEP 1: GAS MAIN & GAS HEADERS

1. Gas pipe (gas main and gas headers) must be sized to provide a total maximum pressure drop of 0.3" W.C. (natural gas) or 0.5" W.C. (propane) between gas meter and each module's gas valve. If shop drawings with approved pipe sizes are not available, use sizing guidelines recommended in Appendix B at the rear of this manual.

2. Gas main (from meter to gas headers) must have a non-restrictive lubricated plug valve installed close to the modules as well as a full-sized sediment trap at the

lowest point in the gas main. The vertical rise of sediment trap must be a minimum of three times gas main pipe diameter.

3. The gas header is the manifold to which each module's gas valve is connected; the connection at each gas valve inlet requires a ground joint union. If total equivalent pipe length (straight pipe plus fittings) from gas valve inlet to header is 5-feet or less, use a pipe diameter that matches gas valve inlet; over 5-feet, calculate pipe diameter.

4. All piping must be supported with floor supports or by hangers, not by the boilers or accessories. Always follow good piping practices. Pipe joint compound must be compatible with gas being used. Check local codes and utilities for any special requirements.

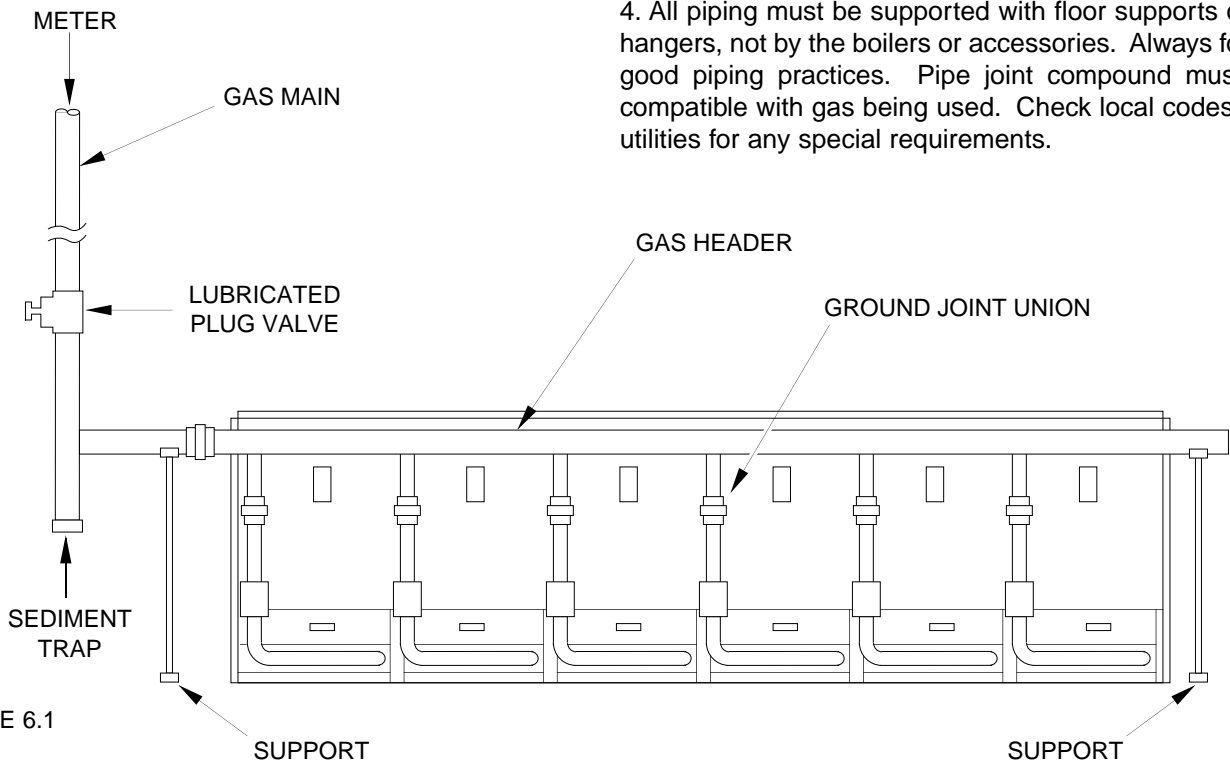


FIGURE 6.1

STEP 2: TEST GAS PIPING

DANGER: Before placing gas piping into service, carefully test it to assure every joint is gas tight. Bubble test all joints with soap solution. NEVER TEST WITH AN OPEN FLAME AS FIRE OR EXPLOSION WILL RESULT.

For any pressure testing in excess of 1/2 psi, the module and its individual shutoff valve must be isolated from the piping system by disconnecting them and capping the outlet(s). For any pressure testing equal to or less than 1/2 psi, module must be isolated from the piping system by closing its manual shutoff valve.

Minimum pressure required at the gas valve inlet is 5" W.C., 5.5" W.C. on R300 modules (natural gas) and 11" W.C. (propane). Maximum pressure allowable at the gas valve inlet is 12" W.C. If the gas pressure is above these limits, a pressure regulator must be installed. If the gas pressure is below these limits, contact the local utility.

WHEN PRESSURE TESTING IS COMPLETED, CLOSE MAIN GAS SHUT-OFF VALVE & SET BOILER COMBINATION GAS VALVES IN "OFF" POSITION

SECTION 7: WIRING THE HEATING PLANT

For Vent Damper-equipped modules: Attach damper cables to cable clamps on module front panels and join the molex connectors.

DANGER: Turn off electrical power supply before servicing. Contact with live electric components can cause shock or death.

CAUTION: Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation

Verify proper operation after servicing.

If shop drawings with approved control selection and wiring diagrams are not available, you can use the control and wiring guidelines recommended in Appendix C at the rear of this manual. For individual module wiring refer to wiring diagrams in Figures 7.1 thru 7.3.

All electrical wiring must be in accordance with requirements of the authority having jurisdiction or, in absence of such requirements, with National Electrical Code NFPA-70- latest edition. If an external electrical source is utilized, module must be electrically grounded in accordance with requirements of the authority having jurisdiction or, in the absence of such requirements, with the National Electrical Code NFPA-70- latest edition. UL listed power limited circuit cable is almost universally approved for safety controls on heating equipment, either internally or externally, without protection of conduits or raceway.

For Canada, installations must be in accordance with Standard C.S.A. C22.1 Canadian Electrical Code, Part 1 and Part 2, and/or local codes.

Safety devices (such as low water cut-offs and manual reset high limits) must be wired so they shut down all modules protected by those devices. Switch ratings on safety or control devices must not be exceeded; this may require the use of relays for larger heating plants.

Air and water temperature sensor wiring must not be run in the same conduit as power wiring; use shielded wiring in runs over 25 feet long.

NOTE: If any of the original wire supplied with module must be replaced, use similar wire of 105 C rating. Otherwise, insulation may melt or degrade, exposing bare wire.

NOTE: Module transformers must not be used to power external accessories (i.e. zone valves, relays, etc.) Otherwise, transformers will be overloaded and burn out.

POWER REQUIREMENTS PER MODULE

| | |
|--------|------------------------|
| MR: | .2 amps 115V/60Hz Side |
| | 1.0 amps 24V/60Hz Side |
| MR-P: | .2 amps 120V/60Hz Side |
| | 1.0 amps 24V/60Hz Side |
| MR-PV: | .3 amps 120V/60Hz Side |
| | 1.5 amps 24V/60Hz Side |

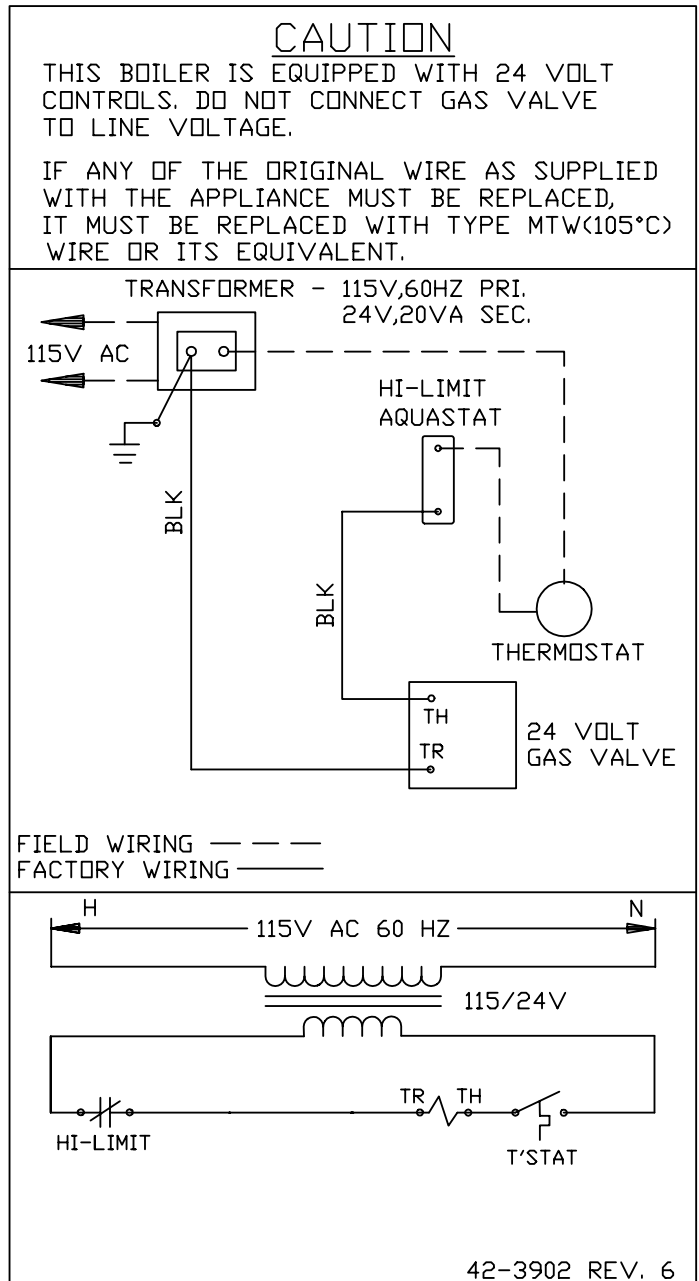
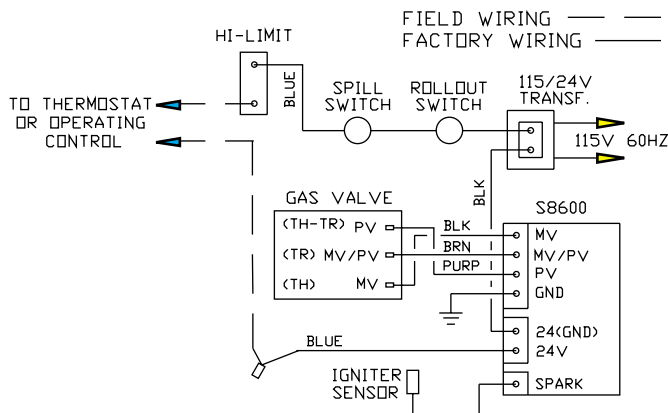


FIGURE 7.1 WIRING DIAGRAM & OPERATION SEQUENCE FOR BOILERS EQUIPPED WITH STANDING PILOT

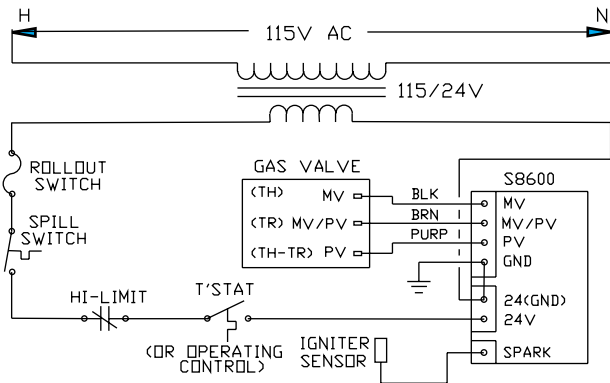
**OPERATING SEQUENCE
FOR BOILERS EQUIPPED WITH
HONEYWELL ELECTRONIC PILOT CONTROL**

SENSING CIRCUIT IS CONTINUOUSLY MONITORED.
THERMOSTAT (OR OPERATING CONTROL) CALLS FOR HEAT.
IF NO FAILURE EXISTS, THE PILOT VALVE AND IGNITER
ARE ENERGIZED.

PILOT IS IGNITED AND SENSOR SENSES FLAME.
MAIN VALVE IS ENERGIZED AND IGNITER DE-ENERGIZED.
UNIT CONTINUES TO OPERATE UNTIL THERMOSTAT
(OR OPERATING CONTROL) IS SATISFIED.



IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE BOILER MUST BE REPLACED, USE A SIMILAR WIRE OF 105° C RATING.



SPILL AND ROLLOUT SWITCHES USED WHEN INPUT IS LESS THAN 300,000 BTUH

42-5704 REV. 4

FIGURE 7.2 WIRING DIAGRAM & OPERATION SEQUENCE FOR BOILERS EQUIPPED WITH INTERMITTENT PILOT

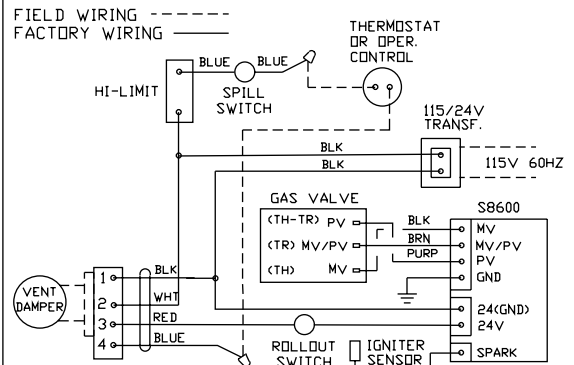
**OPERATING SEQUENCE
FOR BOILERS EQUIPPED WITH VENT DAMPER
AND HONEYWELL ELECTRONIC IGNITION CONTROL**

MOTOR DRIVES VENT DAMPER TO CLOSED POSITION AND REMAINS CLOSED DURING STANDBY.
SENSING CIRCUIT IS CONTINUOUSLY MONITORED.
THERMOSTAT (OR OPERATING CONTROL) CALLS FOR HEAT.
DAMPER BLADE OPENS.

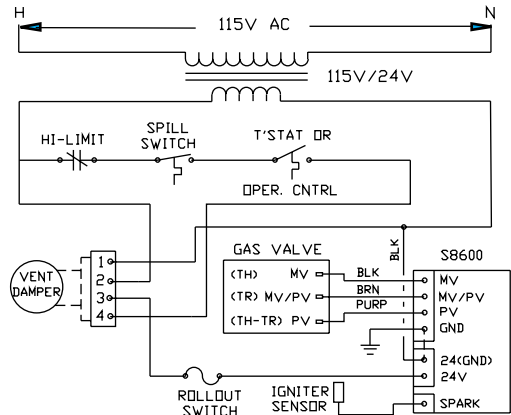
DAMPER END SWITCH CLOSES (PROVING DAMPER OPEN).
IF NO FAILURE EXISTS, THE PILOT VALVE AND IGNITER
ARE ENERGIZED.

PILOT IS IGNITED AND SENSOR SENSES FLAME.
MAIN VALVE IS ENERGIZED AND IGNITER DE-ENERGIZED.
UNIT OPERATES UNTIL THERMOSTAT (OR OPERATING
CONTROL) IS SATISFIED.

SYSTEM RETURNS TO STANDBY WITH DAMPER CLOSED.



IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE BOILER MUST BE REPLACED, USE A SIMILAR WIRE OF 105° C RATING.



SPILL AND ROLLOUT SWITCHES USED WHEN INPUT IS LESS THAN 300,000 BTUH

42-5705 REV.5

FIGURE 7.3 WIRING DIAGRAM & OPERATION SEQUENCE FOR BOILERS EQUIPPED WITH INTERMITTENT PILOT & VENT DAMPER

SECTION 8: HEATING PLANT START-UP

STEP 1: PLANNING AHEAD

1. Check that flow direction arrows imprinted on water system components are pointing in the proper direction.
2. If system was not previously hydrotested, fill system. Check all temperature/pressure indicators to assure there is at least the desired cold fill pressure in the system.
3. Check all fittings and components for visible signs of leakage, including each module's (and header's) supply and return water connections.
4. Check that system pump(s) are interlocked with the heating plant's operating controls so modules cannot fire without pump(s) running.

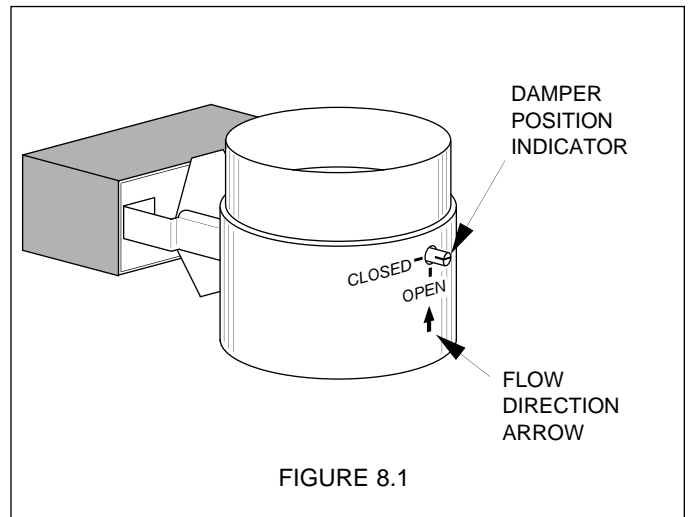
STEP 2: START-UP & ADJUSTMENTS

Safe lighting and other performance criteria were met with the gas manifold and control assembly provided on the module when module underwent tests specified in ANSI Z21.13b-1994.

WARNING: Never store combustible materials, gasoline or any product containing flammable vapors or liquids in the vicinity of the heating plant! Do not allow lint, paper, rags or other combustibles to accumulate around the heating plant! Never place clothing, rags or other combustible materials on the heating plant. Failure to comply with this warning can result in a fire which will cause extensive property damage, severe personal injury or death!

NOTE: Do not draw water from heating system for cleaning. Minerals in the water can build up on heat transfer surface and cause overheating and subsequent failure of the cast iron sections.

1. Thoroughly purge the heating system following standard purging practices. Remember, every loop in the system must be properly purged.
2. Check air elimination equipment for proper operation to ensure that there is no air in the heating system.
3. With the gas valve OFF, turn on power to modules. Open all zones individually and let system pump(s) run until all air is purged from each zone (sound of air bubbles flowing in piping has been eliminated).
4. Operate system pump(s) with all zones open; continue for the minimum time required to pass entire system volume through separation point until sound of air bubbles flowing in piping has been eliminated.
5. For vent damper-equipped modules, set operating control(s) to call for heat. Observe that vent damper position indicator has rotated to the open position (see Figure 8.1). **Damper must be in the open position when appliance main burner is operating.**



- a. After damper opens, spark should appear at pilot ignition electrode.
 - b. Set operating control(s) to no longer call for heat. Spark should stop. Observe that damper position indicator rotates to the closed position.
6. Open the main manual gas valve, allowing gas to flow through gas piping system. Open each module's gas valve.
 7. Set operating control(s) to call for heat. Follow directions in lighting instruction labels on front of module jackets and light the boiler modules.
 8. Allow system water temperature to rise slowly to about 30°F above fill temperature; shut down modules but allow system pump(s) to run continuously. When all sounds of air bubbles are eliminated, increase system temperature another 30°F. Repeat procedure until maximum system design temperature is reached.
 9. Observe pilot and main burner flame (see Figure 8.2). All burner ports should be ignited and burn with a steady blue flame.

STEP 2: START-UP & ADJUSTMENTS (CONTINUED)

CAUTION: Never leave the job with yellow burning flames. This condition indicates poor combustion and will quickly carbonize the module, reducing efficiency and module life. It may also be an indication of improper venting or combustion air supply. If unable to adjust flame properly, consult your local utility.

10. Modules are shipped from factory with primary air shutters on main burner wide open. These air shutters should be left in the wide open position unless there is lifting of the flame above the burner ports. If there is lifting, the air shutters should be gradually closed until lifting is eliminated. It may also be necessary to adjust the primary air shutters if the input rate is reduced by a change in the orifices.

11. After burners have fired for about 15 minutes check gas input rate to each module as follows:

- a. Make sure all other appliances served by the gas meter are turned off during timing of gas input rate.
- b. Measure the number of seconds it takes for each module to use 10 cubic feet of gas. Divide 36,000 by the number of seconds; this is the number of cubic feet of gas used per hour. Multiply this figure by the heating value of the gas (obtained from your local utility) to obtain Btu input per hour.

Example: R-300B module takes 2 minutes to use 10

cubic feet of natural gas. Utility indicated gas heating value is 1000 Btu/cu ft. Therefore:

$$(2 \times 60) = 120 \text{ seconds}$$

$$\frac{36,000}{120} \times 1000 = 300,000 \text{ Btu/hr}$$

Therefore, the module input is correct.

12. If module input needs to be corrected, adjust combination gas valve pressure regulator. (Regulator is factory set at 3-1/2" W.C. for natural gas and 10" W.C. for propane.) Turn adjusting screw clockwise to increase gas flow (increase input). Turn adjusting screw counterclockwise to decrease gas flow (decrease input). In no case should final manifold pressure setting vary more than $\pm .3$ " W.C. from factory-set pressures. If rated input cannot be obtained with regulator adjustment, gas supply pressure or orifice size may be the cause. Consult your local utility and Hydrotherm.

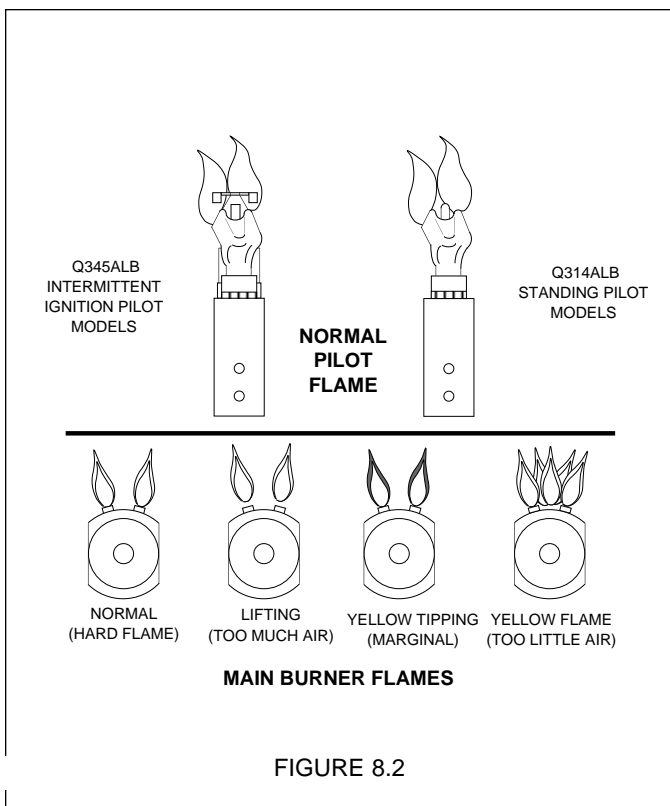
13. Gas burner orifices supplied with modules have been carefully designed to provide the correct gas input rate for most gas conditions typically found in the U.S. Occasionally, however, the local gas characteristics may not allow the module to be properly adjusted for input. If this is the case, the local utility or Hydrotherm may recommend orifices be changed. When changing orifices, follow procedures in Step 3.

14. Start and stop burners several times by raising and lowering the control settings. Observe light-off, flame configuration and color.

15. Check all safety and operating controls to be sure they are operating in accordance with manufacturer's recommendations.

a. **Hi-Limit Aquastat:** Mounted on each module, it cuts off gas supply to module when module water temperature exceeds setting. Check high limit is set at 220°F. To verify aquastat operation, with a small screwdriver, reduce high limit setting to 100°F. Fire module until water temperature reaches or exceeds 100°F, at which time the burner should shut off. If for any reason burner does not shut off, or allows the water temperature to exceed 120°F, replace aquastat. If no replacement is necessary, return setting to 220°F.

b. **Manual Reset High Limit:** Mounted in supply header, it shuts off all module burners if system operating water temperature exceeds setting. Check that setting is 250°F. To verify operation, with a small screwdriver, reduce setting while heating plant is firing. All module burners should shut off when the



STEP 2: START-UP & ADJUSTMENTS (CONTINUED)

operating water temperature exceeds the reduced setting. If module burners do not shut off, check high limit electrical wiring. If O.K., replace high limit.

- c. Check that low water cutoff(s) actually shut down heating plant as intended.

16. Before leaving the job, make sure heating plant installation has been inspected and approved by local authorities having jurisdiction over the installation.

