

# 850 Piping

## (From Manual)

- b. Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 in.<sup>2</sup> per 2,000 BTUH (1,100 mm<sup>2</sup> per kW) of total input rating of all equipment in the enclosure.
2. **One permanent opening**, commencing within 12 in. (305 mm) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 in. (25 mm) from the sides and back and 6 in. (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors, and shall have a minimum free area of:
- a. 1 in.<sup>2</sup> per 3,000 BTUH (740 mm<sup>2</sup> per kW) of the total input rating of all equipment located in the enclosure, and
- b. Not less than the sum of the areas of all vent connectors in the confined space.

**WARNING:** Do not use the “one permanent opening” method if the equipment room is under negative pressure conditions.

## Canadian Installations

**CAUTION:** All combustion air must be drawn from the air outside of the building; the mechanical equipment room must communicate directly with the outdoors.

1. Ventilation of the space occupied by the heater shall be provided by an opening(s) for ventilation air at the highest practical point communicating with the outdoors. The total cross-sectional area of such an opening(s) shall be at least 10% of the area required in 2. and 3. (below), but in no case shall the cross-sectional area be less than 10 in.<sup>2</sup> (65 cm<sup>2</sup>).
2. For heaters using a barometric damper in the vent system, there shall be a permanent air supply opening(s) having a cross section area of not less than 1 in.<sup>2</sup> per 7,000 BTUH (320 mm<sup>2</sup> per kW) up to and including 1 million BTUH, plus 1 in.<sup>2</sup> per 14,000 BTUH (160 mm<sup>2</sup> per kW) in excess of 1 million BTUH. This opening(s) shall be either located at or ducted to a point not more than 18 in. (450 mm) nor less than 6 in. (152 mm) above the floor level. The duct can also “goose neck” through the roof. The duct is preferred to be straight down

and terminated 18 in. (450 mm) from the floor, but not near piping. This air supply opening requirement shall be in addition to the air opening for ventilation air required in 1. (above).

**WARNING:** Care must be taken to ensure that the equipment room is not under negative pressure conditions.

3. For heaters when air supply is provided by natural air flow from outdoors for a power burner and there is no draft regulator, drafthood or similar flue gas dilution device installed in the same space, in addition to the opening for ventilation air required in 1., there shall be a permanent air supply opening(s) having a total cross-sectional area of not less than 1 in.<sup>2</sup> for each 30,000 BTUH (74 mm<sup>2</sup> per kW) of total rated input of the burner(s), and the location of the opening(s) shall not interfere with the intended purpose of the opening(s) for ventilation air referred to in 1. This opening(s) can be ducted to a point not more than 18 in. (450 mm) nor less than 6 in. (152 mm) above the floor level. The duct can also “goose neck” through the roof. The duct is preferred to be straight down 18 in. (450 mm) from the floor, but not near piping.
4. Refer to the B149 Installation Code for additional information.

## Water Piping

### General

The heater should be located so that any water leaks will not cause damage to the adjacent area or structures.

**CAUTION:** This boiler requires forced water circulation when the burner is operating. See Table G and Table H for minimum and maximum flow rates and water pump selection. The pump must be interlocked with the boiler to prevent heater operation without water circulation.

**NOTE:** Minimum pipe size for in/out connections is 1-1/2” NPT for model 300 and 2” NPT for models 400, 500, 700 and 850. Verify proper flow rates and ΔT as instructed in this manual.

**NOTE:** The continuous inlet water temperature must be no less than 50°F.

---

## Relief Valve Installation and Piping

**WARNING:** Pressure relief valve discharge piping must be piped near the floor and close to a drain to eliminate the potential of severe burns. Do not pipe to any area where freezing could occur. Refer to local codes.

The heater is supplied with a Section IV “HV” stamped relief valve sized for the full input of the unit. The relief valve assembly is shipped loose and must be mounted directly to the heater outlet. No valve shall be installed between the heater and the relief valve. The relief valve shall be mounted with its spindle vertical (see Fig. 1, 2 and 3 on page 6). Relief valve discharge piping shall provide no less than the cross sectional area of the relief valve outlet and must be routed to a safe point of discharge. Installation must comply with all national, state and local codes.

**WARNING:** The pressure relief valve must be installed at the outlet of the boiler. No valve is permitted to be installed between the boiler and the relief valve.

## Temperature & Pressure Gauge

The temperature and pressure gauge is shipped loose for field installation and must be installed within 12 inches of the boiler outlet (if possible) in an easily readable location. Installation must comply with ASME Section IV as well as all applicable national, state and local codes.

## Hydrostatic Test

Unlike many types of heaters, this heater does not require hydrostatic testing prior to being placed in operation. The heat exchanger has already been factory-tested and is rated for 160 psi operating pressure. However, Raypak does recommend hydrostatic testing of the piping connections to the heater and the rest of the system prior to operation. This is particularly true for hydronic systems using expensive glycol-based anti-freeze. Raypak recommends conducting the hydrostatic test before connecting gas piping or electrical supply.

Leaks must be repaired at once to prevent damage to the heater. NEVER use petroleum-based stop-leak compounds.

To perform hydrostatic test:

1. Connect fill water supply. With bleed valve open, fill heater with water. When water flows from bleed valve, shut off water. Close bleed valve. Carefully fill the rest of the system, making sure to eliminate any entrapped air by using high-point vents. Close feed valve. Test at standard operating pressure for at least 24 hours.
2. Make sure constant gauge pressure has been maintained throughout test.
3. Check for leaks. Repair if found.

## Hydronic Heating

### Pump Selection

In order to ensure proper performance of your heater system, you must install a correctly-sized pump. Raypak recommends designing for a  $\Delta T$  within the range of 20°F to 40°F (5°C to 20°C). See Table G for acceptable flow rates for each model ( $\Delta T$  is the temperature difference between the inlet and outlet water when the heater is firing at full rate).

### Feedwater Regulator

Raypak recommends that a feedwater regulator be installed and set at 12 psi minimum pressure at the highest point of the system. Install a check valve or back flow device upstream of the regulator, with a manual shut-off valve as required by local codes.

### Piping

All high points should be vented. A heater installed above radiation level must be provided with a low water cut-off device (sales order option F-10). This heater, when used in connection with a refrigeration system, must be installed so that the chilled medium is piped in parallel with the heater with appropriate valves to prevent the chilled medium from entering the heater.

The piping system of a hot water heater connected to heating coils located in air handling units where they may be exposed to circulating refrigerated air, must be equipped with flow control valves or other automatic means to prevent gravity circulation of the heater water during the cooling cycle. It is highly recommended that the piping be insulated.

## Air-Separation/Expansion Tank

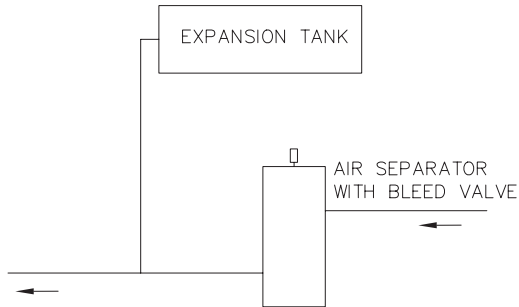
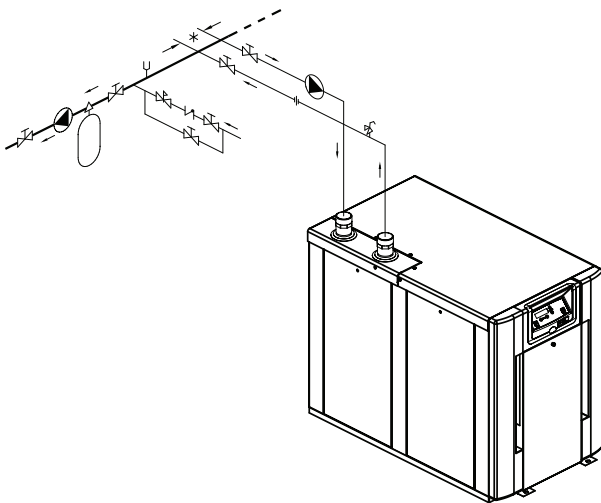


Fig. 6: Air-Separation/Expansion Tank

All heaters should be equipped with a properly sized expansion tank and air separator fitting as shown in Fig. 6 above.