STEP 3: HOW TO CHANGE ORIFICES (IF NECESSARY)

1. Shut off power supply and gas supply to module.
2. Remove burner access panel. To remove burners, lift up and to the rear until burners are disengaged from the orifices.
3. Check orifices for proper drill size which is stamped onto the body of the brass orifice. Size can also be checked by using a pin gauge (see Figure 8.3).
4. All orifices are screwed into the manifold and may be removed by using a 5/8" wrench or socket.
5. Reverse above procedures to install orifices and burners. **BE SURE TO REINSTALL BURNER WITH BURNER PORTS ON TOP SURFACE (UPRIGHT).**

| TYPE OF GAS | MANIFOLD PRESSURE | R-180 MOD. | R-210 MOD. | R-250 MOD. | R-300 MOD. |
|--|-------------------|------------|------------|------------|------------|
| NAT. GAS 1000 BTU/CU FT. 0.60 SG | 3.5 | 37 | 33 | 33 | 31 |
| L.P. GAS 2500 BTU CU. FT. 1.5 SG | 10.0 | 52 | 51 | 51 | 49 |

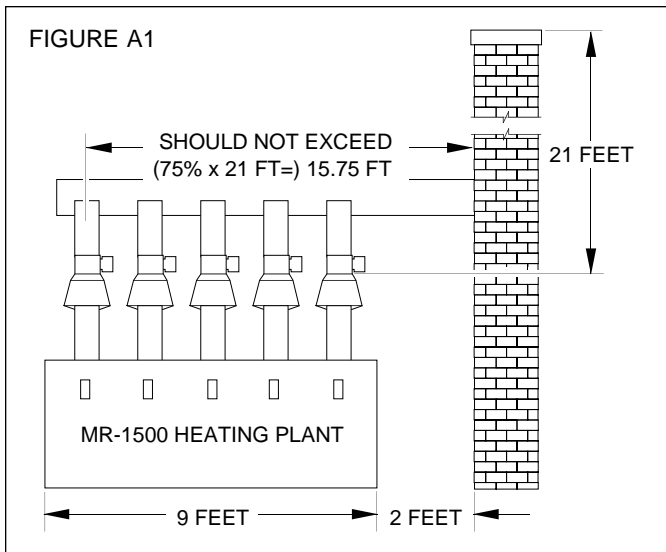
FIGURE 8.3 ORIFICE DRILL SIZE

APPENDIX A: BREECHING/CHIMNEY SIZING

Size the breeching first, as restriction to flow through the breeching will effect the capacity of the chimney.

BREECHING LENGTH

Maximum breeching length (from the furthest module to the chimney) for each bank of boilers is limited by the chimney height. As a general rule, maximum breeching length should not exceed 75% of chimney height; this can be superseded by specially engineered venting systems. For all gas-fired heating plants, chimney height is measured from the top of the draft hood outlet. Therefore, it is important to locate the heating plant as close to the chimney as possible. To minimize breeching length and corresponding chimney height requirement, only 24" required between the chimney and first module.



| BOILER MODEL | LGTH | BOILER MODEL | LGTH | BOILER MODEL | LGTH |
|--------------|------|--------------|-------|--------------|-------|
| MR-360C | 3'6" | MR-840C | 7'1" | MR-180B | 10'7" |
| MR-420C | 3'6" | MR-900B | 5'4" | MR-2100B | 12'4" |
| MR-500C | 3'6" | MR-1000C | 7'1" | MR-2400B | 14'1" |
| MR-600B | 3'6" | MR-1200B | 7'1" | | |
| MR-750C | 5'4" | MR-1500B | 8'10" | | |

FIGURE A1

Example: Let's assume a MR-1500B heating plant has been specified and the chimney height is limited to 21-feet due to building constraints (see Figure A1). The breeching length for the heating plant should not exceed 15.75 feet. Using the dimension chart in Figure A2, an MR-1500B heating plant requires approximately 9-feet in length plus a 2-foot minimum clearance between the first module and the chimney; thus, breeching length is compatible with the allowable chimney height.

Breeching Length Formula: For your installation.

$$1. \frac{\text{Chimney Ht.}}{\text{ft.}} \times 75\% = \frac{\text{Max. Breech Lg.}}{\text{ft.}}$$

$$2. \frac{\text{Plant Lg.}}{\text{ft.}} + \frac{\text{From 1st Mod To Chimney}}{\text{ft.}} = \frac{\text{Req. Breech Lg.}}{\text{ft.}}$$

3. If required length is equal to or less than maximum length, application is O.K. If required length exceeds maximum length, then you would have to consider appropriately dividing the heating plant or bank of boilers.

BREECHING DIAMETER

1. Determine if one full size breeching, which is preferred, or a tapered transition to a smaller diameter will be used in the breeching run to serve the particular heating plant or bank of boilers.

2. Determine the number of vent connectors being accommodated by each section of the breeching (one vent connector per module).

3. Treating each section separately, determine the correct breeching size from sizing table in Figure A3. (Size is based on heating plant operating at sea level; first module 2-ft from chimney; breeching full size and insulated from top of draft hood or vent damper to chimney entrance; and 1-ft minimum vent connector height. The recommendations in Figure A3 are not to be used for any other configuration; for non-standard configurations, consult Hydrotherm factory directly.)

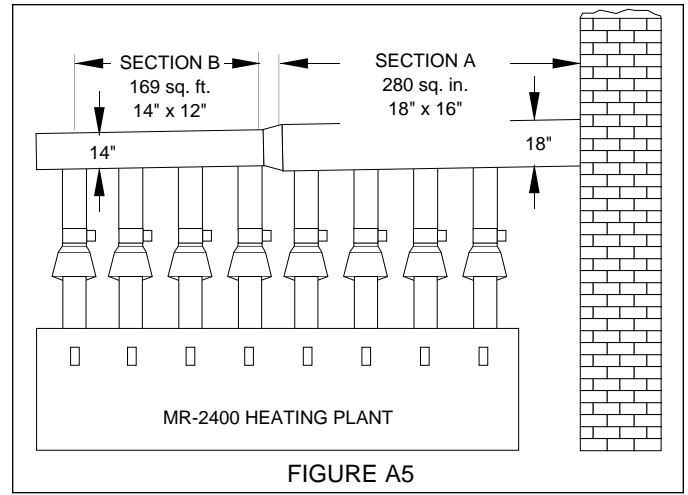
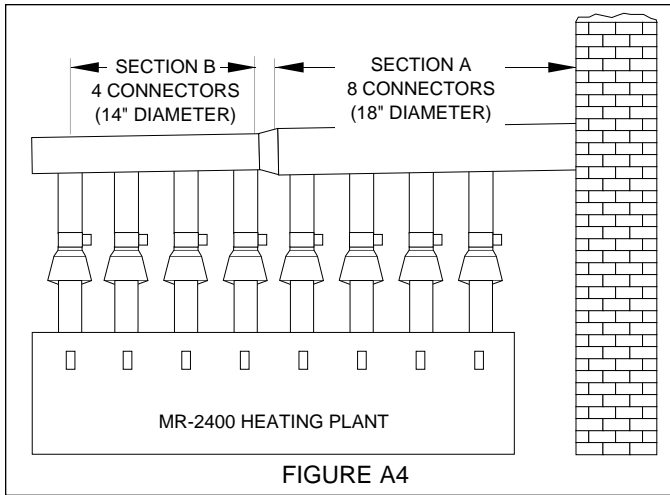
Example: Let's assume a MR-2400B heating plant.

1. Breeching will be circular with a tapered transition, identified as Section A and Section B (see Figure A4).

2. The number of vent connectors feeding into Section A is 8 (all of the vent connectors in the heating plant). The number of vent connectors feeding into Section B is 4.

| BOILER MODEL | NUMBER OF MODULES | BREECHING SIZE (RECOMMENDED) | |
|--------------|-------------------|------------------------------|----------------------------|
| | | CIRCULAR DIA. IN. (I.D.) | RECTANGULAR SQ. IN. (I.D.) |
| MR-360C | 2 | 10 | 86 |
| MR-420C | 2 | 10 | 86 |
| MR-500C | 2 | 10 | 86 |
| MR-600B | 2 | 10 | 86 |
| MR-750C | 3 | 12 | 124 |
| MR-840C | 4 | 12 | 124 |
| MR-900B | 3 | 12 | 124 |
| MR-1000C | 4 | 14 | 169 |
| MR-1200B | 4 | 14 | 169 |
| MR-1500B | 5 | 16 | 221 |
| MR-1800B | 6 | 16 | 221 |
| MR-2100B | 7 | 18 | 280 |
| MR-2400B | 8 | 18 | 280 |

FIGURE A3



3. For Section A size, under the heading "Number of Modules" in Figure A3, go down to 8 and read a-cross to the column, "Breeching Size," where you'll find that Section A must be 18" in diameter. For Section B size, go down to 4 modules, where you'll find that Section B must be 14" in diameter. Where the two breeching sections are connected, a 14"-to-18" tapered increaser must be used.

Rectangular Breeching: Where necessary to use rectangular instead of circular breeching, the larger dimension of the rectangle must be in the vertical position. As shown in Figures A5 and A3, Section A is 280 square inches and Section B is 169 square inches. The size of the rectangles will be about 18" high by 16" wide for Section A and 14" high by 12" wide for Section B.

CHIMNEY SIZING

If the existing chimney will be used for the new heating plant, it cannot be assumed that chimney size is adequate. Chimney size must be based on the chimney's capacity, which involves several factors, the first of which is the chimney's capability to handle the heating plant Btuh input capacity that is to be vented into it. For example, an eight-module MR-2400B heating plant has a Btuh input of 2,400,000; therefore, the chimney must be sized to handle a minimum of 2,400,000 Btuh. However, if the installation has two MR-2400B heating plants vented into the same chimney, then the chimney capacity must be 4,800,000 Btuh input.

Chimney capacity is directly related to what's connected to it - the chimney does not function on its own, but operates in conjunction with the breeching and equipment connected to it. Another important factor is draft loss; equipment and breeching must be located as close as possible to the chimney to minimize draft loss. Equipment located further away from the chimney will have greater draft loss, necessitating a chimney with a greater capacity to accommodate the greater draft loss.

Chimney capacity also varies with its height and inside diameter. The higher the chimney, the greater its capaci-

ty; the larger the inside diameter, the greater its capacity. Any two different size chimneys can have equal capacity; that is, a short chimney with a larger inside diameter can have the same capacity as a higher chimney with a smaller inside diameter.

Chimney height determines the total draft which can be developed and is generally governed by the building height/design and boiler room location. Chimney inside diameter determines the restriction to flow with the larger diameter having less restriction. Generally, the inside diameter should never be smaller than the diameter of the breeching connecting into it.

Figure A6 shows minimum and recommended chimney sizes for Multi-Temp gas-fired heating plants. (The sizes are based on first module located 2-ft from chimney and proper breeching size, as determined from Appendix A. If first module is located more than 2-ft from chimney or breeching is a non-standard configuration, then proper chimney height and diameter, for a specific heating plant Btuh input capacity and breeching, can be determined from ASHRAE or National Fuel Gas Code guidelines.)

| BOILER MODEL | NUMBER OF MODULES | CHIMNEY INSIDE DIAMETER DIA. (IN.) X HEIGHT (FT.) | |
|--------------|-------------------|---|-------------|
| | | MINIMUM | RECOMMENDED |
| MR-360C | 2 | 10 x 9 | 10 X 12 |
| MR-420C | 2 | 10 x 9 | 10 X 13 |
| MR-500C | 2 | 10 x 13 | 10 X 17 |
| MR-600B | 2 | 10 x 19 | 12 X 17 |
| MR-750C | 3 | 12 x 16 | 14 X 15 |
| MR-840C | 4 | 12 x 21 | 14 X 19 |
| MR-900B | 3 | 12 x 21 | 14 X 19 |
| MR-1000C | 4 | 13 x 20 | 14 X 19 |
| MR-1200B | 4 | 13 x 26 | 16 X 20 |
| MR-1500B | 5 | 14 x 30 | 18 X 21 |
| MR-1800B | 6 | 15 x 33 | 18 X 25 |
| MR-2100B | 7 | 16 x 35 | 20 X 25 |
| MR-2400B | 8 | 18 x 32 | 20 X 29 |

FIGURE A6

APPENDIX B: GAS PIPE SIZING

Figure B1 provides recommended gas header and gas main pipe sizes for Multi-Temp heating plants. For accurate size selection, be sure to use total equivalent pipe length; that is, the equivalent foot-length of all fittings, such as elbows, tees and valves, used in the gas pipe run (which can be determined from National Fuel Gas Code tables), added to the straight length of pipe.

Considering gas pipe sizing involves selecting the proper diameter, for the initial determination only, as a rule of thumb add 20% for the fittings to the straight length of piping to get a total equivalent length. However, once a diameter has been selected, the total equivalent length must be verified.

CALCULATING GAS PIPE SIZING

If the information provided in Figure B1 is not sufficient for your application situation, then you can easily calculate the gas pipe diameter. You need to know:

1. Total Btuh input of all modules in the heating plant.
2. Heating value (Btu per cubic foot) of the natural gas (not required for propane), which can be obtained from the local gas utility.
3. Total equivalent lengths of the gas main and the gas headers which must be sized separately.

Figures B3 and B4 are pipe sizing table for natural gas and propane gas piping. They apply for sizing black iron pipe only and are based on total equivalent pipe length and maximum capacity of the pipe (in cubic feet of gas per hour for natural gas or in thousands of Btu per hour for propane). Natural gas sizing table assumes a 1000 Btu/cu.ft. heating value for natural gas.

Gas Headers (Natural Gas)

1. Determine cubic feet of gas per hour for each bank of modules, using the following formula:

$$\text{Module Bank Btuh Input} \div \text{NG Heating Value} = \text{Cubic Feet Per Hour}$$

2. Determine length of the header, which is typically dependent on length of the bank of modules which it serves (see Figure B2). In most cases, the header is straight pipe only.

3. In Figure B3, find the appropriate pipe length in the upper portion of the table under "Length of Pipe, Feet" heading.

4. Move down the column; match the cubic feet per hour (from Step 1). Higher capacity selection is acceptable.

5. Move across to the left-hand column "Nominal Iron Pipe Size, Inches" and read required pipe size.

Gas Main (Natural Gas)

1. Determine the cubic feet of gas per hour for the total heating plant, using the following formula:

$$\text{Heating Plant Btuh Input} \div \text{NG Heating Value} = \text{Cubic Feet Per Hour}$$

| BOILER MODEL | LGTH | BOILER MODEL | LGTH | BOILER MODEL | LGTH |
|--------------|------|--------------|-------|--------------|-------|
| MR-360C | 3'6" | MR-840C | 7'1" | MR-180B | 10'7" |
| MR-420C | 3'6" | MR-900B | 5'4" | MR-2100B | 12'4" |
| MR-500C | 3'6" | MR-1000C | 7'1" | MR-2400B | 14'1" |
| MR-600B | 3'6" | MR-1200B | 7'1" | | |
| MR-750C | 5'4" | MR-1500B | 8'10" | | |

FIGURE B2

| BOILER MODEL | NO. OF MODS. | GAS HEADER PIPE SIZE (IN.) | GAS MAIN PIPE SIZE (INS.) | | | | | | | | | | | | | | PRESS. DROP (W.C.) | | |
|--|--------------|----------------------------|---------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------------|-----|-----|
| | | | LENGTH OF MAIN FROM METER (FT.) | | | | | | | | | | | | | | | | |
| | | | 40 | | 60 | | 80 | | 100 | | 125 | | 150 | | 175 | | | 200 | |
| NG | LP | NG | LP | NG | LP | NG | LP | NG | LP | NG | LP | NG | LP | NG | LP | NG | LP | | |
| MR-360C MR-420C MR-500C MR-600B | 2 | 1-1/4" | 1-1/2" | 1-1/4" | 1-1/2" | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/2" | 2" | 2" | | | 0.3 |
| MR-750C | 3 | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/2" | 2" | 1-1/2" | 2 | 1-1/2" | 2-1/2" | 1-1/2" | 2-1/2" | 2" | 2-1/2" | 2-1/2" | | | |
| MR-840C | 4 | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/2" | 2" | 1-1/2" | 2 | 1-1/2" | 2-1/2" | 1-1/2" | 2-1/2" | 2" | 2-1/2" | 2-1/2" | | | |
| MR-900B | 3 | 1-1/4" | 2" | 1-1/4" | 2" | 1-1/2" | 2" | 1-1/2" | 2 | 1-1/2" | 2-1/2" | 1-1/2" | 2-1/2" | 2" | 2-1/2" | 2-1/2" | | | |
| MR-1000C MR-1200B | 4 | 1-1/2" | 2" | 1-1/2" | 2" | 1-1/2" | 2-1/2" | 2" | 2-1/2" | 2" | 2-1/2" | 2" | 3" | 2" | 3" | 3" | | | |
| MR-1500B | 5 | 1-1/2" | 2" | 1-1/2" | 1-1/2" | 2" | 2-1/2" | 2" | 2-1/2" | 2" | 3" | 2" | 3" | 2" | 3" | 3" | | | |
| MR-1800B | 6 | 2" | 2-1/2" | 2" | 2-1/2" | 2" | 3" | 2" | 3" | 2" | 3" | — | 3" | — | 3" | 4" | | | |
| MR-2100B | 7 | 2" | 2-1/2" | 2" | 3" | 2" | 3" | 2" | 3" | — | 3" | — | 3" | — | 4" | 4" | | | |
| MR-2400B | 8 | 2" | 3" | 2" | 3" | 3" | — | 3" | — | — | — | — | — | — | — | — | | | |

FIGURE B1

FIGURE B3

**Maximum Capacity of Pipe in Cubic Feet of Natural Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 Inch Water Column
(Based on a 0.60 Specific Gravity Gas)**

| Nominal Iron Pipe Size, Inches | Internal Diameter, Inches | Length of Pipe, Feet | | | | | | | | | | | | | |
|--------------------------------|---------------------------|----------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 |
| 1/4" | .326 | 32 | 22 | 18 | 15 | 14 | 12 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 6 |
| 3/8" | .493 | 72 | 49 | 40 | 34 | 30 | 27 | 25 | 23 | 22 | 21 | 18 | 17 | 15 | 14 |
| 1/2" | .622 | 132 | 92 | 73 | 63 | 56 | 50 | 46 | 43 | 40 | 38 | 34 | 31 | 28 | 26 |
| 3/4" | .824 | 278 | 190 | 152 | 130 | 115 | 105 | 96 | 90 | 84 | 79 | 72 | 64 | 59 | 55 |
| 1" | 1.049 | 520 | 350 | 285 | 245 | 215 | 195 | 180 | 170 | 160 | 150 | 130 | 120 | 110 | 100 |
| 1-1/4" | 1.380 | 1,050 | 730 | 590 | 500 | 440 | 400 | 370 | 350 | 320 | 305 | 275 | 250 | 225 | 210 |
| 1-1/2" | 1.610 | 1,600 | 1,100 | 890 | 760 | 670 | 600 | 560 | 530 | 490 | 460 | 410 | 380 | 350 | 320 |
| 2" | 2.067 | 3,050 | 2,100 | 1,650 | 1,450 | 1,270 | 1,150 | 1,500 | 990 | 930 | 870 | 780 | 710 | 650 | 610 |
| 2-1/2" | 2.469 | 4,800 | 3,300 | 2,700 | 2,300 | 2,000 | 1,850 | 1,700 | 1,600 | 1,500 | 1,400 | 1,250 | 1,130 | 1,050 | 980 |
| 3" | 3.026 | 8,500 | 5,900 | 4,700 | 4,100 | 3,600 | 3,250 | 3,000 | 2,800 | 2,600 | 2,500 | 2,200 | 2,000 | 1,850 | 1,700 |
| 4" | 4.026 | 17,500 | 12,000 | 9,700 | 8,300 | 7,400 | 6,800 | 6,200 | 5,800 | 5,400 | 5,100 | 4,500 | 4,100 | 3,800 | 3,500 |

FIGURE B4

**Maximum Capacity of Pipe in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure)
(Based on a Pressure Drop of 0.5 Inch Water Column)**

| Nominal Iron Pipe Size, Inches | Length of Pipe, Feet | | | | | | | | | | | |
|--------------------------------|----------------------|------|------|------|------|------|------|------|------|------|------|------|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 |
| 1/2" | 275 | 189 | 152 | 129 | 114 | 103 | 96 | 89 | 83 | 78 | 69 | 63 |
| 3/4" | 567 | 393 | 315 | 267 | 237 | 217 | 196 | 185 | 173 | 162 | 146 | 132 |
| 1" | 1071 | 732 | 590 | 504 | 448 | 409 | 378 | 346 | 322 | 307 | 275 | 252 |
| 1-1/4" | 2205 | 1496 | 1212 | 1039 | 937 | 834 | 771 | 724 | 677 | 630 | 567 | 511 |
| 1-1/2" | 3307 | 2299 | 1858 | 1559 | 1417 | 1275 | 1180 | 1086 | 1023 | 967 | 866 | 787 |
| 2" | 6221 | 4331 | 3465 | 2992 | 2646 | 2394 | 2205 | 2047 | 1921 | 1811 | 1606 | 1498 |

- Determine total equivalent length of gas main. Remember, if exact number/type of fittings are not known, for initial determination only, add 20% for fittings to the straight length of piping to get a total equivalent length.
- In Figure B3, find appropriate pipe length in upper portion of table under "Length of Pipe, Feet" heading.
- Move down the column; match the cubic feet per hour (from Step 1). Higher capacity selection is acceptable.
- Move across to the left-hand column "Nominal Iron Pipe Size, Inches" and read required pipe size.
- Once a diameter has been selected, verify the total equivalent length.

Gas Headers (Propane)

- Determine Btuh input for each bank of modules.
- Determine the length of the header, which is typically dependent on the length of the bank of modules which it serves (see Figure B2). In most cases, the header is straight pipe only.
- In Figure B4, find appropriate pipe length in upper portion of table under "Length of Pipe, Feet" heading.

- Move down the column; match the Btuh input (from Step 1). Higher capacity selection is acceptable.
- Move across to the left-hand column "Nominal Iron Pipe Size, Inches" and read required pipe size.

Gas Main (Propane)

- Determine Btuh input for the total heating plant.
- Determine total equivalent length of gas main. Remember, if exact number/type of fittings are not known, for initial determination only, add 20% for fittings to the straight length of piping to get a total equivalent length.
- In Figure B4, find appropriate pipe length in upper portion of table under "Length of Pipe, Feet" heading.
- Move down the column; match the Btuh input (from Step 1). Higher capacity selection is acceptable.
- Move across to the left-hand column "Nominal Iron Pipe Size, Inches" and read required pipe size.
- Once a diameter has been selected, verify the total equivalent length.

APPENDIX C: CONTROL GUIDELINES

CONTROL SYSTEM METHODS

The objective of Multi-Temp control systems is to relate fuel input to actual heating load by automatic step-firing, which means that more or fewer modules are operated in response to automatic controls. Step-firing can be accomplished in many different ways to suit system type & size. Hydrotherm has developed three basic control levels which meet most operating methods encountered.

Level I Control-Constant Supply Water Temperature:

Multiple aquastats in return or supply header with settings spaced at small, equal increments provide low cost step-firing control for small heating plants (2-5 modules) which operate with constant supply water temperature (fan coil systems, etc.). From a cold start, all modules fire and “step out” as individual aquastats are satisfied.

Level II Control-Supply/Outdoor Reset Water Temperature (System J):

Electronic, plug-in, modular control system designed to raise or lower the temperature of

the supply water based on a proportional rise or drop in the temperature at the outside sensor by stage firing of the modular boiler heating plant. This is an effective, low cost control system for small to medium heating plants (2-6 modules) where it is desired to modulate supply water temperature in relation to the outdoor temperature such as in baseboard convactor systems.