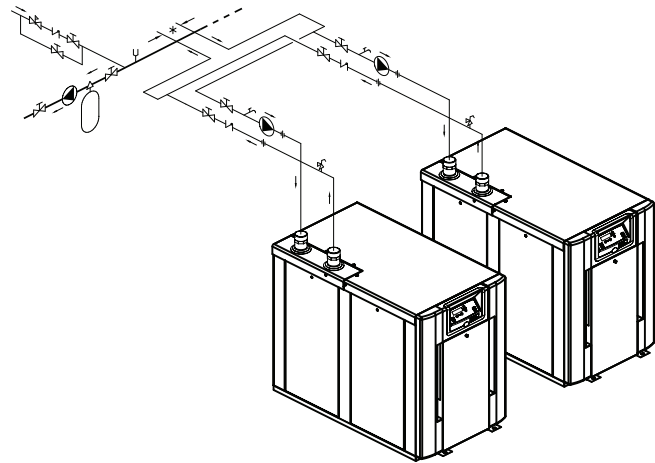
## Three-Way Valves

Three-way valves intended to regulate system water temperatures by reducing flow in the boiler should not be used. Raypak heaters are high-recovery, low-mass heaters which are not subject to thermal shock.



\*Maximum 4 times the pipe diameter or 12", whichever is less.

Fig. 7: Single Heater — Low-Temperature (Heat Pump) Application with Primary/Secondary Piping



\*Maximum 4 times the pipe diameter or 12", whichever is less.

Fig. 8: Dual Heaters (Reverse/Return) with Primary/Secondary Piping

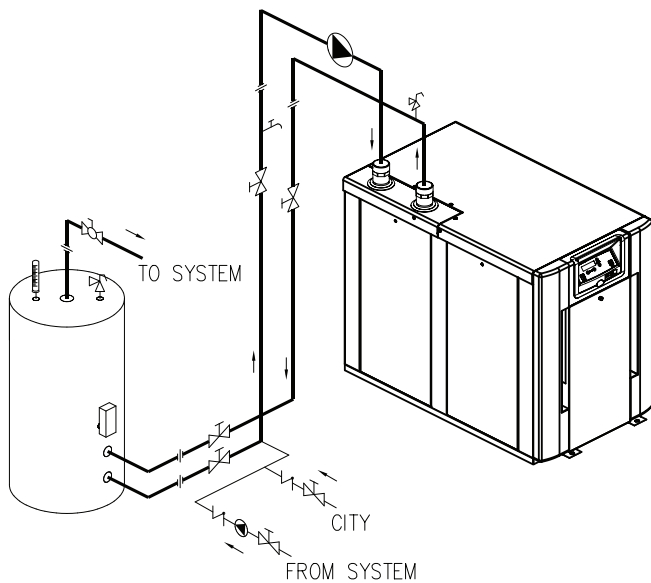
## Domestic Hot Water

When designing the water piping system for domestic hot water applications, water hardness should be considered. Table H indicates the suggested flow rates for soft and medium water. Hard water must be softened for direct heating with the XFyre. Water hardness is expressed in grains per gallon.

Model No.	20°F ΔT		30°F ΔT		40°F ΔT		Min. Flow			Max. Flow		
	gpm	ΔP (ft)	gpm	ΔP (ft)	gpm	ΔP (ft)	gpm	ΔP (ft)	ΔT	gpm	ΔP (ft)	ΔT
300	28	17	19	8	14	5	14	5	40	36	28	16
400	38	18	25	7	19	4	19	4	40	47	29	16
500	47	16	31	7	24	4	24	4	40	56	23	17
700	66	30	44	13	33	7	33	7	40	70	34	19
850	80	40	53	17	40	9	40	9	40	80	40	20

Notes: Basis for minimum flow is ΔT. Basis for maximum flow is gpm.