Level III Control-Outdoor Reset Supply Water Temperature:

Especially designed for large heating plants. the Hydrotherm Model S Electronic Outdoor Reset Step Control provides stable, sequential firing of modules in up to 8 steps and are applicable for systems operating with constant or modulated supply temperatures. Level III control system includes the Model S step control and an outdoor thermostat. As outdoor temperature drops below a present point, the Model S step control is energized and operates the modules to maintain the desired supply water temperatures.

| BASIC CONTROL RECOMMENDATIONS | SPACE HEATING | | | | | | | | COMBINATION SPACE/WATER HEATING | | | | | | | | | | | | | | | | | | |
|---------------------------------------|---------------|---|---|---|---|---|---|---|---------------------------------|---|---|---|---|---|---|---|------|---|---|---|---|---|---|---|------|---|---|
| | Modules | | | | | | | | Heat Exchangers and Modules | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | MC-2 | | | | | | | | MC-3 | | | | | | | | MC-4 | | |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 4 | 5 | 6 | 7 | 8 | |
| CONTROL LEVEL I | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dual Aquastat (L4081A) | 1 | 1 | 2 | | | | | 1 | 1 | 2 | | | | | 1 | 1 | | | | | | | 2 | | | | |
| Single Aquastat (L4006A) | — | 1 | — | | | | | — | 1 | — | | | | | 1 | 2 | | | | | | | — | | | | |
| Air Therm. (T6013A) | 1 | 1 | 1 | | | | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | | | 1 | | | | |
| L.W. Cutoff (#746 or RW700A) | 1 | 1 | 1 | | | | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | | | 1 | | | | |
| Manual Reset Hi-Limit (L4006E) | 1 | 1 | 1 | | | | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | | | 1 | | | | |
| Reverse Aquastat (L4006B) | | | | | | | | 1 | 1 | 1 | | | | | 1 | 1 | | | | | | | 1 | | | | |
| CONTROL LEVEL II (System J) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AR Reset Module | 1 | 1 | 1 | 1 | 1 | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| Y Transformer Module | 1 | 1 | 1 | 1 | 1 | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| S Stage Module | 1 | 2 | 3 | 4 | 5 | | | — | 1 | 2 | 3 | 4 | | — | 1 | 2 | 3 | | | | | — | 1 | 2 | | | |
| AA Winter/Summer Circulator Starter | 1 | 1 | 1 | 1 | 1 | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| L.W. Cutoff (#746 or RW700A) | 1 | 1 | 1 | 1 | 1 | | | — | 2 | 2 | 2 | 2 | | — | 2 | 2 | 2 | | | | | — | 2 | 2 | | | |
| Manual Reset Hi-Limit (L4006E) | 1 | 1 | 1 | 1 | 1 | | | — | 2 | 2 | 2 | 2 | | — | 2 | 2 | 2 | | | | | — | 2 | 2 | | | |
| SPDT Aquastat (L6006A) | | | | | | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| Dual Aquastat (L4081A) | | | | | | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 2 | 2 | | | |
| Single Aquastat (L4006A) | | | | | | | | | | | | | | — | 1 | 1 | 1 | | | | | | | | | | |
| 2" Motorized Valve (V5045/2045) | | | | | | | | — | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | |
| 2-1/2" Motorized Valve (V51B/Q100A) | | | | | | | | | | | | | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| D Temperature Display Module (Opt.) | 1 | 1 | 1 | 1 | 1 | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| CLK Night Set-Back Prog. Clock (Opt.) | 1 | 1 | 1 | 1 | 1 | | | — | 1 | 1 | 1 | 1 | | — | 1 | 1 | 1 | | | | | — | 1 | 1 | | | |
| CONTROL LEVEL III | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Model S step Control (Hydrotherm) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 |
| L.W. Cutoff (#746 or RW700A) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 |
| Manual Reset Hi-Limit (L4006E) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 |
| SPDT Aquastat (L6006A) | | | | | | | | — | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 |
| Dual Aquastat (L4081A) | | | | | | | | — | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 2 | 2 | 2 | 2 |
| Single Aquastat (L4006A) | | | | | | | | | | | | | | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | |
| 2" Motorized Valve (V5045/2045) | | | | | | | | — | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | |
| 2-1/2" Motorized Valve (V51B/Q100A) | | | | | | | | | | | | | | — | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | 1 | |

CONTROL FUNCTIONS & DESCRIPTIONS

Combination Gas Valve: Factory-assembled with each module. Combines main shut-off cock, pressure regulator and main magnetic gas valve, plus the added safety of a second in-line magnetic valve interlocked to assure absolute safe, reliable lighting. Automatically closes if gas supply or power is interrupted. Factory-supplied transformer provides power to gas valve.

Transformer: Power source for the control circuit; cannot be interconnected with one another nor used as a power source for other controls. For Model MR, one transformer per four modules if factory supplied; with a rating of 24 volts/75VA, it can adequately power for gas valves; built-in circuit breaker with reset button is provided as protection against overload. For Models MR-P and MR-PV, one transformer for each module is factory supplied, with rating of 24 volts/20VA (MR-P) or 24 volts/40VA (MR-PV).

Hi-Limit Aquastat: One per module is factory-supplied (well is factory-assembled on each module). Is a hi-limit temperature safety control only; it must not be used as an operating control. For mounting, see Section 5 in this manual.

Manual Reset Hi-Limit: Safety control used to shut off all boilers if system temperature exceeds the setting, usually 250° F. Must be reset manually by pushing red button in cover. Locate in supply piping downstream of connection of the last module, as previously discussed in Section 3 in this manual.

Low-Water Cut-Off: Electronic type or float type. Used to shut off boilers if water level should fall below its sensor location. Locate in supply header, as previously discussed in section 3 in this manual.

Immersion Aquastats: Single and dual aquastats are used to open a control circuit in response to increasing water temperature. May be used in multiples to provide step firing in response to either supply or return water temperature. Dual aquastat, controlled through one temperature sensor probe, has two individually adjustable temperature actuated switches; single aquastat has one adjustable switch. Locate in return header; return water temperature is preferred method for controlling system.

Outdoor Air Thermostat: Switching device used to turn on system or system components at a desired outdoor temperature. Is also used as a heat starter to automatically switch on system power to start heating plant. It is generally set at an outdoor temperature of 65° F, has a 20-ft capillary tube with remote liquid filled bulb and comes with sunshield for mounting on a north wall where sun's effects are minimized; control box can be mounted anywhere within the length of the capillary tube.

System J: The basic control system consists of an "AR" reset module which accepts add-on "AA" winter/summer circulator starter, "Y" transformer module, and "S" staging modules. Optional add-on modules include "D" temperature display module and "CLK" night set-back programmable clock. Five pin connectors between modules speed installation time and eliminate potential wiring errors. The modules can be mounted on any wall surface or an optional DIN rail.

Motorized Valves: Commonly used on combination space and service water heating applications. Externally powered from a 24-volt source and controlled by a single-pole double-throw switching device, for fully open or closed positions. Typical application is to interrupt water flow to the space heating section of the heating plant whenever service water heating is in jeopardy, resulting in a priority for service water heating; this is accomplished by installing an aquastat in the heat exchanger shell, wired to the motorized valve control circuit so it will close off boiler water flow to space heating when the heat exchanger shell temperature falls below the aquastat setting. For mounting of motorized valve, see Section 3 in this manual.

Electronic Outdoor Reset Step Control: (Hydrotherm Model S Control) Designed specifically to reset system supply water temperature in relation to outdoor temperature for large heating plants by step-firing the required number of boiler modules for the desired system supply temperature. Consists of all solid state components:

1. Control box for mounting in boiler room includes microprocessor, L.E.D. indicating lights, and supply and air temperature digital read out.
2. Outdoor temperature sensor & sunshield for mounting on a north wall, and supply water temperature sensor for mounting in supply header (no capillaries; both wired electronically).

Optional equipment includes night set-back and time/cycle monitor. Follow installation instructions packaged with controls.

WIRING DIAGRAM EXAMPLES

This manual provides several examples of heating plant control method applications for your use. For additional information, contact your local Hydrotherm sales representative or the Hydrotherm factory directly.

Space Heating Only Applications: Level I Control, Figure C2; Level II Control, Figure C3; Level III Control, Figure C4.

Space & Volume Water Heating Applications With MC Heat Exchanger: Level I Control, Figure C5; Level II Control, Figure C6; Level III Control, Figure C7.

NOTE: CONTROLS (THERMOSTATS, LOW WATER CUT-OFFS, AQUASTATS) ARE RATED AT 8 AMP.-120V, 5.1 AMP.-240V (1/2 HP). WHEN CIRCUIT POWER EXCEEDS THIS, CONTACTORS MUST BE USED. 24V TRANSFORMER MUST HAVE 60VA MINIMUM RATING.

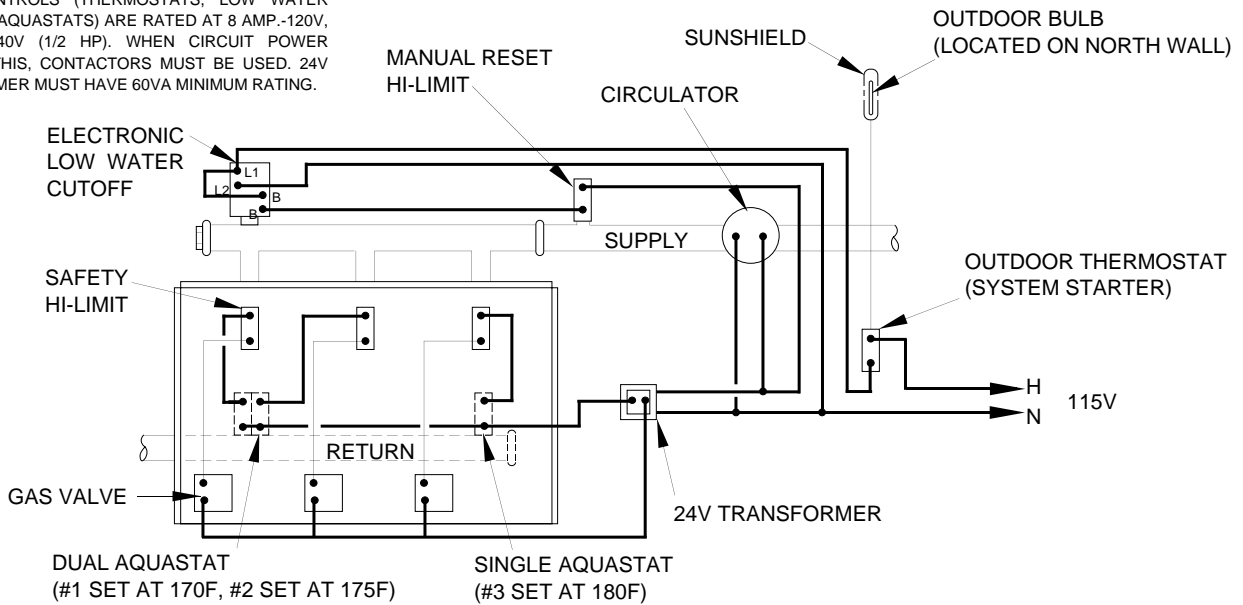


FIGURE C2: EXAMPLE OF LEVEL I CONTROL FOR SPACE HEATING ONLY

When outdoor temperature falls below setting of outdoor thermostat, transformer and circulator are energized. All modules will fire until temperature in return header reaches setting of modulating aquastats. Aquastats will then shut off modules until a point is reached where modules still firing are just able to satisfy heat load. Example (3-module system), as return temperature rises, dual aquastat "steps-out" module #1 (i.e. at 170F), then module #2 (i.e., at 175F). Single aquastat "steps out" module #3 at maximum return temperature (i.e., at 180F).

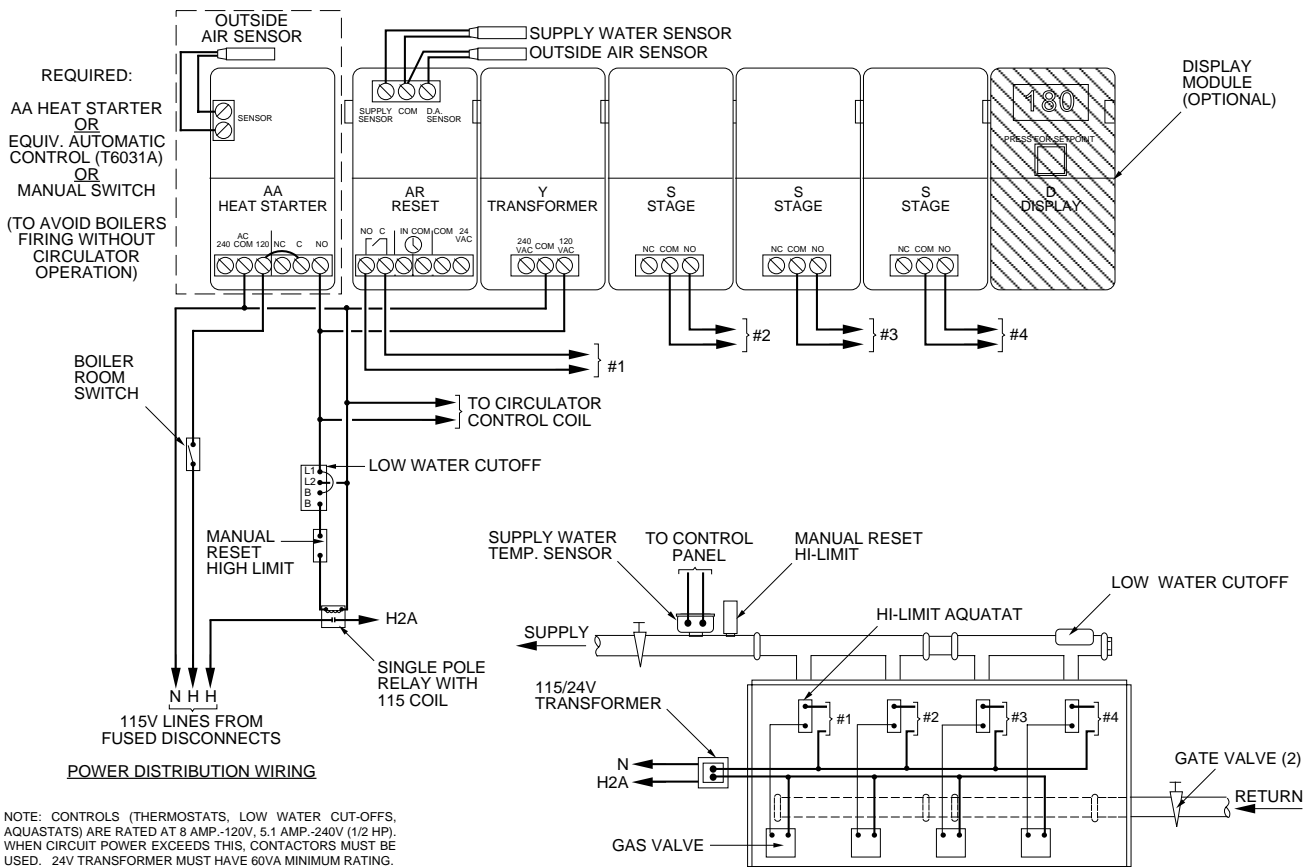


FIGURE C3: EXAMPLE OF LEVEL II CONTROL FOR SPACE HEATING ONLY

When outdoor temperature falls below setting of heat starter module, transformer and circulator circuits are energized. Reset module regulates supply water temperature in relation to outdoor temperature. Individual stage modules turn on more boiler modules as the outdoor temperature falls below their settings.

NOTE: CONTROLS (THERMOSTATS, LOW WATER CUT-OFFS, AQUASTATS) ARE RATED AT 8 AMP-120V, 5.1 AMP-240V (1/2 HP). WHEN CIRCUIT POWER EXCEEDS THIS, CONTACTORS MUST BE USED. 24V TRANSFORMER MUST HAVE 60VA MINIMUM RATING.

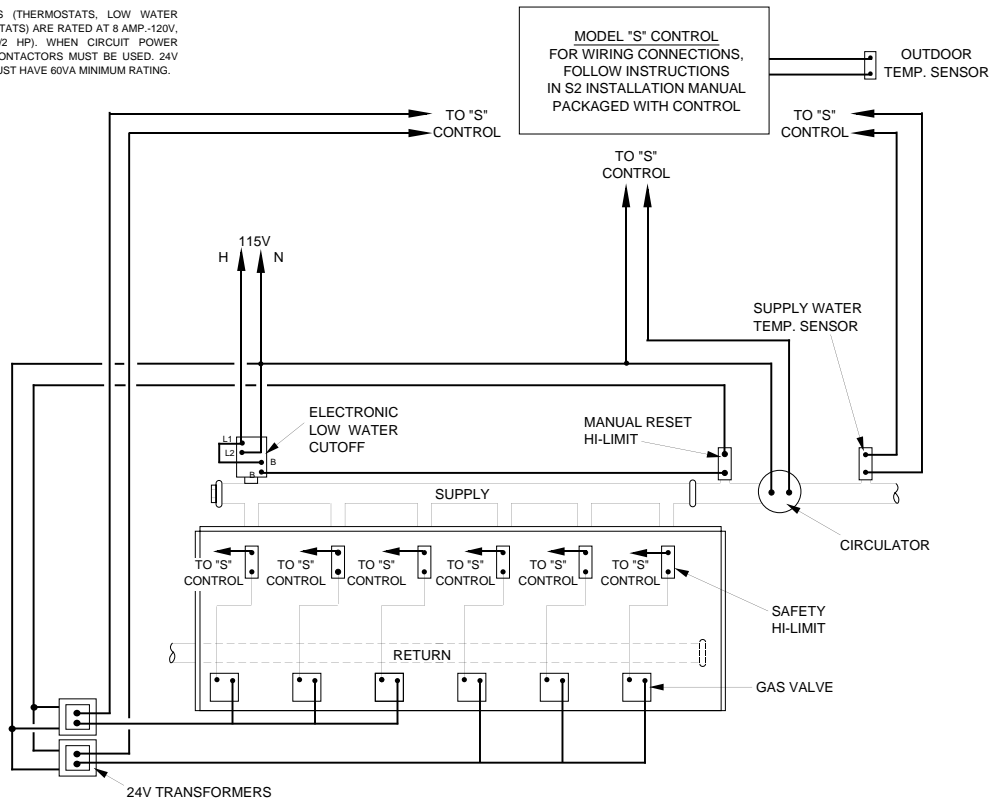


FIGURE C4: EXAMPLE OF LEVEL III CONTROL WITH MODEL "S" CONTROL FOR SPACE HEATING ONLY

When outdoor temperature falls below setting of outdoor temperature sensor, the circulator and Model "S" control circuits are energized. The Model "S" control will begin to fire boiler modules until sufficient temperature is present at the supply water temperature sensor to meet the demands of the Model "S" control. As the outdoor air temperature (as detected by the outdoor temperature sensor) decreases, the Model "S" control again causes modules to fire, until a higher supply water temperature is reached.

NOTE: CONTROLS (THERMOSTATS, LOW WATER CUT-OFFS, AQUASTATS) ARE RATED AT 8 AMP-120V, 5.1 AMP-240V (1/2 HP). WHEN CIRCUIT POWER EXCEEDS THIS, CONTACTORS MUST BE USED. 24V TRANSFORMER MUST HAVE 60VA MINIMUM RATING.

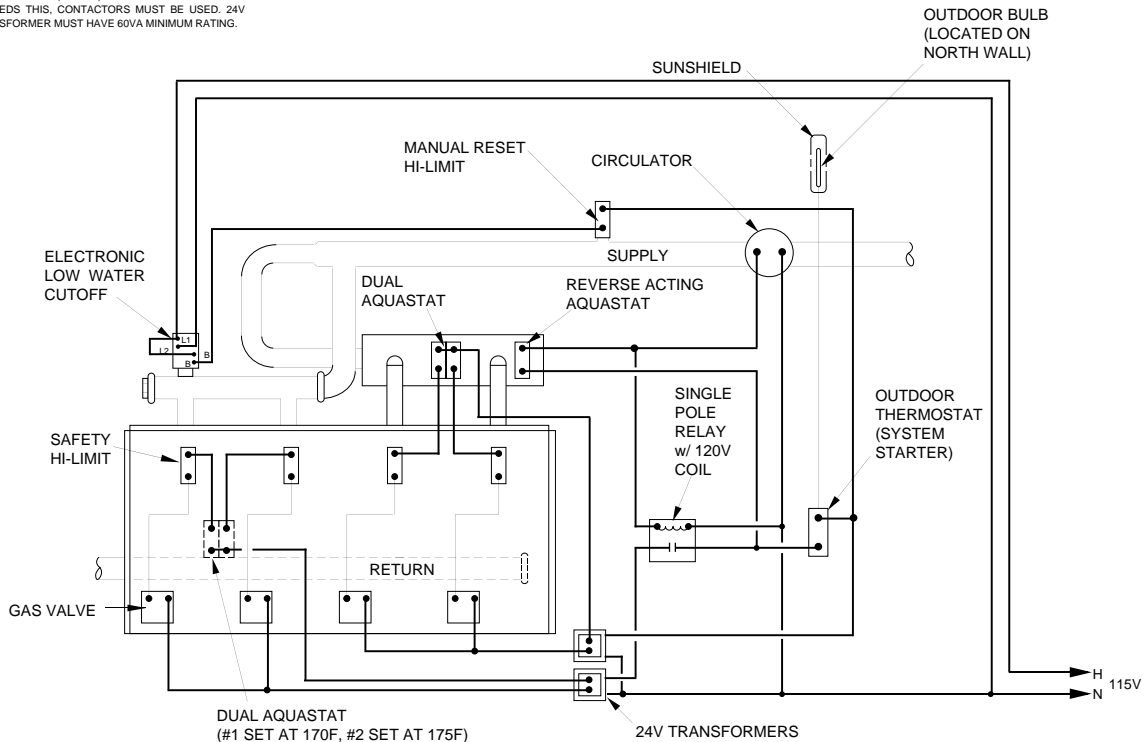


FIGURE C5: EXAMPLE OF LEVEL I CONTROL FOR COMBINATION SPACE & SERVICE WATER HEATING

Two modules maintain service hot water by dual modulating aquastat mounted in heat exchanger for year-round operation. When outdoor temperature drops below its setting, outdoor thermostat energizes system circulator and remaining two modules to provide heat to heating system. If water temperature in the heat exchanger drops below a pre-set minimum, reverse acting aquastat cuts out circulator until temperature rises above minimum. Single pole relay ensures that heating system boilers do not fire without circulator being energized.

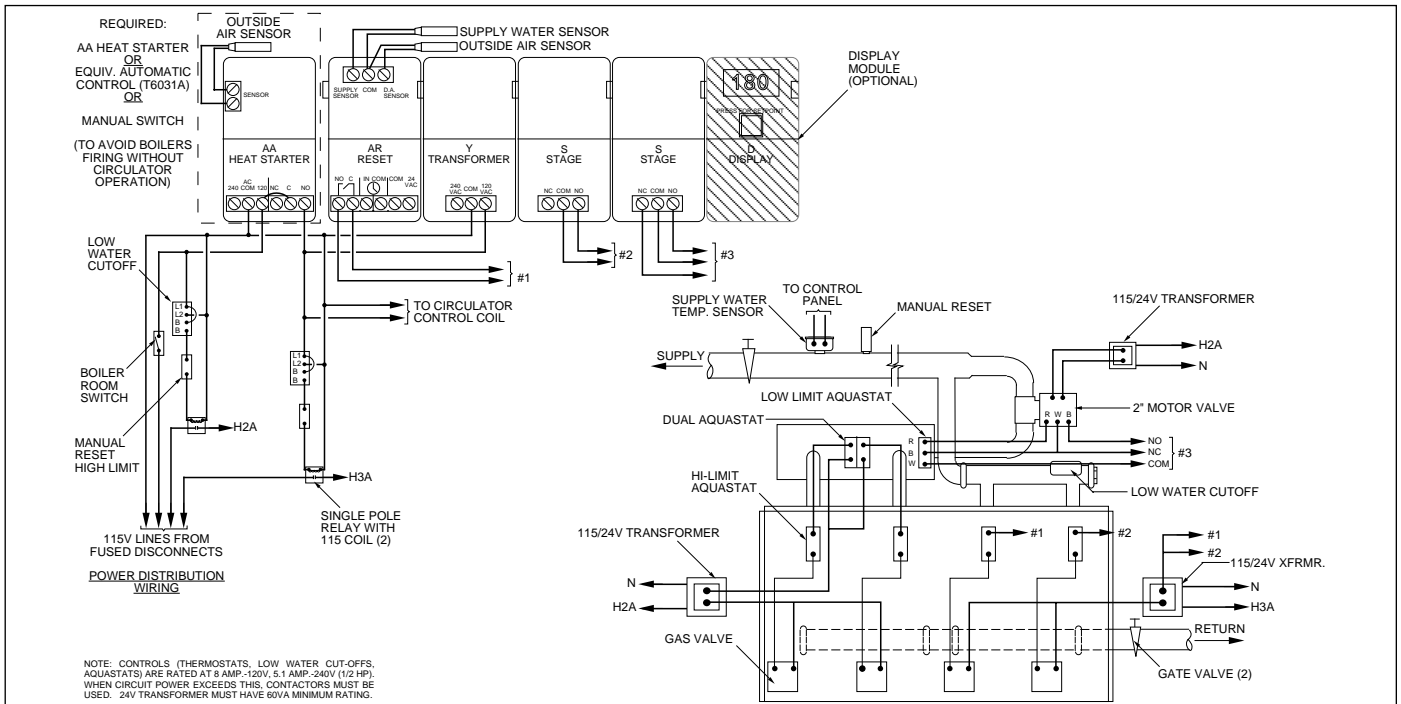


FIGURE C7: EXAMPLE OF LEVEL II CONTROL FOR COMBINATION SPACE AND SERVICE WATER HEATING

Two modules maintain domestic hot water by modulating aquastats mounted in the heat exchanger for year-round operation. When the outdoor temperature falls below the setting of the heat starter module, the circulator and transformer circuits are energized. The reset module will fire the first module to maintain the supply water temperature according to the setting of the control. As the outdoor temperature decreases below the setting of the stage modules, the reset module will fire both modules. As the outdoor temperature decreases below the setting of the last stage module, the motorized valve will open, allowing the domestic hot water modules to contribute to space heating. If the water temperature in the heat exchanger falls below the setting of the low limit aquastat, the motor valve will close, retaining all the capacity in the heat exchanger for domestic hot water.