Table G: Heater Rates of Flow and Pressure Drops

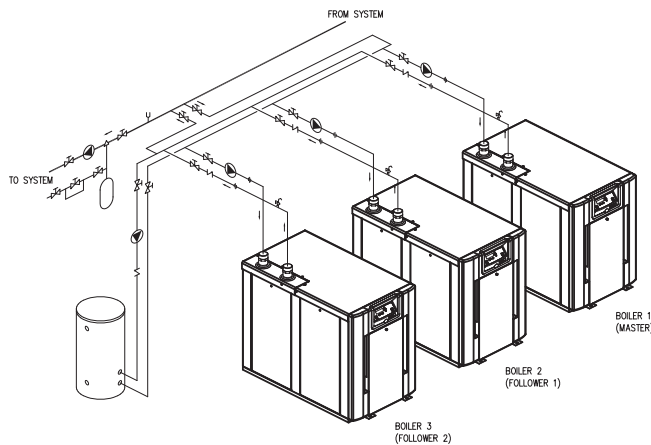


**Fig. 9: Single Domestic Hot Water Heater and Storage Tank**

**NOTE:** If local codes require a vacuum relief valve, acquire one locally and install per valve manufacturer's instructions.

## Potable Water and Space Heating

**CAUTION:** When this heater is used for both potable water and space heating, observe the following to ensure proper operation.



**Fig. 10: Multiple Boilers — Reverse Return, Primary/Secondary Piping with Indirect DHW**

1. All piping materials and components connected to the water heater for the space heating application shall be suitable for use with potable water.
2. Toxic chemicals, such as used for boiler treatment, shall not be introduced into the potable water used for space heating.
3. If the heater will be used to supply potable water, it shall not be connected to any heating system or components previously used with a non-potable water heating appliance.
4. When the system requires water for space heating at temperatures higher than 140°F (60°C), a means such as a mixing valve shall be installed to temper the water in order to reduce scald hazard potential.

Model No.	Soft (0–4 grains per gallon)					Medium (5–15 grains per gallon)				
	$\Delta T$	gpm	$\Delta P$	MTS	SHL	$\Delta T$	gpm	$\Delta P$	MTS	SHL
300	30	19	8	1-1/2	10	24	24	17	1-1/2	19
400	30	25	7	2	8	20	38	18	2	21
500	30	31	7	2	8	20	47	16	2	20
700	30	44	13	2	17	20	66	30	2	38
850	32	51	16	2	20	24	67	28	2	36

$\Delta T$  = Temperature rise, °F.

$\Delta P$  = Pressure drop through heat exchanger, ft.

SHL = System head loss, ft (based on heater and tank placed no more than 5 ft apart and equivalent length of 25 ft of tubing).

gpm = Gallons per minute, flow rate.

MTS = Minimum tubing size.

**CAUTION:** For scale free operation with Medium water (5–15 grains per gallon of total hardness), the operating control must NOT be set higher than 130°F. For higher than 130°F operation, or Hard water (>16 grains per gallon of total hardness), a water softener/treatment system must be utilized.

**Table H: Domestic Water Heater Flow Rate Requirements**

# W3-902 Piping (From Manual)

## SECTION D: WATER PIPING - GENERAL

The boiler should be located so that any water leaks will not cause damage to the adjacent area or structures.

**CAUTION:**

*This boiler requires forced water circulation when the burner is operating. See Table D-1 for minimum and maximum flow rates and water pump selection. The pump must be interlocked with the boiler to prevent boiler operation without water circulation.*

### RELIEF VALVE PIPING

**WARNING:**

*Pressure relief valve discharge piping must be piped near the floor close to a floor drain to eliminate the potential of severe burns. Do not pipe to any area where freezing could occur. Refer to local codes.*

### HYDROSTATIC TEST

Unlike many other types of boilers, Raypak boilers do not require hydrostatic testing prior to being placed in operation. The heat exchanger has already been factory-tested and is rated for 150 PSI operating pressure. However, Raypak does recommend hydrostatically testing the piping connections to the boiler and the rest of the system prior to operation. This is particularly true for hydronic systems using expensive glycol-based antifreeze. Raypak recommends conducting the hydrostatic test before connecting gas piping or electrical supply.