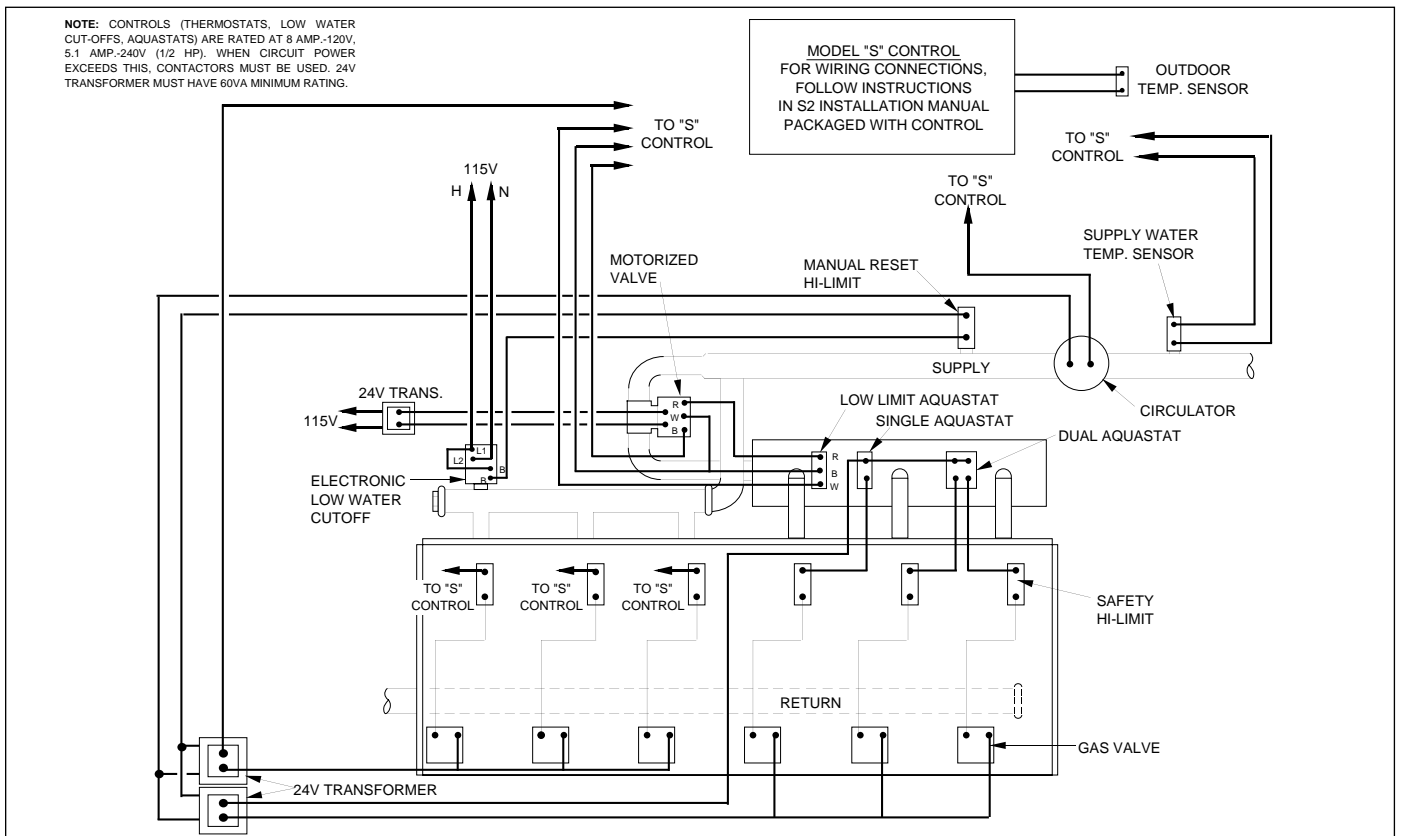
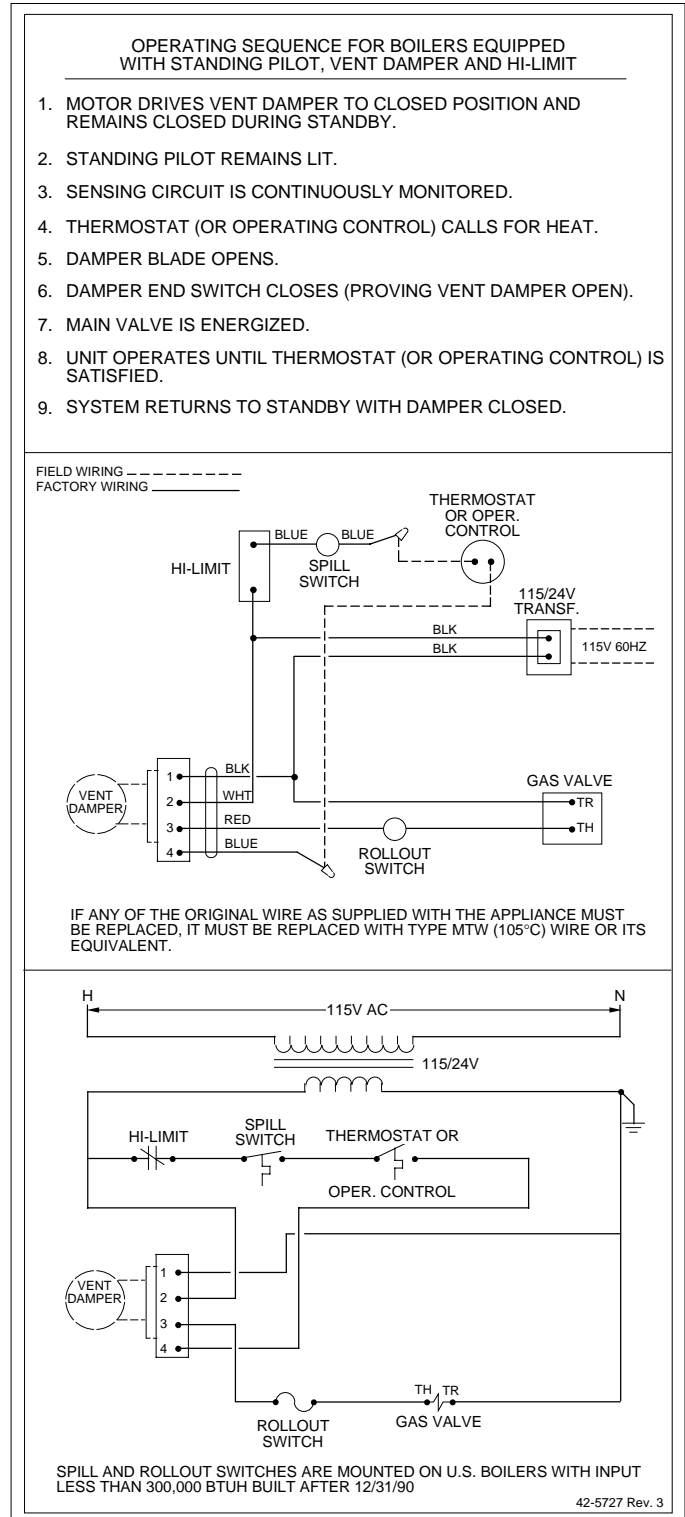


FIGURE C7: EXAMPLE OF LEVEL III CONTROL FOR COMBINATION SPACE & SERVICE WATER HEATING

Three modules maintain domestic hot water by modulating aquastats mounted in the heat exchanger for year-round operation. When outdoor temperature falls below the setting of the outdoor temperature sensor, the circulator and Model "S" control circuits are energized. The Model "S" control will begin to step fire modules until sufficient water temperature is present at the supply water temperature sensor to meet the demand of the Model "S" control. When the heating load is great enough to operate Step 8 of the Model "S" control, the motorized valve will open, allowing the domestic hot water modules to contribute to the space heating. If the water temperature in the heat exchanger falls below the setting of the low limit aquastat, the motorized valve will close, retaining all of the capacity of the heat exchanger for domestic hot water.

APPENDIX D: FIELD INSTALLATION OF VENT DAMPER ON MR BOILER WITH STANDING PILOT USING KIT BM-9168

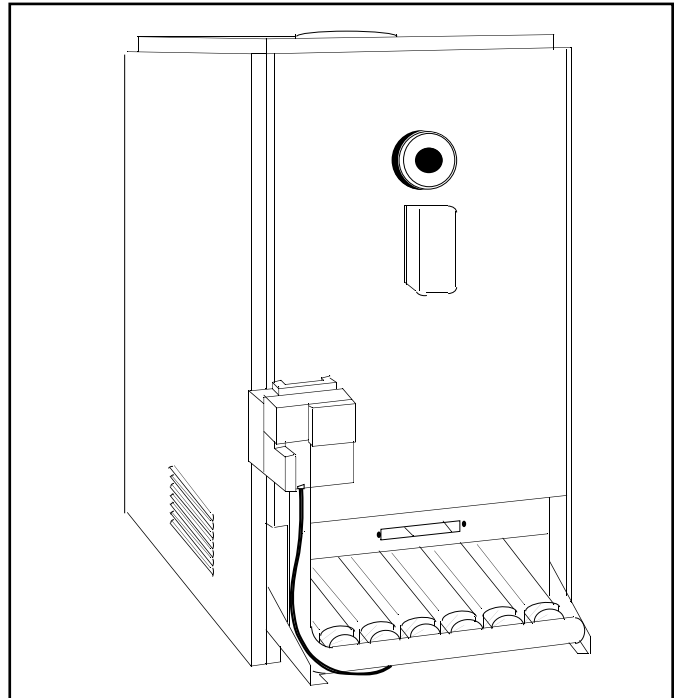
1. Install vent damper per page 12.
2. To wire the vent damper to each module do the following:
 - a. Remove wiring harness from BM-9168 kit.
 - b. Connect the red wire to the gas control terminal "TH".
 - c. Connect the black wire with the flag terminal to the gas control terminal "TR".
 - d. Connect the white wire with fork terminal to the bottom terminal on the Hi Limit.
 - e. Connect the white wire with stripped end to the 24V side of the 115V/24 transformer.
 - f. Connect the lack wire with stripped end to the 24V side of the 115V/24 transformer.
 - g. Connect the blue wire to thermostat or operating control.
 - h. Connect thermostat or operating control to unused terminal on Hi Limit.
 - i. Connect the vent damper with wiring harness provided with vent damper by plugging the one end inside the damper motor and the other end into the Molex receptacle on the wiring harness provided with this kit.
3. Repeat above instructions for each module. Note that each module will need its own vent damper and wiring kit BM-9168.
4. To fire unit, follow heating plant start up procedure in Section 8 on page 19.



MODEL R SERIES REPLACEMENT PARTS LIST

ORDERING INFORMATION

when ordering replacement parts, provide the model and serial number shown on the unit rating plate as well as the part number and name as shown in the parts list. Parts may be obtained from your local Hydrotherm heating contractor.



| REF NO. | NAME OF PART | PART NO. | NUMBER REQUIRED PER BOILER | | | |
|---------|-------------------------------------|----------|----------------------------|--------|--------|--------|
| | | | R-180C | R-210C | R-250C | R-300B |
| 1 | Absorption Unit | BM-3105 | 1 | 1 | | |
| | Absorption Unit | BM-3106 | | | 1 | 1 |
| 2 | Section, Base | BM-9686 | 1 | 1 | 1 | 1 |
| 3 | Section, Middle | BM-9689 | 2 | 2 | 3 | 3 |
| | Section, Middle (1/2" Tap) | BM-9690 | 1 | 1 | 1 | 1 |
| 4 | Section, Top | BM-9691 | 1 | 1 | | 1 |
| | Section, Top | BM-9692 | | | 1 | |
| 5 | Push Nipple | 53-1373 | 4 | 4 | 5 | 5 |
| 6 | Tie Rod - 5/16X16 1/2" with N. & W. | 44-1116 | 2 | 2 | | |
| | Tie Rod - 5/16X20" with N.& W. | 44-1105 | | | 2 | 2 |
| 7 | Base Side Plate - L.H. - Insulated | BM-3333 | 1 | 1 | 1 | 1 |
| 8 | Base Side Plate - R.H. - Insulated | BM-3334 | 1 | 1 | 1 | 1 |
| 9 | Front Tie Bar | 03-3024 | 1 | 1 | 1 | 1 |
| 10 | Rear Tie Plate - Insulated | BM-3335 | 1 | 1 | 1 | 1 |
| 11 | Base Door - Insulated | BM-3336 | 1 | 1 | 1 | 1 |
| 12 | Bracket, Manifold - L.H. | 55-1606 | 1 | 1 | 1 | 1 |
| 13 | Bracket, Manifold - R.H. | 55-1607 | 1 | 1 | 1 | 1 |
| 14 | Bracket, Burner | 55-1030 | 1 | 1 | | |
| | Bracket, Burner | 55-1031 | | | 1 | 1 |
| 15 | Reflector Shield | 03-3219 | 1 | 1 | 1 | 1 |
| 16 | Burner | 03-7114 | 5 | 5 | 6 | 6 |
| | Burner w/Pilot Bracket | 03-7118 | 1 | 1 | 1 | 1 |

| REF NO. | NAME OF PART | PART NO. | NUMBER REQUIRED PER BOILER | | | |
|---------|--|------------|----------------------------|--------|--------|--------|
| | | | R-180C | R-210C | R-250C | R-300B |
| 17 | Burner Orifice #39 (Nat.) (MR only) | 25-1121 | 6 | 6 | 7 | 7 |
| | Burner Orifice #35 (Nat.) (MR only) | 25-1130 | | | | |
| | Burner Orifice #31 (Nat.) (MR only) | 25-1118 | | | | |
| | Burner Orifice # 52 (Prop.) (MR only) | 25-1129 | | | | |
| | Burner Orifice # 51 (Prop.) (MR only) | 25-1124 | | | | |
| | Burner Orifice # 49 (Prop.) (MR only) | 25-1127 | | | | |
| 18 | Manifold | 24-1109 | 1 | 1 | | |
| | Manifold | 24-1110 | | | 1 | 1 |
| 19 | Pilot Ass'y-Nat.Q314A w/Q309A&BCR18 | BM-8072 | 1 | 1 | 1 | 1 |
| | Pilot Ass'y-Prop.Q314A w/Q309A&BBR10 | BM-8073 | 1 | 1 | 1 | 1 |
| 20 | Pilot Orifice - Nat. (BCR18) | 62-3326 | 1 | 1 | 1 | 1 |
| | Pilot Orifice - Prop. (BBR10) | 62-3327 | 1 | 1 | 1 | 1 |
| 22 | Thermocouple - (KR-16R) | 04-1336 | 1 | 1 | 1 | 1 |
| 23 | Pilot Line with Fittings | BM-3318 | 1 | 1 | 1 | 1 |
| 24 | Gas Valve - Nat. VR8300C 4043 | 02-1552 | 1 | 1 | 1 | 1 |
| | Gas Valve - Prop. VR8300C 4035 | 02-1553 | 1 | 1 | 1 | 1 |
| 25 | Hi-Limit Aquastat-L4006A | BM-4897 | 1 | 1 | 1 | 1 |
| | Aquastat Relay-L8148E | 02-2406 | 1 | 1 | 1 | 1 |
| 26 | Well - 1/2" | 02-3413 | 1 | 1 | 1 | 1 |
| 27 | Temp./Press. Indicator (For 30 # R.V.) | 20-1014 | 1 | 1 | 1 | 1 |
| | T/P Indicator (for 30 # R.V.) MR Only | 20-1015 | 1 | 1 | 1 | 1 |
| | Temp./Press. Indicator (For 50 # R.V.) | 20-1003 | 1 | 1 | 1 | 1 |
| | Temp./Press. Indicator (For 75/100 # R.V.) | 20-1011 | 1 | 1 | 1 | 1 |
| 29 | Grid Ass'y. | BM-9614 | 1 | 1 | 1 | 1 |
| | Grid Ass'y. | BM-9615 | | | | |
| | Grid Ass'y. | BM-9616 | | | | |
| | Grid | 03-2206.1 | | | | |
| 30 | Dome - 7" | 01-2104 | 1 | 1 | | |
| | Dome - 7" | 01-2106 | | | 1 | |
| | Dome - 8" | 01-2105 | | | | 1 |
| 31 | Bracket, Dome | 55-3800 | 2 | 2 | 2 | 2 |
| 32 | Draft Hood - 7" | 03-8144 | 1 | 1 | 1 | 1 |
| | Draft Hood - 7" | 03-8143 | | | | |
| | Draft Hood - 8" | 03-7609 | | | | |
| 33 | Nipple - 3/4" X 9 " | 53-1133 | 1 | 1 | 1 | 1 |
| | Nipple - 3/4" X 11" | 53-1135 | | | | |
| 34 | Coupling - 3/4" | 56-5001 | 1 | 1 | 1 | 1 |
| 35 | Press. Relief Valve - 30 PSI | 22-1203 | 1 | 1 | 1 | 1 |
| | Press. Relief Valve - 50 PSI | 22-1200 | 1 | 1 | 1 | 1 |
| | Press. Relief Valve - 75 PSI | 22-1803 | 1 | 1 | 1 | 1 |
| | Press. Relief Valve - 100 PSI | 22-1201 | 1 | 1 | 1 | 1 |
| 36 | Transformer - 115/24V, 20VA | 26-3005 | 1 | 1 | 1 | 1 |
| | Transformer - 75 VA | 26-3200 | | | | |
| 37 | Junction Box - 24V | 58-1800 | 1 | 1 | 1 | 1 |
| 38 | Side Panel - Jacket | 03-1060.1S | 2 | 2 | 2 | 2 |
| 39 | Front Panel - Jacket | 03-1033S | 1 | 1 | 1 | 1 |
| 40 | Rear Panel - Jacket | 03-1034S | 1 | 1 | 1 | 1 |
| 41 | Top Panel - L.H. - Jacket | 03-1060.4S | 1 | 1 | 1 | 1 |
| 42 | Top Panel - R.H. - Jacket | 03-1060.6S | 1 | 1 | 1 | 1 |
| - | Jacket Ass'y (Less Front Panel) | 03-1032S | 1 | 1 | 1 | 1 |
| - | Cope Seal (5 Ft. required) | 10-6625S | 5 | 5 | 6 | 6 |

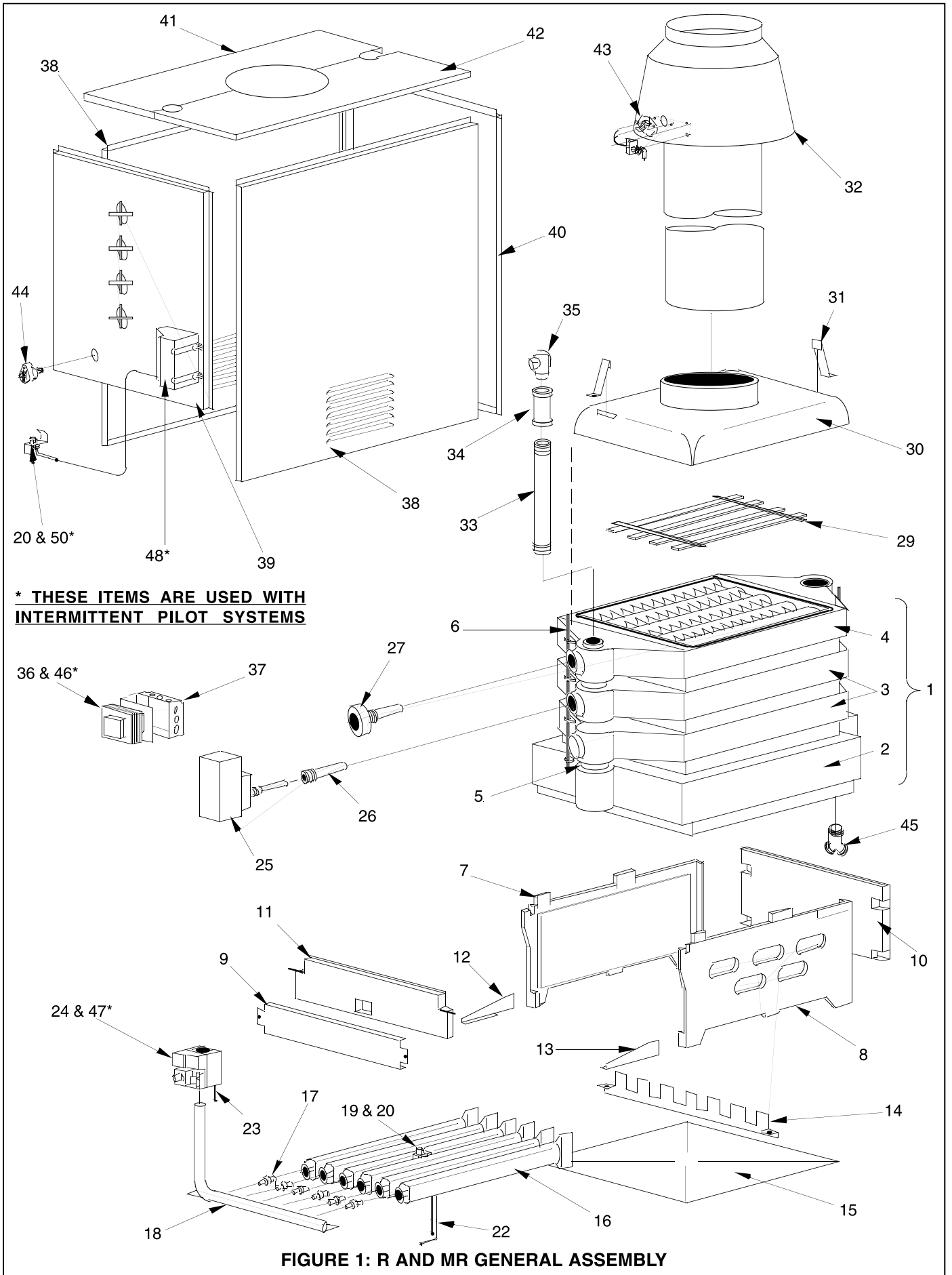


FIGURE 1: R AND MR GENERAL ASSEMBLY

| REF. NO | NAME OF PART | PART NO. | NUMBER REQUIRED PER BOILER | | | |
|---------|--------------|----------|----------------------------|--------|--------|--------|
| | | | R-180C | R-210C | R-250C | R-300B |
| 45 | Drain Cock | 51-1201 | 1 | 1 | 1 | 1 |

MULTI-TEMP JACKET PARTS LIST

| NAME OF PART | "A" BATTERY (2 MODULES) | | "B" BATTERY (3 MODULES) | |
|--------------------|-------------------------|-----------|-------------------------|-----------|
| | PART NO. | NO. REQ'D | PART NO. | NO. REQ'D |
| Jacket - Complete | BM-9112S | 1 | BM-9113S | 1 |
| Side Panel | 03-1060.1S | 2 | 03-1060.1S | 2 |
| Front Panel | 03-1060.2S | 1 | 03-1061.2S | 1 |
| Rear Panel | 03-1060.3S | 1 | 03-1061.3S | 1 |
| Top Panel L.H. | 03-1060.4S | 1 | 03-1060.4S | 1 |
| Top Panel - Center | 03-1060.5S | 1 | 03-1060.5S | 2 |
| Top Panel - R.H. | 03-1060.6S | 1 | 03-1060.6S | 1 |
| Stiffening Channel | 03-1060.7S | 2 | 03-1060.7S | 3 |

ADDITIONAL COMPONENTS FOR VENT DAMPER (For use with Intermittent Pilot Only)

| REF NO. | NAME OF PART | PART NO. | NUMBER REQUIRED PER BOILER | | | |
|---------|----------------|----------|----------------------------|--------|--------|--------|
| | | | R-180C | R-210C | R-250C | R-300B |
| - | Vent Damper 7" | 02-5854 | 1 | 1 | 1 | |
| - | Vent Damper 8" | 02-5855 | | | | 1 |
| - | Cable Bracket | 03-7144 | 1 | 1 | 1 | 1 |

PARTS FOR HONEYWELL INTERMITTENT PILOT SYSTEM (SEE FIGURE 1)

| REF NO. | NAME OF PART | PART NO. | NUMBER REQUIRED PER BOILER | | | |
|---------|----------------------------------|----------|----------------------------|--------|--------|--------|
| | | | R-180C | R-210C | R-250C | R-300B |
| 46 | Transformer - 40VA | 26-3001 | 1 | 1 | 1 | 1 |
| 47 | Gas Valve-24V Nat. VR8304P 4332 | 02-1554 | 1 | 1 | 1 | 1 |
| | Gas Valve-24V Prop. VR8304P 4330 | 02-1555 | 1 | 1 | 1 | 1 |
| 48 | Pilot Control - S8600F (Nat.) | BM-8142 | 1 | 1 | 1 | 1 |
| | Pilot Control - S8600M (Prop.) | BM-8143 | 1 | 1 | 1 | 1 |
| 50 | Igniter Sensor - Q3451B-1103 | 62-3668 | 1 | 1 | 1 | 1 |

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