Leaks must be repaired at once to prevent damage to the boiler. NEVER use petroleum-based stop-leak compounds.

1. Connect fill water supply. Fill boiler with water (be sure bleed valve is open). When water flows from bleed valve, shut off water. Close bleed valve. Carefully fill the rest of the system, being sure to eliminate any entrapped air by using high point vents. Close feed valve. Test at standard operating pressure for at least 24 hours.
2. Make sure constant gauge pressure has been maintained throughout test.
3. Check for leaks. Repair if found.

### LOW TEMPERATURE SYSTEM

Boiler requires minimum inlet temperature of 105°F. Consult sections E, F for piping details.

### TEMPERATURE & PRESSURE GAUGE

The temperature and pressure gauge is factory-mounted in the inlet/outlet header.

## SECTION E: HYDRONIC HEATING PIPING

### PUMP SELECTION

In order to insure proper performance of your boiler system, you must install a properly sized pump. Raypak recommends using a 20°F Delta T as design Delta T. (Delta T is the temperature difference between the inlet and outlet water when the boiler is firing at full rate). If a Delta T larger than 20°F is necessary, see Table D-1 for minimum flow rate requirements.

### PRESSURE DROP IN FEET OF HEAD FEEDWATER REGULATOR

Raypak recommends that a feedwater regulator be installed and set at 12 PSIG minimum pressure at the highest point of system. Install a check valve or back flow device upstream of the regulator, with a manual shut off valve as required by local codes.

### PIPING - HEATING BOILERS

All high points should be vented. Purge valves and a bypass valve should be installed. A boiler installed above radiation level must be provided with a low water cutoff device. The boiler, when used in connection with a refrigeration system, must be installed so the chilled medium is piped in parallel with the boiler with appropriate valves to prevent the chilled medium from entering the boiler.

The boiler piping system of a hot water heating boiler connected to heating coils located in air handling units where they may be exposed to circulating refrigerated air, must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. It is highly recommended that the piping be insulated.

### AIR-SEPARATION/EXPANSION TANK

All boilers should be equipped with a properly sized expansion tank and air separator fitting as shown in the following diagrams.

### THREE-WAY VALVES

Valves designed to blend water temperatures or reduce water circulation through the boiler should not be used. Raypak heaters are high recovery low mass heaters not subject to thermal shock. Raypak offers a full line of electric sequencers that produce direct reset of boiler water temperature. Refer to the Controls Section in our Complete Catalog.

**Table E-1 BOILER RATE OF FLOW AND PRESSURE DROP**

Model	10°F ΔT		20°F ΔT		30°F ΔT		MIN FLOW			MAX FLOW		
	GPM	ΔP (ft)	GPM	ΔP (ft)	GPM	ΔP (ft)	GPM	ΔP (ft)	ΔT	GPM	ΔP (ft)	ΔT
302	51	3.2	25	<1.0	N/A	N/A	20	<1.0	25	90	9.8	6
402	68	5.4	34	1.45	22	<1.0	20	<1.0	34	90	10.0	7
502	85	9.2	42	2.30	28	1.05	21	<1.0	40	90	10.5	9
652	N/A	N/A	55	4.00	36	1.75	28	1.05	40	90	10.7	12
752	N/A	N/A	64	5.50	42	2.50	32	1.55	40	90	11.0	14
902	N/A	N/A	76	8.50	51	3.80	38	2.20	40	90	11.8	17

NOTE: Basis for Minimum flow -20 gpm or 40° ΔT  
Maximum flow -90 gpm.

Flow switch will not operate if flow is less than 20 gpm.



**SINGLE BOILER - LOW TEMPERATURE APPLICATION (HEAT PUMP) PRIMARY/SECONDARY PIPING**

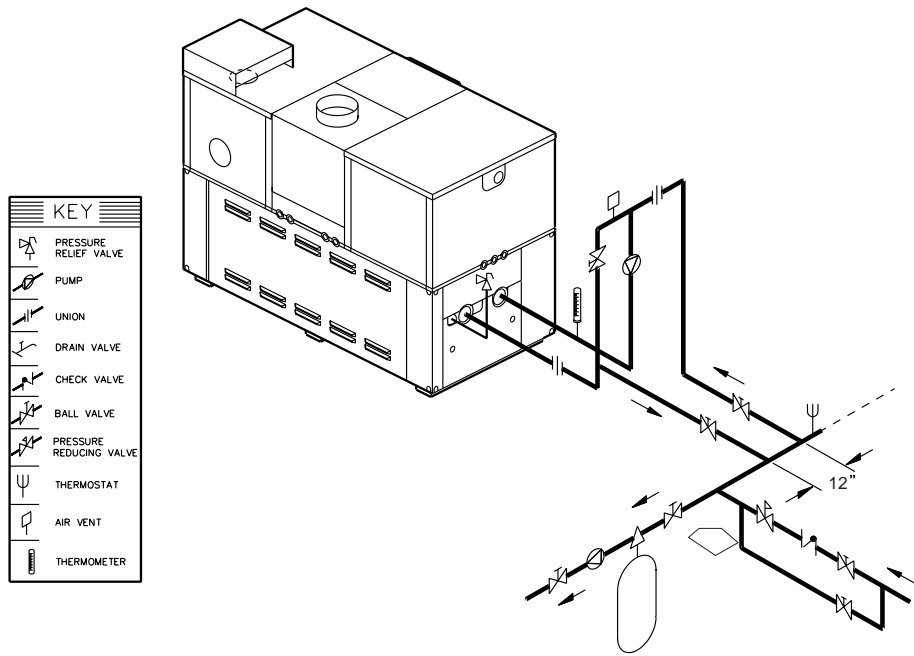


Fig. #9223

**DUAL BOILER PRIMARY/SECONDARY PIPING**

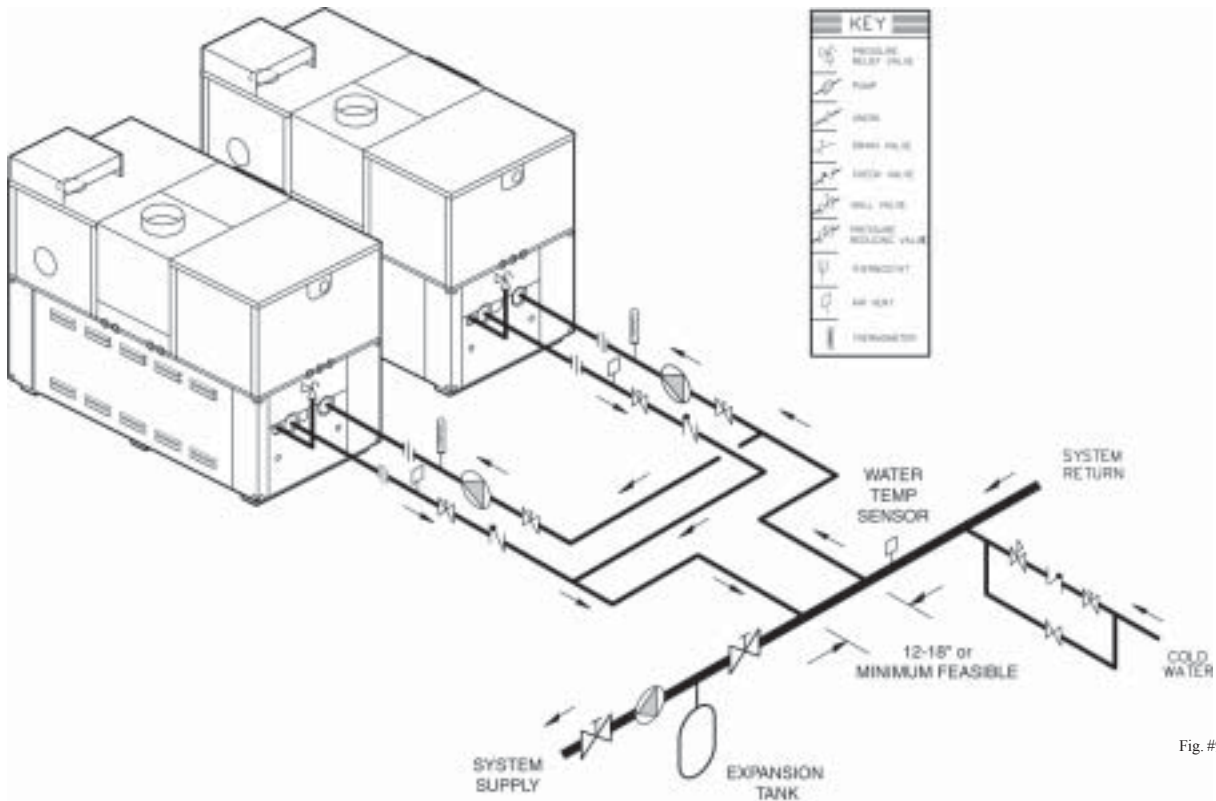


Fig. #9232.2

## SECTION F: DOMESTIC HOT WATER PIPING

When designing the water piping system for domestic water applications, water hardness should be considered. Table F-1 indicates the suggested flow rates for soft, medium and hard water. Hardness is specified as grains per gallon.

TABLE F-1  
DOMESTIC WATER HEATER  
FLOW RATE REQUIREMENTS

MODEL	SOFT					MEDIUM					HARD*				
	0-4 GRAINS PER GALLON					5-15 GRAINS PER GALLON					16 + OVER GRAINS PER GAL.				
	$\Delta T$	GPM	$\Delta P$	MPS	SHL	$\Delta T$	GPM	$\Delta P$	MPS	SHL	$\Delta T$	GPM	$\Delta P$	MPS	SHL
302	13	40	2.0	2	4.6	10	52	3.3	2	7.4	6	80	7.8	2	17.0
402	17	40	2.0	2	4.6	13	52	3.3	2	7.4	9	80	8.0	2	17.4
502	21	40	2.1	2	4.7	17	52	3.5	2	7.6	10	84	9.0	2	19.5
652	28	40	2.2	2	4.8	20	55	4.1	2	8.8	12	90	10.7	2	22.1
752	31	42	2.5	2	5.2	20	64	5.5	2	11.0	14	90	11.0	2	22.4
902	31	50	3.8	2	7.7	20	76	8.5	2	16.8	17	90	11.8	2	23.2

$\Delta T$  = Temperature rise, degrees F  
GPM = Gallons/minute, flow rate

$\Delta P$  = Pressure drop, ft, through heat exchanger  
MPS = Minimum pipe size, NPT

SHL = System head loss, ft.

System head loss based on heater and tank placed no more than 5 ft. apart and equivalent length pipe/fittings as follows:  
2" NPT = 75 ft.

\* Must use optional cupronickel tubes.

### POTABLE WATER AND SPACE HEATING APPLICATION

**CAUTION:** *When this heater is used for both -potable water and space heating- follow the steps below to insure proper operation.*

- A. All piping materials and components connected to the water heater for the space heating application shall be suitable for use with potable water.
- B. Toxic chemicals, such as used for boiler treatment, shall not be introduced into the potable water used for space heating.
- C. If the water heater will be used to supply potable water, it shall not be connected to any heating system or components previously used with a nonpotable water heating appliance.
- D. When the system requires water for space heating at temperatures higher than 140°F, a means such as a mixing valve shall be installed to temper the water in order to reduce scald hazard potential.

### SINGLE DOMESTIC HOT WATER HEATER WITH ONE STORAGE TANK

